COMMISSION J: Radio Astronomy (November 2004 – October 2007)

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J1 Overview of Japanese radio astronomy activity

Japan is one of major activity countries for radio astronomy. Especially, Japan became a major partner of ALMA project, which is a millimeter and submillimeter large array with 80 telescopes at Atacama Desert of Chili. Japan shares quarter burden for the construction and operation. In concrete terms, Japan has constructed ACA (Atacama Compact Array), which consists of four 12-m telescopes and twelve 7-m telescopes, and 3 band receiver cartridges for whole ALMA telescopes. At the field of VLBI researches, VERA (VLBI Exploration of Radio Astrometry) became operation phase and measured the most distant celestial objects by using trigonometric parallax measurement technique. Nobeyama 45-m millimeter telescope and millimeter array were used for open use observations. Nobeyama 45-m telescope has 25-beam observation facilities and made good CO molecule emission maps of neighborhood galaxies. And ASTE telescope, which is a 10-m submillimeter telescope at Atacama Desert, became operational phase. And NANTEN telescope, which is a 4-m submillimeter telescope at Chili, has made wide field mapping observations of southern hemisphere sky. And Japanese VLBI network observations have restarted under the collaborations with related universities and institutes, which makes around 10 station VLBI network observations with centimeter wavelength. It will be expanded for East Asia VLBI network with Korea and China. On September 2007, SELENE satellite was launched, which is a lunar probe vehicle. In order to make precise hypsographic map and gravity map of whole lunar globe, Japanese VLBI network has used for the satellite tracking.

J2 Observatory report

J2.1 National Astronomical Observatory of Japan (NAOJ)
J2.1.1 Nobeyama Radio Observatory
With continuing the open use of 45-m telescope, NMA (Nobeyama Millimeter Array), and RAINBOW (the combined interferometer of NMA and the 45-m telescope) and also supporting the ALMA construction, we mainly achieved the following. First, we started the science operation of ASTE (Atacama Submillimeter Telescope Experiment) 10-m telescope in Chile and its open use (limited to the inside of Japanese astronomical community). Secondly, we achieved very high quality wide-field imaging with the 45-m telescope by combining of 25 beam receiver (BEARS) at 3mm and OTF (on-the-fly) mapping technique. In terms of scientific output, there are several distinctive research achievements; 1) we published CO atlas of galaxies with the 45-m telescope, 2) a brand-new method to diagnose nuclear energy sources was proposed based on NMA/RAINBOW observations, 3) the intensive study of star-formation in galaxies was performed with jointly using the 45-m telescope and ASTE, and 4) intensive and extensive millimeter galaxy (forming massive galaxy) survey and dense core to proto-planetary disk survey were successfully performed with the bolometer camera at 1.1 mm, AzTEC from U.Mass, on ASTE. The key roles of the Nobeyama Radio Observatory in the course of the next four or five years (that is, the construction phase of ALMA) are the further promotion of millimeter and submillimeter astronomy toward ALMA-era. For that purpose, the open use of NRO 45-m telescope and ASTE is planned to be continued as well as performing legacy/key science projects with the best use of synergy by the complementary telescopes, the 45-m telescope and ASTE. In addition, the upgrade of existing instruments and the developments of new instruments are planed for performing cutting edge science as much as possible towards the ALMA era; e.g., the development of new receiver and spectrometer for the 45-m telescope, and new continuum camera for ASTE. NMA could help the science projects very much, if the follow-up observations with high spatial resolutions are desirable and NMA can be continued to be operational.

J2.1.2 Mizusawa VERA observatory

Mizusawa VERA observatory is carrying out VERA project and Japanese VLBI network project. And as a research project, we have the optical fiber linked VLBI experiment.   VERA project aims to make the 3-D map of the galaxy and reveal the kinematic field of the Galaxy.   We suppose it will show the distribution of mass in the Galaxy, especially the distribution of the dark matter.   In order to make precise astrometry measurements, VERA is equipped with 2-beam observation system for the complete phase referencing VLBI observations.   It can simultaneously observe two objects within 2.2 degree separations.   VERA aims trigonometric parallax measurements with 10 micro-arc-second accuracy.

VERA got construction funds at 2000 and 2001.   They covered the construction of four 20-m radio telescopes, receivers, digital equipments, recorders, control system and other related equipments.   At the end of March 2001, constructions of basic hardware system was completed.   In 2003, VERA succeeded usual one-beam VLBI observations and feasibility was confirmed.   In 2004, we started the test of 2-beam observations and succeeded to make a continuum map with phase referencing.

In 2005, geodesy observations were started with the GSI 32-m VLBI station.   The position of GSI VLBI station is well determined on the world coordinate.   VERA stations are referred to the GSI station.   And remote operation system from Mizusawa had started.   Then observation time increased from 1,500 hours per year to 3,000 hours per year.   Moreover Japanese VLBI network with Usuda 64-m, Yamaguchi 32-m, Tsukuba 32-m, Kashima 34-m and Gifu 11-m telescopes had started observations for AGNs with relatively low brightness.

In 2006, VERA succeeded to measure the trigonometric parallaxes of S269 and Orion-KL.   And around 10 sources were started to measure the precise trigonometric parallaxes and proper motions. The common use observations were internationally opened.   And five VLBI stations; Usuda 64-m, Yamaguchi 32-m, Tsukuba 32-m, Kashima 34-m and Gifu 11-m telescope, were combined with 2.4 Gbps optical fiber link.   The test of high sensitivity mapping was started.

In 2007, some papers related to VERA observations were published.   Especially the S269 observation is the furthest determination of the trigonometric parallax. Also VERA has succeeded the distance measurements of Orion-KL with 2% error, which is competitive for the most accurate measurements of VLBA.   And around 10 sources were started to measure the precise trigonometric parallaxes and proper motions.   The common use observations were internationally opened.   And five VLBI stations; Usuda 64-m, Yamaguchi 32-m, Tsukuba 32-m, Kashima 34-m and Gifu 11-m telescope, were combined with 2.4 Gbps optical fiber link.   The science observations of high sensitivity mapping were started. .

Mizusawa VERA observatory also organizes the Japanese VLBI network, which has 11 VLBI stations including VERA.   We collaborate universities; Hokkaido University, Tsukuba University, Ibaraki University, Gifu University, Osaka Prefecture University, Yamaguchi University and Kagoshima University.   Also Institute of Space and Astronoutical Science, Geographical Survey Institute and National Institute of information and Communication Technology have joined to Japanese VLBI network.   And optical fiber VLBI experiment project aims to build a high sensitivity VLBI network using wide bandwidth data transmission.   And it could observe low brightness objects with high angular resolution of VLBI. (H.Kobayashi)

J2.1.3 ALMA project

The Atacama Large Millimeter/submillimeter Array (ALMA), an international astronomy facility, is a partnership among Europe, Japan, and North America, in cooperation with the Republic of Chile. ALMA is funded in Europe by the European Organization for Astronomical Research in the Southern Hemisphere, in Japan by the National lnstitutes of Natural Sciences(NINS) in cooperation with the Academia Sinica in Taiwan, and in North America by the U.S. National Science Foundation (NSF) in cooperation with the National Research Council of Canada (NRC).   ALMA construction and operations are led on be half of Europe by ESO, on behalf of Japan by the National Astronomical 0bservatory of Japan (NAOJ), and on behalf of North America by the National Radio Astronomy Observatory (NRAO), which is managed by Associated Universities, Inc. (AUI).

The mission of the ALMA project at NAOJ is to conduct the following activities in collaboration with the international partners to achieve the scientific goals of ALMA :

l） Design, develop, build and deliver ALMA subsystems

The major subsystems assigned to Japan are：
（a）the Atacma Compact Array(ACA) that is composed of 16 antennas, a dedicated correlator, and
（b）the receiver Cartridges for Band 4,8, and 10 that are integrated into the receiver front end subsystem and mounted on every ALMA antennas.

Softwares needed for these subsystems are also developed and integrated in the ALMA software system.

2）Contribution to the cost of common infrastructure
Contribute proper shares to the costs of site development, the permanent power supply. and other infrastructure.

3）System integration and verification
Participate in the joint activities of Assembly, Integration and Verification(AIV) and Commissioning and Science Verification (CSV) to finish ALMA as a scientific instrument.

4）Preparation for the scientific operations
Set up the East Asian ALMA Regional Center (EA-ARC), one of the three ARCs in the world, to interface ALMA with the science community. The function consists of the generic "core function" shared with the other ARCs and the special function designed to meet the needs of the East Asian regional community.

5）Scientific operations and maintenance
Operate ALMA throughout its lifetime(at least 30years) with an appropriate maintenance and improvements in various magnitudes. Serve the science community through EA-ARC by providing not only the observing opportunity with ALMA according to proposals but also the archival data from observations in the past to promote science with ALMA.

We have started the construction of the Atacama Large Millimeter/submillimeter Array（ALMA）as an international collaboration project, After a tough negotiation, agreement was signed in 2004 that established the trilateral structure of North America, Europe, and Japan (and Taiwan). Japan contributes 25% to the project.

At the end of December 2007, we had delivered three 12-m antennas and the correlator for the ACA system at the ALMA construction site in Chile, and have started the system integration and verification activity. The fourth 12-m antenna is being assembled on site. We have developed the detailed design of the remaining twelve antennas 7-m in diameter, and their production was started. We have completed the design and development of Band4 and 8 receiver cartridges meeting the unprecidented specifications of ALMA receivers . Their detailed design incorporates our considerations for production of a large number of units. We have made the system design for Band 10 and almost completed the developments of its design elements, being ready to proceed with the detailed design after a Preliminary Design Review（PDR）.

J2.1.4 ASTE

ASTE (Atacama Submillimeter Telescope Experiment) is a 10-m submillimeter telescope operating since 2002 in the Atacama Desert in northern Chile. The telescope is operated jointly by NAOJ and collaborators, including University of Tokyo and Universidad de Chile. We have performed wide range of astronomical observations utilizing newly installed instruments.

The ASTE antenna has an excellent performance with its surface accuracy adjusted to 19 microns r.m.s., and its pointing accuracy of 2 arc-minutes r.m.s. Two main receiver systems were used for the observing run for the resent years, which are SIS receiver at 345 GHz for spectroscopy, and a bolometer camera "AzTEC" for continuum imaging.

The SIS receiver employs a cartridge type plug-in cryogenics at 4 K, where we can use the common cryogenic system for several receiver cartridges. The initial stage of the observation was done by a receiver cartridge called "SC345", which is a double side-band receiver at 345 GHz developed mainly by the University of Tokyo. Thanks to the excellent observing condition in the Atacama site, the system has shown a system noise temperature within 130 K to 200 K (DSB) at 345 GHz. Various scientific results produced by this system has been published in the special issue of PASJ, as well as the first joint conference for ASTE in March 2006, organized jointly by Chile and Japan.

AzTEC is a 144 element semiconductor bolometer camera at 270 GHz developed by University of Massachusetts and collaborators. UMass and NAOJ discussed to operate this AzTEC camera on ASTE telescope to push forward the continuum observations in the southern sky. The targets for the key science projects with AzTEC on ASTE include proto-planetary disks, Sunyaev-Zel'dovich effect through clusters of galaxies, and an extensive survey of submillimeter galaxies. The first year run was a great success producing many interesting results, which includes new detections of hundreds of submillimeter galaxies.

We have been working on technical developments for the future as well. The SC345 SIS receiver is to be upgraded to a side-band separating (2SB) receiver (CATS345), and a wide band F-FX type auto-correlator (WHSF) which covers a wide bandwidth of 8 GHz in total is showing up. A superconductive imaging submillimeter-wave camera with nine-element SIS photon detectors at 650 GHz (SISCAM-9), has been tested on the telescope to receive its first light from the moon. (H. Ezawa)

J2.1.5 Lunar exploration

Japanese Lunar Explorer (KAGUYA) was launched successfully on Sep. 14, 2007 and has been continuously observing the whole moon. Two radio-metric experiments were performed in the KAGUYA mission to measure the precise lunar gravity field. One is a 4-way Doppler experiment using a relay sub-satellite (Rsar) for the direct measurement far-side lunar gravity. Another is a differential VLBI experiment with the two sub-satellites (Rstar and Vstar) which transmit three carrier waves at S band and one carrier wave at X band. Both experiments have been done successfully. World-first precise far-side lunar gravity map has been produced. In the multi-wavelength differential VLBI experiment, removal of the phase ambiguity was attained and pico-second order accuracy was confirmed through the same-beam observation using VERA network of NAOJ. VLIB observation of KAGUYA by VERA stations and four oversea stations (Shanghai, Urumqi, Hobart, Wettzell) can enhance the accuracy of satellite orbit and then lunar gravity field. (S. Sasaki, H. Hanada).

J2.1.6 Nobeyama Solar Radio Observatory

Nobeyama Solar Radio Observatory (NSRO) carries out solar radio observations and researches on solar physics by multi-wavelength analyses including radio. We observed the Sun routinely with the Nobeyama Radioheliograph (NoRH) and Radio Polarimeters (NoRP). By combining the radio data with data taken from sattellites and from the ground, we study solar activity, especially particle acceleration processes in solar flares. Obtained data are opened to scientists in solar and related field. Through these activities, NSRO serves as international center for solar data analyses and research.

We have operated NoRH and NoRP and observed data are archived and opened to scientists in the world for common use. We invited large number of Japanese and foreign scientists and provided data for common use and collaboration. Scientific research of NSRO is highly biased to collaboration with outer users rather than own research. We organized an international symposium "Solar Physics with the Nobeyama Radioheliograph" in 2004 and published the proceedings book and a special issue in PASJ journal.

J2.2 Japan Aerospace Exploration Agency (JAXA)
J2.2.1 Space VLBI VSOP and VSOP-2

The first VLBI dedicated satellite, HALCA for the VSOP (VLBI Space Observatory Programme) mission, was operated in 1997-2005. Almost 800 observations at 1.6 and 5.0 GHz were conducted to study the compact cores and the parsec-scale jets of extragalactic radio sources and other objects.

Following the success of the first space VLBI mission VSOP, JAXA and NAOJ started the next generation Space VLBI project, VSOP-2 (ASTRO-G) since 2007. The nominal launch epoch is the fiscal year 2012 with H2A rocket. The orbit of the ASTRO-G satellite will be 25,000km apogee and 1,000 km perigee with the inclination of 31 degree. The observing bands are 8, 22 and 43 GHz. The 35,000 km baseline between ASTRO-G and the ground radio telescopes at 43 GHz, provides the angular resolution of about 40 micro arcseconds to observe innermost regions of AGN jets and astronomical masers.

To achieve more sensitive VLBI observation, the 9.3m large deployable reflector, the attitude control

system with fast switching and the pointing accuracy for 43 GHz observation, a cooled mm-wave receiver by Stirling cycle refrigerator, giga-bit data transmission, and high accuracy orbit determination are the main technical challenges in the ASTRO-G development.

This project is also planned as a wide international collaboration for ground radio telescopes, correlators, link stations, and the science operation, as we did in VSOP (HALCA) mission. (M.Tsuboi&Y.Murata)

J2.2.2 Usuda and Uchinoura

Usuda 64-m antenna is mainly used for the tracking of spacecrafts, Hayabusa (MUSES-C), Kaguya (SELENE) and Geotail, for which S and X band receivers are installed. It was also used for a ground VLBI station for VSOP (HALCA) project, and supported VSOP L and C band observations.   C-band receiver was modified to observable 6.7GHz methanol line.   We use K4 and K5 VLBI terminals to join the Japanese VLBI network observations.   Uchinoura 34-m antenna is mainly used for the operation of near-earth satellites. We installed both K4 and K5 VLBI terminal system to 34m, and started S/X-band VLBI observations.   These telescopes are also used for the spacecraft orbit determination using VLBI technique. (N.Mochizuki)

J2.3 National Institute of Information and Communication Technology (NICT)

National Institute of Information and Communication Technology (NICT) is   operating 34-m and 11-m radio telescopes at Kashima and another 11-m radio   telescope at Koganei. They are mainly used for geodetic and astronomical VLBI observations and pulsar timing observations. As one of the Technical Development Centers of International VLBI Service for Geodesy and Astrometry   (IVS), NICT has been developing two types of disk-based data acquisition systems. One is Gbps-class VLBI observing systems (K5/VSI) with digital filtering function [Takeuchi et al. 2006] and the other is multi channel VLBI system (K5/VSSP)[Kondo et al. 2006; Koyama et al. 2006].   Software correlator programs which   run on multiple PC systems for distributed processing are under development   as the correlator part of the K5 system. Application of VLBI technique for spacecraft navigation has been studied for spacecraft Nozomi [Sekido et al. 2004] and Hayabusa. A compact VLBI system is under the development with combination of small-size telescope and K5 wide-band sampler for certification of accurate 10km baseline Ishii et al. 2007]. Accurate ionospheric delay modeling and estimation of ionospheric total electron contents with VLBI has been studied [Hobiger et al., 2006, 2007a, 2007b]. As single dish observations, Kashima 34m radio telescope has been used for regular pulsar timing observation. Additionally, spectral line observations with 22GHz receiver have been performed under collaboration with Kagoshima University.

J2.4 60-cm Telescope of the U. Tokyo

The radio astronomy group at Institute of Astronomy in the University of Tokyo runs a 60-cm radio telescope located at Nobeyama with support of Nobeyama Radio Observatory.   The telescope is designed for survey observations of the Galactic plane in the CO (J=2-1) line at 220-230 GHz.   The beam size of 9 arcmin enables us to make direct comparison with the CO (J=1-0) line obtained using the 1.2-m telescope operated by Harvard Smithsonian Center for Astrophysics.   We have upgrated the telescope system with cooperation of radio astronomy groups in Osaka Prefecture University and Tokyo Gakugei University since 2003.   The new receiver is 2SB type and it can make simultaneous observations in both 12CO (J=2-1) and 13CO (J=2-1).   After the upgrade the telescope system has improved by a factor of ten in the intengration time to reach the same sensitivity as before.   Since 2007 winter we have started a new galactic plane survey and large area mapping of nearby molecular clouds.   The first paper about the new system was published by Nakajima et al. (2007) PASJ 59, 1005.   (T. Handa)

J3 Solar System Radio Astronomy (2004.11-2007.10)

Dynamics of Jupiter's radiation belt (JRB) has been investigated by observing the synchrotron radiation (JSR) using single dish radio telescopes of Tohoku University (325 and 785MHz), Nagoya University (327MHz) and National Institute of Information and Communications Technology (2300MHz), Japan, and a radio interferometer named Giant Metrewave Radio Telescope (GMRT,

610MHz), India. Long-term monitoring of JSR at 327MHz for 1995 - 2004 showed that variations of JRB electrons of about 5MeV are roughly 4 times larger than those of higher energy electrons (-15MeV) and have been controlled by solar wind dynamic pressure or solar UV/EUV flux when these parameters are large values [Nomura et al., 2006, 2007]. A multi-frequency JSR observation at 325 - 2300MHz had been made in May to June, 2007 simultaneously with an interferometer observation using the GMRT. The campaign observation suggested that short term variations with the time scale of days to weeks were larger at lower energy JRB electrons and the variations of lower energy electrons might not be induced by solar activities which are considered to be a main promoter at higher energy electrons, but induced by some Jupiter's inner processes [Misawa et al., 2007; Tsuchiya et al., 2007; Imai et al., 2007].

An interferometer at the lunar surface has been studied to realize high sensitivity and high resolution observations at a low frequency below 15MHz which is impossible from the ground due to the ionospheric shielding effect. This study has been made for the purpose of investigating solar system bodies, interstellar matter, extra-galaxies and initial cosmic structure. A goal of this study is construction of a low frequency array on the lunar far-side where man-made and natural noises from the Earth can be always avoided and radio bursts from the Sun can be shielded during the lunar night. As the first step of this project, feasibility of an Earth-Moon baseline interferometer at 25MHz has been examined for revealing source size and generation processes of Jupiter's decameter wave and for making fundamental measurements of the lunar surface environment [Iwata et al., 2006; Noda et al., 2006; Kawano et al., 2007].

Investigating the constituents and the isotope ratios of planetary atmosphere is key to understanding the physical and chemical environment and the evolutionary processes of the solar planetary system. The Nagoya University has performed the observations of the atmospheric minor constituents of the Jovian planets and Mars at 330-360 GHz band and 215-245 GHz band by utilizing the ASTE 10-m radio telescope of the National Astronomical Observatory of Japan and NANTEN2 4-m radio telescope of Nagoya University, respectively. These telescopes are operated at Pampa La Bola of Atacama Highland, Chile (alt. 4800). Nagoya University are planning a long-term monitoring of the rotational line of carbon monoxide in the Martian atmosphere in order to study the influence of solar activity on the atmospheric compositions and the physical conditions.

The interplanetary scintillation (IPS) method using radio sources distributed over the sky can observe the dynamics and structure of the solar wind in three dimensions with a relatively short time cadence. Because of this advantage over in-situ measurements, the Solar-Terrestrial Environment Laboratory (STEL) of the Nagoya University has been conducting IPS observations at a frequency of 327 MHz on a daily basis between April and mid-December using the four-station system. The STEL four-station system consists of large-aperture (~2,000 m^2) asymmetric cylindrical parabolic antennas located at Toyokawa, Fuji, Kiso and Sugadaira, and nearly 40 radio sources are used for daily IPS observations. The solar wind data collected with this system are available via the web page; http://stesun5.stelab.nagoya-u.ac.jp/ips_data-e.html. A solar wind prediction experiment has been carried out under collaboration between CASS/UCSD and STEL using the computer tomography analysis of realtime IPS data. The predictions of speed and density variations at 1 AU are displayed on STEL and UCSD web servers (http://ips.ucsd.edu/index_v_n.html, http://stesun5.stelab.nagoya-u.ac.jp/forecast/).

To improve a spatial resolution of the IPS observations, construction of a new radiotelescope dedicated for IPS observations started in 2006 at Toyokawa. The new radiotelescope, called the Solar Wind Imaging Facility (SWIFT), is a meridian-transit-type cylindrical parabolic antenna with a physical aperture of 106 m NS X 38 m EW and an illumination efficiency of 91 % (a design value), and it will enable to observe twice as many IPS sources as the existing IPS antennas can. An observation frequency is 327 MHz which is the same as the existing one. The feed system of the SWIFT consists of 192 (NS) × 2 (EW) phased-array dipoles, which forms a single steerable beam in the meridian plane between S 60 deg to N 30 deg with respect to the zenith. An overall test of the SWIFT is underway to check and optimize the system performance.

Three-dimensional (3D) structure and radial evolution of coronal mass ejection (CME) in the interplanetary space (beyond the field-of-view of the coronagraph) are poorly understood despite their importance in the space weather research. STEL IPS observations were analyzed to elucidate these enigmas of CME. A series of interplanetary disturbances associated with intense CMEs were clearly

detected from STEL IPS observations during October to November 2003, and some important aspects have been revealed from detailed analysis of IPS data for this period. A loop-shaped high-density structure has been determined from the model fitting analysis of IPS observations for the 2003 October 28 halo CME event, which is the most prominent one among the Halloween storms. This reconstructed feature has been compared with 3D distribution of the solar wind density reconstructed from Solar Mass Ejection Imager (SMEI) observations, and as the result, they are found to be in good agreement (correlation coefficient ~0.6). It is also found that the loop structure is roughly aligned to the direction of the magnetic flux rope inferred from cosmic ray modulation data and in situ solar wind data. Consequently, the loop structured identified from the IPS observations is considered to represent the coronal ejecta confined within the magnetic flux rope. Another noteworthy point disclosed from STEL IPS observations is large-scale reduction in the solar wind density after occurrence of the 2003 October 28 CME event (Tokumaru et al., 2005, 2007; Jackson et al., 2007). Here, it should be noticed that there is a variety of global features determined for interplanetary CME events. Some CMEs are associated with loop-shaped interplanetary disturbances, and others are associated with shell-shaped high density structures. For example, STEL IPS observations for the 1999 September 20 CME event suggest that an interplanetary counterpart of this CME has a shell-shaped distribution. This distribution is consistent with in situ measurements by the "Nozomi" spacecraft, which is the Mars mission of Japan. The origin of this shell-shaped disturbance is ascribed to the compression region driven by the IP shock (Tokumaru et al., 2006a, b).

One of the main issues of solar wind research is the mechanism of solar wind acceleration. Recent studies reveal that the solar wind speed (V) correlates with corona magnetic parameters (B/f) during the solar activity minimum, where the B and f represent photospheric magnetic field and magnetic flux expansion rate, respectively. To verify this relationship, solar wind IPS data from 1995 to 2005 were analyzed. As result, it was found that V linearly depended on B/f through the solar cycle, and also found that the proportional coefficient peaked at the solar activity minimum and reached its lowest level at the solar activity maximum (Fujiki et al., 2005; Hakamada et al., 2005; Kojima et al., 2007).

Phase scintillation measurements of the "Nozomi" spacecraft X-band waves taken during the solar occultation between 2000 December and 2001 January have been used to investigate the density turbulence in the near-Sun plasma for an unprecedentedly wide frequency range. The scintillation spectra obtained within 20 solar radii show a three-part structure; the Kolmogorov turbulence at <0.5 Hz, a local flattening between 0.5 and 3 Hz, and a steep fall at higher frequencies (Imamura et al., 2005). (M.Tokumaru)

References and Abstracts

- Abada-Simon, M., J. Casares, A. Evans, S. Eyres, R. Fender, S. Garrington, O. de Jager, N. Kuno, I. G. Martíez-Pais, D. de Martino, H. Matsuo, M. Mouchet, G. Pooley, G. Ramsay, A. Salama, and B. Schulz [2005a], "First Detections of the Cataclysmic Variable AE Aquarii in the Near to Far Infrared with ISO and IRAS: Investigating the Various Possible Thermal and Non-Thermal Contributions," Astron. Astrophys., vol.433, pp.1063-1077.

➢ We have used ISO to observe the Magnetic Cataclysmic Variable AE Aquarii in the previously unexplored range from 4.8 μm up to 170 μm in the framework of a coordinated multi-wavelength campaign from the radio to optical wavelengths. We have obtained for the first time a spectrum between 4.8 and 7.3 μm with ISOCAM and ISOPHOT-P: the major contribution comes from the secondary star spectrum, with some thermal emission from the accretion stream, and possibly some additional cyclotron radiation from the post-shock accretion material close to the magnetised white dwarf. Having reprocessed ISOPHOT-C data, we confirm AE Aqr detection at 90 μm and we have re-estimated its upper limit at 170 μm. In addition, having re-processed IRAS data, we have detected AE Aqr at 60 μm and we have estimated its upper limits at 12, 25, and 100 μm. The literature shows that the time-averaged spectrum of AE Aqr increases roughly with frequency from the radio wavelengths up to ~ 761 μm; our results indicate that it seems to be approximately flat between ~761 and ~ 90 μm, at the same level as the 3σ upper limit at 170 μm; and it then decreases from ~ 90 μm to ~ 7 μm. Thermal emission from dust grains or from a circum-binary disc seems to be very unlikely in AE Aqr, unless such a

disc has properties substantially different from those predicted recently. Since various measurements and the usual assumptions on the source size suggest a brightness temperature below 10^9 K atλ3.4 mm, we have reconsidered also the possible mechanisms explaining the emission already known from the submillimetre to the radio. The complex average spectrum measured from ~ 7 μm to the radio must be explained by emission from a plasma composed of more than one "pure" non-thermal electron energy distribution (usually assumed to be a power-law): either a very large volume (diameter 80 times the binary separation) could be the source of thermal bremsstrahlung which would dominate from ~ 10 μm to the ~millimetre, with, inside, a non-thermal source of synchrotron which dominates in radio; or, more probably, an initially small infrared source composed of several distributions (possibly both thermal, and non-thermal, mildly relativistic electrons) radiates gyro-synchrotron and expands moderately: it requires to be re-energised in order to lead to the observed, larger, radio source of highly relativistic electrons (in the form of several non-thermal distributions) which produce synchrotro.

- Abada-Simon, M., J. Casares, A. Evans, S. Eyres, R. Fender, S. Garrington, O. de Jager, N. Kuno, I. G. Martíez-Pais, D. de Martino, H. Matsuo, M. Mouchet, G. Pooley, G. Ramsay, A. Salama, and B. Schulz [2005b], "AE Aquarii Emission Processses from Radio to Infrared," Proc. of "The Astrophysical of Cataclysmic Variables and Related Objects", eds. J. M. Hameury and J. P. Lasotu, ASP Conf. Ser. vol.330, pp.341-342.

➢ AE Aquarii is a Magnetic Cataclysmic Variable (MCV) flaring at all wavelengths. The origin emission from radio to 10 μm is thought to be magneto-bremsstrahlung from both thermal and non-thermal electron energy distributions.

- Akabane, K., and N. Kuno [2005], "Dust Content in Compact HII Regions (NGC 7538-IRS1, IRS2, and IRS3)," Astron. Astrophys., vol.431, pp.183-195.

➢ The luminosity of the central star of the compact HII regions of NGC 7538 was estimated from the solid angle of the IR sources subtended relative to the central star, and was found to be 5~ 10 times as intense as that of IR sources. Under the single central star approximation, the luminosity gives a stellar UV photon rate $N_U(*)$ (s^{-1}) of ~3.0 × 10^{48}, ~1.5 × 10^{49}, ~5.1 × 10^{49}, and ~1.7 × 10^{47} for the compact HII regions of NGC 7538-IRS1(A/2), B, IRS2, and IRS3, respectively. N_U (*) and the observed electron density, n_e, provide the dust opacity of the ionizing photon, τ_{Sd}, for the optical path out to the Str mgren sphere radius r_S, assuming a gas with standard dust content. Ionizing photon opacity over the same optical path but with the actual dust content τ_{Sda} is also derived from r_i / r_S, where r_i is the radius of the ionized sphere, which is estimated from $N_U(*)$ and the observed volume emission measure n_e^2 $(4\pi r_i^3/3)$ (Spitzer 1978). An observational trend of $\gamma\{N_U(*) / 4\pi r_i^2{}^{1/2} \sim$ constant, where $\gamma = S_{da} / S_d\}$, was obtained for the 4 compact HII regions of the NGC 7538(N). Fourteen selected compact HII regions from data catalogued by VLA observations were examined for this trend, and a similar result was obtained. A limit of γ as 15 γ 0.1 was given for the 14 selected sources. The size of the dust-depleted cavity of the NGC 7538(N) suggested by Chini et al. (¥cite{Chini1986}) coincides with that of the ionized sphere of the IRS2 of the region.

- Ao, Y., J. Yang, K. Sunada, and K. Tatematsu [2006], "CS J=2-1 Observations towards Massive Dense Cores," Proc. of the IAU Symp. vol.231, "Astrochemistry Throughout the Universe: Recent Successes and Current Challenges," eds. by Dariusz C. Lis, Geoffrey A. Blake & Eric Herbst, 2005, poster presentation, Session I.03.

➢ We present the results of CS J=2-1 map observations towards 17 massive forming regions selected from the previous CO line survey cold IRAS sources along the Galactic plane (Yang et al. 2002). All sources were detected in CS J=2-1 and showed the existence of CS cores around the associated IRAS sources. The average values for core radius R, average line width ?V, CS column density NCS, volume density n, virial mass MVIR and CS abundance log X(CS) are 0.40 pc, 2.31 km s^{-1}, 1.3 x 10^{14} cm^{-2}, 5.5 x 10^4 cm^{-3}, 620 M_{sol} and -8.93, separately. We examined the archival VLA radio continuum data for all sources, with 4 additional sources from the previous work (Ao, Yang, & Sunada 2004). Extended HII regions were found towards 12 sources and UCHII regions were associated with 5 sources. 4 remaining sources with high far-infrared luminosities without radio continuum emission were classified as the candidates of high-ass protostellar objects (HMPOs), which were found to be characterized by low LFIR/MV

IR ratios.

- Aoki, W., I. Iwata, K. Ohta, N. Tamura, M. Ando, M. Akiyama, G. Kiuchi, and K. Nakanishi [2007], "Balmer Absorption Lines in FeLoBALs," Proc. of the "The Central Engine of Active Galactic Nuclei", eds. Luis C. Ho and Jian-Min Wang, ASP Conf. Ser., vol.373, pp.337-338.

➢ We discovered non-stellar Balmer absorption lines in two many-narrow-trough FeLoBALs (mntBALs) by the near-infrared spectroscopy with Subaru/CISCO. Presence of the non-stellar Balmer absorption lines is known to date only in the Seyfert galaxy NGC 4151; thus our discovery is the first cases for quasars. Since all known active galactic nuclei with Balmer absorption lines share similar characteristics, it is suggested that there is a population of BAL quasars which have unique structures at their nuclei or unique evolutionary phase.

- Argon, A. L., L. J. Greenhill, J. M. Moran, M. J. Reid, K. M.Menten, and M. Inoue [2004], "The IC 133 Water Vapor Maser in the Galaxy M33: A Geometric Distance," Astrophys. J., vol.615, pp.702-719.

➢ We report on the results of a 14 yr long VLBI study of proper motions in the IC 133 H_2O maser source in the galaxy M33. The method of ordered motion parallax was used to model the three-dimensional structure and dynamics of IC 133 and to obtain a distance estimate, 800±180 kpc. Our technique for determining the distance to M33 is independent of calibrations common to other distance indicators, such as Cepheid period-luminosity relations, and therefore provides an important check for previous distance determinations.

- Ariyoshi, S., H. Matsuo, C. Otani, H. Sato, H. M. Shimizu, K. Kawase, and T. Noguchi [2005], "Characterization of an STJ-Based Direct Detector of Submillimter Waves," IEEE Trans, Appl. Superconductivity, vol.15, pp.920-923.

➢ We have developed submillimeter-wave direct detectors employing niobium-based superconducting tunnel junctions (STJs), with broadband spectral response, high sensitivity and imaging capability. Spectral response peaked at 650 GHz with a fractional bandwidth of 14 percent, which firs one of the important atmospheric windows for an astronomical project. We also confirmed the linearity of the detector response in the dynamic range greater than 106. The measured coupling efficiency was about 0.2, which was lower than the expected value of 0.5. The measured noise current of the detector was 10fA/√Hz, which agreed with the shot noise from the residual leakage current of 100 pA at 0.3 K. Resultant noise equivalent power (NEP) is 1.6 10^{-16} W / √Hz, that is less than the background photon fluctuation limit for ground-based submillimeter-wave observations.

- Asada, K., and M. Inoue [2004a], "A Follow-Up RM Observation for Helical Magnetic Field in 3C273," Proc. of the 7th symposium of the European VLBI Network on New Developments in VLBI Sciences and Technology, eds. R. Bachiller, F. Colomer, J.-F. Desmurs, and P. de Vicente, pp.65-68.

➢ We present results of our follow-up observation for a gradient of Faraday Rotation Measure (RM) across 3C 273 jet. We have found RM gradient across 3C 273 jet, and it may reveals a presence of a helical magnetic field which has been suggested to be related to the formation and collimation of jets by magneto-hydrodynamic models. However, regime we could reveal a distribution of RM was very limited, since 3C 273 was observed as a calibrator. In order to reveal further distribution of RM, we made follow-up observation. We detected gradient of RM across the jet and it continues more than 20 pc in projected distance. In addition, the distribution of the RM shows a significant proper motion. Coincidentally, its apparent proper motion of 5.25 c corresponds to that of the relativistic emitting plasma of 5.26 c.

- Asada, K., M. Inoue, Y. Uchida, and S. Kameno [2004b], "Detection of the Direction of the Rotation of the Accretion Disk or Spinning Black Hole," Proc. of the "Coevolution of Black Holes and Galaxies, 2004", ed. L. C. Ho, Carnegie Observatory Astrophysics Ser., vol. 1.

➢ We show the direction of accretion disk around the possible super massive black hole of 3C 273 or spinning supermassive black hole itself as clockwise based on the observed 3D structure of magnetic field in the jet of 3C 273. Using VLBA polarimetry, we derived distributions of Faraday Rotation Measure (RM) and projected magnetic field of 3C 273 jet. Based on a systematic gradient across the jet of RM and the projected magnetic field, the helical magnetic field is revealed, which is suggested by MHD models. The sign of RM indicates the direction of the twist of the helical magnetic field as a right hand screw. If the observed helical magnetic

field is wound up by the accretion disk around possible super-massive black hole, we can see the direction of the rotation.

- Asada, K., M. Inoue, S. Kameno, and H. Nagai [2005], "A Helical Magnetic Field in 3C 273," Proc. of the "Future Directions in High Resolution Astronomy: A Celebration of the 10th Anniversary of the VLBA", eds. J. D. Romney, and M. J. Reid, ASP Conf. Ser. vol.340, pp.168-170.

➢ Using VLBA polarimetry, we derived distributions of Faraday Rotation Measure (RM) and projected magnetic field of 3C 273 jet. Based on a systematic gradient across the jet of RM and the projected magnetic field, the helical magnetic field is revealed, which is suggested by MHD models. The sign of RM indicates the direction of the twist of the helical magnetic field as a right hand screw. If the observed helical magnetic field is wound up by the accretion disk around possible super-massive black hole, we can see the direction of the rotation.

- Asada, K., S. Kameno, Z.-Q. Shen, S. Horiuchi, D. C. Gabuzda, and M. Inoue [2006], "The Expanding Radio Lobe of 3C 84 Revealed by VSOP Observations," Publ. Astron. Soc. Japan, vol.58, pp.261-270.

➢ The expansion and inner proper motions of a young radio lobe associated with the bright radio source 3C 84 in the Seyfert galaxy NGC 1275 have been detected by VSOP observations. These proper motions are consistent with the evolution scenario of classical double radio sources. The apparent expansion velocity is (0.50 ± 0.09) c. The age of the radio lobe is estimated to be (45.7 ± 8.9)yr in 2001, which is in agreement with the age previously estimated by Romney et al. (1982). The total flux density at 5GHz increased at the end of the 1950's, marked several peaks in the middle of the 1980's, and is presently in a decay phase. The decay of the total flux density can naturally be explained by an adiabatic cooling due to expansion of the radio lobe, and previously measured spectral indices suggest that the emission comes from the surface of the radio lobe.

- Asada, K., M. Inoue, H. Nagai, and S. Kameno [2007], "Further Evidence of Helical Magnetic Field," Proc. of the "The Central Engine of Active Galactic Nuclei", eds. Luis C. Ho and Jian-Min Wang, ASP Conf. Ser., vol.373, pp.211-212.

➢ Based on multi-frequency polarimetry towards 0333+321 using VLBA, we reveal both the distributions of the projected magnetic field and Faraday rotation measure in order to discuss the 3D configuration of the magnetic field. There is a systematic gradient in the distribution of rotation measure, and the sign of its rotation measure is different at both sides of jet respect to the jet axis. It strongly supports that the helical magnetic field in the jet is responsible to the RM gradient, since the sign of the rotation measure can be changed only by changing the direction of the magnetic field.

- Asai, A., K. Ichimoto, K. Shibata, R. Kitai, and H. Kurokawa [2004a], "The Red-Asymmetry Distribution at Hα Flare Kernels Observed in the 2001 April 10 Solar Flare," American Geophysical Union, Fall Meeting 2004, abstract #SH13A-1134.

➢ We report a detailed examination about the evolution of the Halpha flare kernels during an X2.3 solar flare which occurred on 2001 April 10. The Halpha red-asymmetry, that is, the red-shifted Halpha emission, is observed at almost all Halpha flare kernels, during the impulsive phase of the flare. At Halpha kernels nonthermal particles and/or thermal conduction precipitate into the chromospheric plasma, and this is thought to lead the downward compression of the chromospheric plasma, which is observed as the reddening of Halpha emission (e.g. Ichimoto & Kurokawa 1984). We examined the evolution of the flare kernels inside the flare ribbons by using the Halpha images obtained with the Domeless Solar Telescope at Hida Observatory, Kyoto University. We also examined the spatial distribution of the Halpha kernels which show the red-asymmetry and their relationship with the intensity of the Halpha kernels. We found that the stronger the red-asymmetry is, the brighter the Halpha kernel is. Then, we compared the strengthes of the Halpha red-asymmetry at hard X-ray emitting sources with those at the Halpha kernels without the hard X-ray emissions.

- Asai, A., T. Yokoyama, M. Shimojo, and K. Shibata [2004b]. "Downflow as a Reconnection Outflow," Proc. of the 5th Solar-B Science Meeting, "The Solar-B Mission and the Forefront of Solar Physics : Dedicated to the Memory of Yutaka Uchida", ASP Conf. Ser., vol.325, pp.361-366.

- We present a detailed examination about the evolution of TRACE downflow motions (sunward motions) seen above post-flare loops. We found that the times when the downflow motions are seen correspond to those of the bursts of nonthermal emissions in hard X-rays and microwave. These results mean that the downflows occurred when strong magnetic energy was released, and that they are, or at least correlated with, the reconnection outflows. We also propose an observation of downflows as the reconnection outflows by Solar-B.
- Asai, A., T. Yokoyama, M. Shimojo, S. Masuda, and K. Shibata [2004c], "Flare Ribbon Expansion and Energy Release Rate," Proc. of the IAU Symp. 223, "Multi-Wavelength Investigations of Solar Activity", ed. A. V. Stepanov, E. E. Benevolenskaya, and A. G. Kosovivhev, pp.443-444.
- We report a detailed examination about the relationship between the evolution of the Halpha flare ribbons and the released magnetic energy during an X2.3 solar flare which occurred on 2001 April 10. We successfully evaluated the released energy quantitatively, based on the magnetic reconnection model. We measured the photospheric magnetic field strengths and the separation speeds of the fronts of the Halpha flare ribbon, and estimated the released magnetic energy at the flare by using those values. Then, we compared the estimated energy release rates with the nonthermal behaviors observed in hard X-rays and microwaves. We also estimated the magnetic energy released during the flare. The estimated energy release rates in the Halpha kernels associated with the hard X-ray sources are locally large enough to explain the difference between the spatial distribution of the Halpha kernels and the hard X-ray sources. Furthermore, we reconstructed the peaks in the nonthermal emission by using the estimated energy release rates.
- Asai, A., H. Nakajima, M. Shimojo, S. M. White, and H. Hudson [2005a], "Preflare Nonthermal Emission Observed in Microwaves and Hard X-Rays," Proc. of the 9th Asian-Pacific Regional IAU Meeting, pp.46-47.
- We present a detailed examination on the nonthermal emissions during the preflare phase of the large X4.8 solar flare which occurred on 2002 July 23. The microwave data obtained with Nobeyama Radioheliograph, at Nobeyama Solar Radio Observatory, NAOJ, and the hard X-ray data taken with Reuven Ramaty High Solar Spectroscopic Imager obviously showed nonthermal features. We found a faint ejection associated with the flare in the EUV images taken with the Transition Region and Coronal Explorer. Then, we examined the temporal, and spectroscopic features on the emission sources, and found the loop-top sources during the preflare phase both in hard X-rays and in microwaves.
- Asai, A., M. Shimojo, T. T. Ishii, H. Kurokawa, and K. Shibata [2005b], "Solar Flares/CMEs and Space Weather," Proc. of the Second Japanese CAWSES Workshop, p.20.
- Coronal mass ejections (CMEs) are the physically same phenomena as solar flares. They are different from flares on one point that they are observed in different aspects. Even in the case of CMEs that are not associated with any so-called solar flares, they often show flare-like phenomena that are accompanied by energy release on the solar surface. In this talk we would like to review their contribution to the weather research on each aspect.
- Asai, A., H. Nakajima, M. Shimojo, S. M. White, H. Hudson, and R. P. Lin [2006a], "Preflare Nonthermal Emission Observed in Microwaves and Hard X-Rays," Publ. Astron. Soc. Japan, vol.58, pp.L1-L5.
- We present a detailed examination on nonthermal emissions during the preflare phase of the X4.8 flare that occurred on 2002 July 23. The microwave (17GHz and 34GHz) data obtained with the Nobeyama Radioheliograph at Nobeyama Solar Radio Observatory and the hard X-ray data taken with the Reuven Ramaty High Energy Solar Spectroscopic Imager obviously showed nonthermal features in the preflare phase. We also found a faint ejection associated with the flare in the EUV images taken with the Transition Region and Coronal Explorer. We discuss the temporal and spatial features of the nonthermal emissions in the preflare phase, and their relation with the ejection.
- Asai, A., T. T. Ishii, K. Shibata, and N. Gopalswamy [2006b], "Anemone Structure of Active Region NOAA 10798 and Related Geoeffective Flares/CMEs," International Astronomical Union XXVIth General Assembly, Pragua, 14-25 August, 2006, abstract book, p.287 (JD03-72 Oral presentation).

- Introduction: We report the evolution and the coronal features of an active region NOAA 10798, and the related magnetic storms. Method: We examined in detail the photospheric and coronal features of the active region by using observational data in soft X-rays, in extreme ultraviolet images, and in magnetogram obtained with GOES, SOHO satellites. We also examined the interplanetary disturbances from the ACE data. Results: This active region was located in the middle of a small coronal hole, and generated 3 M-class flares. The flares are associated with high speed CMEs up to 2000 km/s. The interplanetary disturbances also show a structure with southward strong magnetic field. These producing the high-speed and geo-effective CMEs even the near limb locations.

- Asai, A., T. Yokoyama, M. Shimojo, S. Masuda, and K. Shibata [2006c], "Flare Ribbon Expansion and Energy Release," J. Astrophys. Astr., vol.27, pp.167-173.

- We report a detailed examination about the relationship between the evolution of the Hα flare ribbons and the released magnetic energy during the April 10 2001 flare. In the Hα images, several bright kernels are observed in the flare ribbons. We identified the conjugated foot-points, by analyzing the lightcurves at each Hα kernels, and showed their connectivities during the flare. The, based on the magnetic reconnection model, we calculated quantitatively the released energy by using the photospheric magnetic field strengths and separation speeds of the Hα flare ribbons. Finally, we examined the downward motions which are observed at the Hα kernels. We found that the stronger the red-asymmetry tends to be associated with the brighter the Hα Kernel.

- Asai, A., H. Nakajima, M. Shimojo, and S. M. White [2006d], "Preflare Features in Microwaves and in Hard X-Rays," Advances in Geosciences, eds. W.-H. Ip, and M. Duldig, vol.2, pp.33-41.

- Not Available

- Asai, A. [2006e], "Flare Associated Oscillations Observed with NoRH," Proc. of Nobeyama Symposium 2004, "Solar Physics with the Nobeyama Radioheliograph", pp.33-38.

- We present an examination of the multi-wavelength observation of a C7.9 flare which occurred on 1998 November 10. This is an imaging observation of the quasi-periodic pulsations (QPPs) obtained with Yohkoh/HXT and Nobeyama Radioheliograph (NoRH). We found that the Alfven transit time along the flare loop was almost equal to the period of the QPP. We therefore suggest that variations of macroscopic magnetic structures, such as oscillations of coronal loops, affect the efficiency of particle injection/acceleration. We also report other QPP events observed with NoRH, and review some works on these flare-associated oscillations.

- Asai, A., H. Nakajima, M. Oka, K. Nishida, and Y. T. Tanaka [2007a], "Loop Top Nonthermal Emission Sources Associated with an Over-the-Limb Flare Observed with NoRH and RHESSI," Adv. Space Res., vol.39, pp.1398-1401.

- We studied the M3.7 class flare which occurred on 2005 July 27, in the active region NOAA 10792. This flare is an over-the-limb flare, and the footpoints are entirely occulted by the solar disk. The microwave and the hard X-ray images obtained with the Nobeyama Radioheliograph and the RHESSI satellite, respectively, clearly showed emission sources above the post-flare loop system. We examined the emission sources in detail spatially, temporally, and spectroscopically. As a result, one of the hard X-ray emission sources and the microwave emission sources are nonthermal.

- Asai, A., T. Yokoyama, M. Shimojo, S. Masuda, and K. Shibata [2007b], "Evolution of Hα Kernels and Energy Release in an X-Class Flare," Proc. of the "New Solar Physics with Solar-B Mission", eds. Shibata, Kazunari, Nagata, Shin'ichi, and Sakurai, T., ASP Conf. Ser., vol.369, pp.461-468.

- The investigation on the evolution of Hα kernels allows us to derive some key information on the energy release processes and the particle acceleration mechanisms during a flare. We report a detailed examination on the relationship between the evolution of the Hα flare ribbons and the released magnetic energy during an X2.3 solar flare which occurred on 2001 April 10. In the Hα images, several bright kernels were observed in the flare ribbons. We identified the conjugated footpoints, by analyzing the light curve at each Hα kernel, and showed their connectivities during the flare. Then, based on the magnetic reconnection model, we calculated quantitatively the released energy by using the photospheric magnetic field strengths and the separation speeds of the fronts of the Hα flare ribbons. We confirmed that the estimated energy release rate corresponds to the nonthermal emission light curves at the strong emission sources. Finally, we

examined the downward motions at the Hα kernels. The "red-asymmetry" features, generated by the precipitation of the nonthermal particles and/or thermal conduction into the chromospheric plasma, were observed for all the flare ribbons. We also found that the stronger the redasymmetry tends to be associated with the brighter Hα kernel.

- Asaki, Y., H. Sudou, Y. Kono, A. Doi, R. Dodson, N. Pradel, Y. Murata, N. Mochizuki, P. G. Edwards, T. Sasao, and E. B. Fomalont [2007], "Verification of the Effectiveness of VSOP-2 Phase Referencing with a Newly Developed Simulation Tool, ARIS," Publ. Astron. Soc. Japan, vol.59, pp.397-418.
  - The next-generation space VLBI mission, VSOP-2, is expected to provide unprecedented spatial resolution at 8.4, 22, and 43 GHz. In this report, phase referencing with VSOP-2 is examined in detail based on a simulation tool called ARIS. The criterion for successful phase referencing was set to keep the phase errors below one radian. Simulations with ARIS reveal that phase referencing achieves good performance at 8.4 GHz, even under poor tropospheric conditions. At 22 and 43 GHz, it is recommended to conduct phase referencing observations under good or typical tropospheric conditions. The satellite is required to have an attitude-switching capability with a one-minute or shorter cycle, and an orbit determination accuracy higher than 10 cm at apogee; the phase referencing calibrators are required to have a signal-to-noise ratio larger than four for a single scan. The probability to find a suitable phase referencing calibrator was estimated by using VLBI surveys. From the viewpoint of calibrator availability, VSOP-2 phase referencing at 8.4 GHz is promising. However, the chance of finding suitable calibrators at 22 and 43 GHz is significantly reduced; it is important to conduct specific investigations for each target at those frequencies.
- Baan, W. A., Y. Hagiwara, and P. Hofner [2007], "HI and OH Absorption toward NGC 6240," Astrophys. J., vol.661, pp.173-184.
  - VLA observations of large-scale H I and OH absorption in the merging galaxy of NGC 6240 are presented with 1" resolution. H I absorption is found across large areas of the extended radio continuum structure with a strong concentration toward the double nucleus. The OH absorption is confined to the nuclear region. The H I and OH observations identify fractions of the gas disks of the two galaxies and confirm the presence of central gas accumulation between the nuclei. The data clearly identify the nucleus of the southern galaxy as the origin of the symmetric superwind outflow and also reveal blueshifted components resulting from a nuclear starburst. Various absorption components are associated with large-scale dynamics of the system including a foreground dust lane crossing the radio structure in the northwest region.
- Beuther, H., T. K. Sridharan, and M. Saito [2005], "Caught in the ACT: The of Massive Star Formation," Astrophys. J. (Letters), vol.634, pp.L185-L188.
  - Combining mid-infrared data from the Spitzer Space Telescope with cold gas and dust emission observations from the Plateau de Bure Interferometer, we characterize the infrared dark cloud IRDC 18223-3 at high spatial resolution. The millimeter continuum data reveal a massive ~184 Msolar gas core with a projected size of ~28,000 AU that has no associated protostellar mid-infrared counterpart. However, the detection of 4.5 mum emission at the edge of the core indicates early outflow activity, which is supported by broad CO and CS spectral line-wing emission. Moreover, systematically increasing N_2H^+(1-0) line width toward the millimeter core center can be interpreted as additional evidence for early star formation. Furthermore, the N_2H^+(1-0) line emission reveals a less massive secondary core that could be in an evolutionary stage prior to any star formation activity.
- Bieging, J. H., W. L. Peters, B. Vila-Vilaro, K. Schlottman, and C. Kulesa [2007], "Sequential Star Formation in the Sh 254-258 Molecular Cloud: HHT Maps of CO J=3-2 and 2-1 Emission," Proc. of the IAU Symp, 237, "Triggered Star Formation in a Turbulent Interstellar Medium", eds. B. G. Elmegreen & J. Palous, p.396.
  - The molecular cloud associated with the Sh 254-258 group of 5 small H II regions appears to be forming a (late)-OB association. We have mapped the associated molecular cloud in the J=2-1 line of the CO molecule over 0.75° × 1°, and the CO J=3-2 line toward the 2 main peaks, with the University of Arizona Heinrich Hertz Submm Telescope (HHT). We propose a scenario for sequential formation of the stars exciting the H II regions, triggered by the compression/heating of the molecular gas.

- Borders, T., L. Sjouwerman, M. Messineo, H. Habing, M. Honma, and H. Imai [2004], "43 GHz SiO Masers and Astrometry with VERA in the Galactic Center," American Astronomical Society Meeting 205, #176.04.

  ➢ We are using the Very Large Array (VLA) to monitor 24 strong circumstellar 43 GHz SiO masers in the inner Galaxy, located within 2.5 degrees of Sgr A*, for estimating 43 GHz SiO maser light curves. The periods and accurate interferometric positions derived in this program will enable VLBI astrometry with the new Japanese VLBI Exploration of Radio Astrometry (VERA) array in the Galactic Center. Furthermore, as most of these stars are at a similar distance, the SiO maser light curves will put constraints on the physical properties of the maser phenomena in the expanding envelopes of these stellar objects. We present the first results from the these ongoing VLA observations, started with the VLA in D-configuration in the summer of 2004 and ending early 2006.

- Borovik, V. N., V. V. Grechnev, O. I. Bugaenko, S. A. Bogachev, I. Y. Grigorieva, S. V. Kuzin, S. V. Lesovoi, M. A. Livshits, A. A. Pertsov, G. V. Rudenko, V. A. Slemzin, A. I. Stepanov, K. Shibasaki, A. M. Uralov, V. G. Zandanov, and I. A. Zhitnik [2005], "Observations of a Post-Eruptive Arcade on October 22, 2001 with CORONAS-F, other Spaceborne Telescope, and in Microwaves," Proc. of the IAU Symp. 226, "Coronal and Stellar Mass Ejections", eds. K. Dere, J.   Wang, and Y. Yan, pp.108-111.

  ➢ Using multi-spectral data, we estimate plasma parameters in the post-eruptive arcade observed on October 22, 2001 at 100 Mm above the limb: the temperature is 6 MK and the plasma density is (5-9) ¥cdot 10^9 cm^{-3}. We state a problem of the long-term equilibrium of the hot top of the arcade high in the corona: either the magnetic field surrounding the arcade well exceeds that one extrapolated in the potential approximation, or beta > 1 both inside and outside the arcade. A downflow observed in soft X-rays can contribute to the equilibrium.

- Butner, H. M., S. Takakuwa, S. B. Charnley, S. D. Rodgers, and J. V. Buckle [2007], "Chemical Differentiation in B5: $H^{13}CO^+$ and CH_3OH Fine Scale Variations," Proceedings in "Protostars and Planets V", LPI contribution no. 1286, p.8470.

  ➢ Not Available

- Byun, D.-Y., B.-C. Koo, K. Tatematsu, and K. Sunada [2006], "Interaction Between the Supernova Remnant HB 21 and Molecular Clouds," Astrophys. J., vol.637, pp.283-295.

  ➢ We have carried out ^{12}CO J=1-0 observations toward the mixed-morphology supernova remnant (SNR) HB 21 using the SRAO 6 m telescope. The whole area of the SNR was covered using full-beam grid spacing (2') and partly using half-beam spacing (1'). We discovered shocked clouds with broad (Deltav>~10 km s^{-1}) emission lines in the north, northwest, and center of the SNR. The large (~20') cloud in the northwest has a bow-shaped morphology and enhanced radio emission along the cloud boundary. Toward the central, X-ray-bright area of the remnant, sensitive CO observations have revealed small broad-line clouds. They are probable candidates for the evaporating clouds, which may be responsible for the enhanced thermal X-rays in the central area. Shocked clouds have also been discovered in the northern V-shaped radio structure. Our results suggest that the unusual radio features and the central thermal X-ray enhancements of HB 21 might be the result of an interaction with molecular clouds. High-resolution mappings of two shocked, 1' sized clumps were made with the NRO 45 m telescope. For the U-shaped clump in the north, we have found that temperature and density increase near the bottom of the U-shape. The observed features coincide with the theoretical expectation for a cloud swept by a shock wave propagating from the south to the north. For the other shocked clump in the south, the central velocity systematically changes with a gradient of 11 km s^{-1} pc^{-1}. We suggest 1.7 kpc as the distance to HB 21 by considering all available distance estimates.

- Cai, H.-B., Z.-Q. Shen, H. Sudou, L.-L. Shang, S. Iguchi, Y. Murata, Y. Taniguchi, K. Walamatsu, and H. Takaba [2007], "Multi-Epoch VLBA Observations of 3C 66A," Astron. Astrophys., vol.468, pp.963-971.

  ➢ We present the results of six-epoch Very Long Baseline Array (VLBA) observations of 3C 66A. The high-resolution Very Long Baseline Interferometer (VLBI) maps obtained at multi-frequency (2.3, 8.4, and 22.2 GHz) simultaneously enabled us to identify the brightest compact component with the core. We find that the spectrum of the core can be reasonably fitted by the synchrotron self-absorption model. Our VLBA maps show that the jet of 3C 66A has two

bendings at about 1.2 and 4 mas from the core. We also give possible identifications of our jet components with the components in previous VLBA observations by analysing their proper motions. We find consistent differences of the position from the core in one component between different frequencies at six epochs.

- Cameron, P. B., P. Chandra, A. Ray, S. R. Kulkarni, D. A. Frail, M. H. Wieringa, E. Nakar, E. S. Phinney, A. Miyazaki, M. Tsuboi, S. K. Okumura, N. Kawai, K. M. Menten, and F. Bertoldi [2005], "Detection of a Radio Counterpart to the 27 December 2004 Giant Flare from SGR 1806-20," Nature, vol.434, pp.1112-115.

➢ It was established over a decade ago that the remarkable high-energy transients known as soft gamma-ray repeaters (SGRs) are located in our Galaxy and originate from neutron stars with intense (1015G) magnetic fields-so-called ℧ magnetars'. On 27 December 2004, a giant flare with a fluence exceeding 0.3ergcm^{-2} was detected from SGR 1806-20. Here we report the detection of a fading radio counterpart to this event. We began a monitoring programme from 0.2 to 250GHz and obtained a high-resolution 21-cm radio spectrum that traces the intervening interstellar neutral hydrogen clouds. Analysis of the spectrum yields the first direct distance measurement of SGR 1806 - 20: the source is located at a distance greater than 6.4kpc and we argue that it is nearer than 9.8kpc. If correct, our distance estimate lowers the total energy of the explosion and relaxes the demands on theoretical models. The energetics and the rapid decay of the radio source are not compatible with the afterglow model that is usually invoked for gamma-ray bursts. Instead, we suggest that the rapidly decaying radio emission arises from the debris ejected during the explosion.

- Chen, Xi, Zhi-Qiang, H. Imai, and R. Kamohara [2006], "Inward Motions of the Compact SiO Masers around VX Sagittarii," Astrophys. J., vol.640, pp.982-994.

➢ We report Very Long Baseline Array (VLBA) observations of 43 GHz v=1, J=1-0 SiO masers in the circumstellar envelope of the M-type semiregular variable star VX Sgr at three epochs during 1999 April-May. These high-resolution VLBA images reveal a persistent ringlike distribution of SiO masers with a projected radius of ~3 stellar radii. The typical angular size of 0.5 mas for individual maser features was estimated from two-point correlation function analysis of maser spots. We found that the apparent size scale of maser features was distinctly smaller than that observed in the previous observations by comparing their fractions of the total power imaged. This change in the size scale of maser emission may be related to stellar activity that caused a large SiO flare during our observations. Our observations confirmed the asymmetric distribution of maser emission, but the overall morphology has changed significantly, with the majority of the maser clustering to the northeast of the star compared to the majority of the masers lying in the southwest in 1992. By identifying 42 matched maser features appearing in all three epochs, we determined the contraction of an SiO maser shell toward VX Sgr at a proper motion of -0.207±0.069 mas yr^{-1}, corresponding to a velocity of about 4 km s^{-1} at a distance of 1.7 kpc to VX Sgr. Such a velocity is on the order of the sound speed and can be easily explained by the gravitational infall of material from the circumstellar dust shell.

- Chifor, C., H. E. Mason, D. Tripathi, H. Isobe, and A. Asai [2006], "The Early Phases of a Solar Prominence Eruption and Associated Flare: a Multiwavelength Analysis," Astron. Astrophys., vol.458, pp.965-973.

➢ Aims. We aim to examine the precursor phases and early evolution of a prominence eruption associated with a M4-class flare and a partial halo coronal mass ejection (CME) observed on 2005 July 27. Our main goal is to investigate the precursor eruption signatures observed in EUV, X-ray and microwave emission and their relation to the prominence destabilisation.
Methods: We perform a multi-wavelength study of the prominence morphology and motion using high-cadence and spatial resolution EUV 171 Å images from the TRACE satellite. The high-temperature flare radiative emission in soft and hard X-rays are analysed through imaging and spectral modeling with RHESSI. Complementary microwave images (17 GHz and 34 GHz) from NoRH are also investigated. Results: The activation of the filament proceeds from one anchored footpoint. We observe "pre-eruption" brightenings in X-ray and EUV images, close to the erupting footpoint of the prominence, being temporally correlated to the point when the prominence first enters a slow-rise phase, and then an accelerated fast-rise phase. The brightness

temperature (T_b) of the prominence at 34 GHz is increasing during the eruption. We also find very good correlation between the prominence height-time profile and the spatially integrated soft X-ray (SXR) emission. Conclusions: We discuss the observed precursor brightenings with respect to possible mechanisms that might be responsible for the prominence destabilisation and acceleration. Our observations suggest that reconnection events localised beneath the erupting footpoint may eventually destabilise the entire prominence, causing the eruption.

- Cho, S.-H., H.-G. Kim, Y.-S. Park, C.-H. Choi, and N. Ukita [2005], "First detection of 28Si18O Maser and Thermal Emission from Orion KL," Astrophys. J. ,vol.622, pp. 390-392.

➢ We present the first astronomical detection of $^{28}Si^{18}O$ maser emission toward Orion KL by using the laboratory-measured line frequencies of $^{28}Si^{18}O$. The simple model of a $^{28}Si^{18}O$ maser condition adopting a line overlap mechanism leads us to confirm a maser action in spite of its lowest relative abundance, i.e., $^{28}Si^{16}O/^{28}Si^{18}O \sim 500$. Mow the $^{28}Si^{18}O$ lines can be used to investigate interstellar physics and chemistry, especially when the depths of the spectral lines of the main species are high.

- Choi, M., T. Kamazaki, K. Tatematsu, and J.-F. Panis [2004], "Structure of the Dense Molecular Gas in the NGC 1333 IRAS 4 Region," Astrophys. J., vol.617, pp.1157-1166.

➢ The NGC 1333 IRAS 4 region was observed in the HCN and HCO$^+$ J=1→0 lines using a single-dish telescope and in the 2.1 mm continuum and the H$_2$CO JK-1K+1=2^{12}→1^{11} line using an interferometer. The single-dish maps show that there are at least two velocity components in emission: one at V$_{LSR}$=6.7 km s^{-1} associated with the IRAS 4 core, and the other at ~8 km s^{-1} associated with a cloud extended from the SVS 13 complex. In addition, there is a foreground cold layer at ~8 km s^{-1} that causes absorption over most of the mapped area. The cloud structure suggests that the blue-skewed line profile of IRAS 4A/B may not be a sign of protostellar collapse. Examinations of both single-dish and interferometric maps suggest that the dip previously seen in the interferometric spectra toward IRAS 4A/B may be caused mostly by the large-scale foreground layer and partly by missing short-spacing flux. Absorption by an infalling envelope with an unusual velocity profile cannot be ruled out. The HCO$^+$ map revealed other molecular cores, one associated with SK 1, and the other with SK 10/14. They are probable sites of star formation.

- Choi, M., K. Tatematsu, G. Park, and M. Kang [2007], "Ammonia Imaging of the Disks in the NGC 1333 IRAS 4A Protobinary System," Astrophys. J. (Letters), vol.667, pp.L183-L186.

➢ The NGC 1333 IRAS 4A protobinary was observed in the ammonia (2, 2) and (3, 3) lines and in the 1.3 cm continuum with a high resolution (about 1.0"). The ammonia maps show two compact sources, one for each protostar, and they are probably protostellar accretion disks. The disk associated with IRAS 4A2 is seen nearly edge-on and shows an indication of rotation. The A2 disk is brighter in the ammonia lines but dimmer in the dust continuum than its sibling disk, with the ammonia-to-dust flux ratios different by about an order of magnitude. This difference suggests that the twin disks have surprisingly dissimilar characters, one gas-rich and the other dusty. The A2 disk may be unusually active or hot, as indicated by its association with water vapor masers. The existence of two very dissimilar disks in a binary system suggests that the formation process of multiple systems has a controlling agent lacking in the isolated star formation process and that stars belonging to a multiple system do not necessarily evolve in phase with each other.

- Deguchi, S., J. Nakashima, and S. Takano [2004], "Study of the Bipolar Nebula IRAS 19312+1950. II. Circumstellar Chemistry," Publ. Astron. Soc. Japan, vol.56, pp.1083-1098.

➢ The bipolar nebula IRAS 19312+1950 is a unique SiO maser source exhibiting both properties of young and evolved objects. To clarify the nature of this object, we made molecular line observations with the Nobeyama 45-m radio telescope. We detected emission from O-bearing (HCO$^+$, SiO, SO, and SO$_2$), C- and N-bearing molecules (CN, CS, HCN, HNC, NH$_3$, N$_2$H$^+$, CH$_3$N, H$_2$CS, and CH$_3$OH), and their isotopic species (C^{17}O, ^{13}C^{18}O, and C^{34}S). The line profiles consist of weak broad ($\Delta \sim$ 30 kms^{-1}) and/or strong narrow ($\Delta <=$ 5 kms^{-1}) components, depending on the molecular species. Strong time variations of H$_2$O and SiO masers were also observed. Numerical modeling of the envelope with the LVG-code resulted in a good fit of the model with a mass loss rate of 2.6 x 10^{-4} M yr^{-1} to the observed intensities for the broad-component lines. On the other hand, non-O-bearing molecules, which only have narrow

profiles, were found to have abundances typical of those in cool dust clouds. No isotopic enrichment was found, indicating little evidence of the narrow cool component being ejecta of the central AGB star or a possible companion. These facts compelled us to conclude that IRAS 19312+1950 is an exotic mass-losing evolved star embedded in a low-mass ($\sim$ 20M) dark cloud.

- Deguchi, S., N. Matsunaga, and H. Fukushi [2005a], "Detection of SiO Maser Emission in V838 Mon," Publ. Astron. Soc. Japan, vol.57, pp.L25-L28.

➢ We report on the detection of 43GHz SiO maser emission in V838 Mon, a prototype of a new class of eruptive variables, in which a red supergiant was formed after a nova-like eruption in 2002. The detection of SiO masers indicates that the star formed after the eruption is indeed a kind of cool mass-losing object with circumstellar masers. The measured radial velocity and the intensity of maser emission are consistent with the object being located at a distance of about 7kpc from the sun. It also suggests that a considerable percentage of SiO masing objects in the Galaxy are formed by the same mechanism as that which created V838 Mon.

- Deguchi, S., J. Nakashima, T. Miyata, and Y. Ita [2005b], "Observations of Stellar Maser Sources with No IRAS Counterpart," Publ. Astron. Soc. Japan, vol.57, pp.933-949.

➢ We investigated stellar maser sources with no IRAS counterpart at the radio, middle-infrared, and near-infrared wavelengths. A 43GHz SiO maser search for 120 2MASS/MSX objects, and 10 OH 1612MHz sources with no or a very faint MSX counterpart, resulted in 43 SiO detections: one OH 1612MHz source, 2 near-infrared stars, and 40 MSX sources. Additional near-infrared J-, H-, and K-band observations of the OH 1612MHz sources detected 5 near-infrared counterparts. Furthermore, middle-infrared imaging observations at 8.8, 9.7, 12.4, and 24.5mum with the Subaru 8.2-m telescope found counterparts for 2 near-infrared stars with SiO masers, and counterparts for 6 OH 1612MHz sources. However, 4 OH 1612MHz sources were not detected in the sensitive near- and middle-infrared searches; three of these are relatively strong OH maser sources for which the positions were known accurately. We conclude that one of these (OH 028.286i-01.801) must be a young object in a star-forming region.

- Deguchi, S., A. Miyazaki, and Y. Chol Minh [2006], "HOCO$^+$ toward the Galactic Center," Publ. Astron. Soc. Japan, vol.58, pp.279-986.

➢ We have identified a weak thermal line, U42.767, which has been detected only in the directions toward Sgr A and Sgr B2, as the HOCO$^+$ 2_{02}-1_{01} transition. Because of the proximity of this line to the SiO maser line at 42.821 GHz (J=1-0 v=2), it was observable simultaneously in $\sim$ 43 GHz SiO maser searches at Nobeyama. From the past data of SiO maser surveys of infrared objects in the Galactic center, we created a map of emission distribution of HOCO$^+$ in the Sgr A molecular cloud as well as maps of the ^{29}SiO J = 1-0 v = 0 thermal emission and H53α emission. The emission distribution of HOCO$^+$ was quite similar to that of ^{29}SiO emission. This suggests that an enhancement of the HOCO$^+$ abundance in the galactic center is induced by shock activities,which release CO_2 molecules frozen on grains into gases.

- Deguchi, S., J. Nakashima, N. Koning, and S. Kwok [2007a], "Evolution of Master/IR Objects with Very Thick Dust Envelopes," Proc. of the IAUS. 234, "Planetary nebulae in our galaxy and beyond", eds. M. J. Barlow, and R. H. Mendez, pp.385-386.

➢ Some stellar maser sources at preplanetary stage have very thick circumstellar envelopes, for which no near-infrared identifications have been made. We investigated such stars at radio/NIR/MIR wavelengths using the NRO 45-m, ANU 2.2-m, UH 2.2-m, and SUBARU 8.2-m telescopes. Furthermore, using the Spitzer/Glimpse survey of the Galactic plane, we found counterparts in the 3.6 micron band for all of the OH/IR objects without previous NIR identification. One of the most interesting objects among these is IRAS 18450-0148 (W43A) with collimated outflows. Their spectra indicate that they have massive thick disks.

- Deguchi, S., T. Fujii, Y. Ita, H. Imai, H. Izumiura, O. Kameya, N. Matsunaga, A. Miyazaki, A. Mizutani, Y. Nakada, J. Nakashima, and A. Winnberg [2007b], "An SiO Maser Search off the Galactic Plane," Publ. Astron. Soc. Japan, vol.59, pp.559-587.

➢ We searched for the SiO J=1-0 v= 1 and 2 maser lines at $\sim$ 43 GHz in 277 2MASS/MSX/IRAS sources off the Galactic plane (|b|> 3°), which resulted in 119 (112 new) detections. Among the new detections, are two very faint objects with MSX 12 μm flux densities below 2 Jy. These are likely to be O-rich AGB-stars associated with dwarf-galaxy tidal tails. The sample also includes

medium bright MSX objects at moderately high Galactic latitudes (3°<|b|<5°) and in the IRAS gap at higher latitudes. A signature of a warp of the inner Galactic disk is found for a disk subsample. This warp appears relatively strongly in the area of 0°<l<45° and 3°<|b|<5°. We also found a group of stars that does not follow to the Galactic rotation. This feature appears in the Galactic disk at l~ 27°, and extends more than 15° in Galactic latitude, like a stream of tidal debris from a dwarf galaxy.

- Deguchi, S., N. Matsunaga, and H. Fukushi [2007c], "SiO Maser Emission in V838 Mon," Proc. of the "The Nature of V838 Mon and its Light Echo", eds. R. L. M. Corradi and U. Munari, ASP Conf. Ser. vol.363, pp.81-86.

➢ We present further radio observations of V838 Mon in the SiO and several other molecular lines after 2005 April. The detection of SiO masers in this object indicates that the star formed after eruption is indeed a cool mass-losing object with circumstellar masers. Further observations of SiO masers found a sudden increase within a few months and succeeding flattening of maser intensities, suggesting a sudden slow onset of mass-loss from the central star after the 2002 eruption. A detection of CO emission 30" north of the star is also reported. A possible implication for stellar evolution in related objects is given.

- Deguchi, S., J. Nakashima, S. Kwok, and N. Koning [2007d], "Identification of Very Red Counterparts of SiO Maser and OH/IR Objects in the GLIMPSE Survey," Astrophys. J., vol.664, pp.1130-1143.

➢ Using the 3.6, 4.5, 5.8, and 8.0 mum images with 1.2" pixel resolution of the Spitzer/GLIMPSE survey, we investigated 23 masing and 18 very red objects, which are extremely faint in the near-infrared bands. We found the counterpart for all of the selected objects on the GLIMPSE images. Color indices in these IR bands suggest the presence of a high-extinction layer of more than a few tenths of a solar mass in front of the central star. Furthermore, radio observations in the SiO and H_2O maser lines found characteristic maser-line spectra of the embedded objects, e.g., the SiO J=1-0 line intensity in the v=2 state is stronger than that of the v=1 state, or very thick circumstellar matter, some of which cannot be ascribed to the AGB wind of the central star. Individually interesting objects are discussed, including two newly found water fountains and an SiO source accompanying a nebulosity.

- DeLuca, E. E., M. A. Weber, A. L. Sette, L. Golub, K. Shibasaki, T. Sakao, and R. Kano [2005], "Science of the X-Ray Sun: The X-Ray Telescope on Solar-B," Adv. Sp. Res., vol.36, pp.1489-1493.

➢ The X-Ray Telescope (XRT) on Solar-B is designed to provide high resolution, high cadence observations of the X-ray corona through a wide range of filters. The XRT science team has identified four general problems in coronal physics as the primary science goals for our instrument. Each of these goals will require collaborative observations from the other Solar-B instruments: EUV Imaging Spectrograph (EIS) and Solar Optical Telescope Focal Plane Package (SOT). We will discuss the science goals and observations needed to address those goals.

- Dobashi, K., H. Uehara, R. Kandori, T. Sakurai, M. Kaiden, T. Umemoto, and F. Sato [2005], "Atlas and Catalog of Dark Cluds Based on Digitized Sky Survey I," Publ. Astron. Soc. Japan, vol.57, S1-S386.

➢ We present a quantitative atlas and catalog of dark clouds derived by using the optical database "Digitized Sky Survey I". Applying a traditional star-count technique to 1043 plates contained in the database, we produced an AV map covering the entire region in the galactic latitude range |b|≤40°. The map was drawn at two different angular resolutions of 6' and 18', and is shown in detail in a series of figures in this paper. Based on the AV map, we identified 2448 dark clouds and 2841 clumps located inside them. Some physical parameters, such as the position, extent, and optical extinction, were measured for each of the clouds and clumps. We also searched for counterparts among already known dark clouds in the literature. The catalog of dark clouds presented in this paper lists the cloud parameters as well as the counterparts.

- Dobashi, K., H. Uehara, R. Kandori, T. Sakurai, M. Kaiden, T. Umemoto, and F. Sato [2007], "Atlas and Catalog Dark Clouds Based on Digitized Sky Survey I," Proceedings in "Protostars and Planets V", LPI contribution no. 1286, p.8137.

➢ Not Available

- Doi, A., S. Kameno, and M. Inoue [2005a], "Radio Spectra of the Low-Luminosity Active

Galactic Nucleus NGC 266 at Centimetre-to-Submillimetre Wavelengths," Mon. Not. R. Astron. Soc., vol.360, pp.119-124.

➢ We report multi-frequency and multi-epoch radio continuum observations with multi-spatial resolution for the low-luminosity active galactic nucleus (LLAGN) NGC 266. In the centimetre regime, we find diffuse components with Very Large Array (VLA) observations, and a variable compact core with a rising spectrum with Very Long Baseline Array (VLBA) observations. Although the spectral index of the rising spectrum is consistent with the prediction of the simple advection-dominated accretion flow (ADAF) model, the observed radio power is slightly high compared with that of the model prediction. A spectral break at centimetre-to-millimetre wavelengths is inferred from the upper limits of flux densities from Nobeyama Millimetre Array (NMA) and James Clerk Maxwell Telescope (JCMT) data at millimetre and submillimetre wavelengths, respectively. More complicated considerations are required for the theoretical model to interpret such observed radio properties.

● Doi, A., S. Kameno, K. Kohno, K. Nakanishi, and M. Inoue [2005b], "A High-Frequency Radio Survey of Low-Luminosity Active Galactic Nuclei," Mon. Not. R. Astron. Soc., vol.363, pp.692-704.

➢ We investigate the high-frequency radio spectra of 20 low-luminosity active galactic nuclei (LLAGNs) with compact radio cores. Our millimetre survey with the Nobeyama Millimetre Array (NMA) and analyses of submillimetre archival data that had been obtained with the Submillimetre Common User Bolometer Array (SCUBA) on the James Clerk Maxwell Telescope (JCMT) reveal the following properties. At least half of the LLAGNs show inverted spectra between 15 and 96 GHz; we use the published data at 15 GHz with the Very Large Array (VLA) in a 0.15-arcsec resolution and our measurements at 96 GHz with the NMA in a 7-arcsec resolution. The inverted spectra are not artificially made due to their unmatched beam sizes, because of little diffuse contamination from dust, HII regions, or extended jets in these LLAGNs. Such high-frequency inverted spectra are apparently consistent with a `submillimetre bump', which is predicted by an advection-dominated accretion flow (ADAF) model. We find a strong correlation between the high-frequency spectral index and low-frequency core power measured with very-long-baseline-interferometry (VLBI) instruments. The inverted spectra are found exclusively in low-core-power sources, while steep spectra are in high-core-power ones with prominent pc-scale jets. This suggests that the ADAF and non-thermal jets may coexist. The flux ratios between disc and jet seem to be different from LLAGN to LLAGN; disc components can be seen in nuclear radio spectra only if the jets are faint.

● Doi, A., K. Fujisawa, A. Habe, M. Honma, N. Kawaguchi, H. Kobayashi, Y. Murata, T. Omodaka, H. Sudou, and H. Takaba [2006a], "Bigradient Phase Referencing," Publ. Astron. Soc. Japan, vol.58, pp.777-785.

➢ We propose bigradient phase referencing (BPR), a new radio-observation technique, and report on its performance using the Japanese vely-long-basline-interferometry network (JVN). In this methods, a weak source is detected by phase-referencing using a primary calibrator, in order to play a role as a secondary calibrator for phasa-referencing to a weal target. We will be given the opportunity to select a calibrator from of milli-Jansky sources, one of which may be located at a position closer to the target. With such a smaller separation, high-quality phase-referencing can be achieved. A subsequent more-sophisticated calibration can relocate the array's focus to a hypothetical point much closer to the target; a higher quality of phase referencing is available. Our demonstrative observations with strong radio sources have proved the capabilities of the BPR in terms of the image dynamic ranges and astrometric reproducibility. The image dynamic range on a target has been improved by a factor of about six compared to that of normal phase-referencing; the resultant position difference of the target's emission between two epochs was only 62±50 miroarcsecond, even with less than 2300-km baselines at 8.4 GHz and fast-switching between a target-calibrator pair separated by 2°. 1.

● Doi, A., H. Nagai, K. Asada, S. Kameno, K. Wajima, and M. Inoue [2006b], "VLBI Observations of the Most Radio-Loud, Narrow-Line Quasar SDSS J094857.3+002225," Publ. Astron. Soc. Japan, vol.58, pp.829-834.

➢ We observed the narrow-line quasar SDSS J094857.3+002225, which is known to have the highest radio loudness in the narrow-line Seyfert 1 galaxies (NLS1s), at 1.7-15.4 GHz with the

Very Long Baseline Array (VLBA). This is the first very-long-baseline interferometry (VLBI) investigation of a radio-loud NLS1. We independently discovered (1) very high brightness temperatures from its compactness in a VLBA image and (2) flux variation among the VLBA observation and our other observations with the VLBA and the Very Large Array (VLA). A Doppler factor larger than 2.7-5.5 was required to meet an intrinsic limit of brightness temperature in the rest frame. This is evidence for highly relativistic nonthermal jets in an NLS1. We suggest that the Doppler factor is one of the most important parameters in the determination of the radio loudness of NLS1s. The accretion disk of SDSS J094857.3+002225 is probably in a very high state, rather than the high/soft state, by analog with X-ray binaries with strong radio outbursts and superluminal jets, such as GRS 19156105.

- Doi, A., S. Kameno, and M. Inoue [2006c], "Radio Spectra and Radio-Loudness of Low-Luminosity AGNs," J. Physics: Conference Series, vol.54, pp.335-341.

➢ We investigated the empirical relation between black hole mass (m_{BH}), Eddington ratio (L_{bol}/L_{Edd}), and radio loudness (RRL a ratio of radio to optical luminosity) of nearby low-luminosity active galactic nuclei (LLAGNs). A best-fit plane was found in the three-dimensional space using a sample of 48 nearby LLAGNs: $R_{RL} = m_{BH}0^{-52\pm0.14}(L_{bol}/L_{Edd})^{-0.39\pm0.08}$. This suggests that spectral energy distributions of LLAGNs are controlled by both the black hole mass and accretion rate.

- Doi, A., K. Fujisawa, M. Inoue, K. Wajima, H. Nagai, K. Harada, K. Suematsu, A. Habe, M. Honma, N. Kawaguchi, F. Kawai, H. Kobayashi, Y. Koyama, H. Kuboki, Y. Murata, T. Omodaka, K. Sorai, H. Sudou, H. Takaba, K. Takashima, K. Takeda, S. Tamura, and K. Wakamatsu [2007], "Japanese VLBI Network Observations of Radio-Loud Narrow-Line Seyfert 1 Galaxies," Publ. Astron. Soc. Japan, vol.59, pp.703-709.

➢ We performed phase-reference very long baseline interferometry (VLBI) observations on five radio-loud narrow-line Seyfert 1 galaxies (NLS1s) at 8.4 GHz with the Japanese VLBI Network (JVN). Each of the five targets (RXS J08066+7248, RXS J16290+4007, RXS J16333+4718, RXS J16446+2619, and B3 1702+457) in milli-Jansky levels were detected and unresolved in milli-arcsecond resolutions, i.e., with brightness temperatures higher than 107 K. The nonthermal processes of active galactic nuclei (AGN) activity, rather than starbursts, are predominantly responsible for the radio emissions from these NLS1s. Out of the nine known radio-loud NLS1s, including the ones chosen for this study, we found that the four most radio-loud objects exclusively have inverted spectra. This suggests a possibility that these NLS1s are radio-loud due to Doppler beaming, which can apparently enhance both the radio power and the spectral frequency.

- Egusa, F., Y. Sofue, and H. Nakanishi [2004], "Offsets between Hα and CO Arms of a Spiral Galaxy, NGC 4254: A New Method for Determining the Pattern Speed of Spiral Galaxies," Publ. Astron. Soc. Japan, vol.56, pp.L45-L48.

➢ We examined the offsets between H II regions and molecular clouds belonging to spiral arms of a late-type spiral galaxy, NGC 4254 (M99). We used a high-resolution ^{12}CO (J = 1-0) image obtained by Nobeyama Millimeter Array (NMA) and an Hα image. We derived angular offsets (θ) in the galactic disk, and found that they show a linear dependence on the angular rotation velocity of the gas (Ω_G). This linear relation can be expressed by the equation $\theta = (\Omega_G - \Omega_P) t_{H\alpha}$, where Ω_P and $t_{H\alpha}$ are constant. Here, Ω_P corresponds to the pattern speed of the spiral arms and $t_{H\alpha}$ is interpreted as being the timescale between the peak compression of the molecular gas in the spiral arms and the peak of massive star formation. We could thus determine Ω_P and $t_{H\alpha}$ simultaneously by fitting a line to our θ-G plot, if we assume they are constant. From the plot for NGC4254, we obtained $t_{H\alpha} = (4.8\pm1.2) \times 10^6$ yr and $\Omega_P = 26^{+10}_{-6}$ km s^{-1} kpc^{-1}, which are consistent with previous studies. We suggest that this θ-Ω_G plot can be a new tool to determine the pattern speed and the typical timescale needed for star formations.

- Egusa, F., Y. Sofue, and H. Nakanishi [2006], "Determination of Star Formation Timescale and Pattern Speed of Spiral Galaxies," International Astronomical Union XXVIth General Assembly, Pragua, 14-25 August, 2006, abstract book, p.123 (S237-106 Poster).

➢ We developed a method to determine the star formation timescale and pattern speed in spiral galaxies. Though they are important and fundamental parameters, it has been difficult to derive their value directly from observations. Our method utilizes azimuthal offsets between arms of

HII regions and molecular clouds for the determination. Assuming a circular rotation, a plot of offsets versus angular rotation velocities should be fitted with a line, whose gradient is star formation timescale and abscissa intercept is pattern speed. We have succeeded in deriving these two parameters for three nearby spiral galaxies so far, by the use of CO and H-alpha images from the literatures. Results are listed in Table 1. The derived values of pattern speed are of course different for galaxies, star formation timescales, however, fall into a narrow range: about 4 to 7 Myr. since this value is consistent to a typical teimscale for molecular clouds to collapse gravitationally, global star formation in spiral arms might be mainly triggered by the gravitational collapse of molecular gas.

- Endo, A., K. Kohno, B. Hatsukade, K. Ohta, N. Kawai, Y. Sofue, K. Nakanishi, T. Tosaki, B. Vila-Vilaro, N. Kuno, T. Okuda, and K. Muraoka [2007], "A Revised Estimated of the CO (J=1-0) Emission from the Host Galaxy of GRB 030329 Using the Nobeyama Millimeter Array," Astrophys. J., vol.659, pp.1431-1437.

➢ A sensitive observation of the CO J=1-0 molecular line emission in the host galaxy of GRB 030329 (z=0.1685) has been performed using the Nobeyama Millimeter Array to detect molecular gas and hidden star formation. No sign of CO emission was found, which invalidates our previous report of the presence of molecular gas. The 3σ upper limit on the CO line luminosity (L'_{CO}) of the host galaxy is 6.9×10^8 K km s^{-1} pc^2. The lower limit to the host galaxy's metallicity is estimated to be $12+\log(O/H) \sim 7.9$, which yields a conversion factor from CO line luminosity to H_2 of $\alpha_{CO}=40$ M_{solar} (K km s^{-1} pc^2)$^{-1}$. Assuming this factor, the 3σ upper limit on the molecular gas mass of the host galaxy is 2.8×10^{10} M_{solar}. Based on the Schmidt law, the 3 sigma upper limit on the total star formation rate (SFR) of the host galaxy is estimated to be 38 M_{solar} yr^{-1}. These results independently confirm inferences from previous observations in the optical, submillimeter, and X-ray bands, which regard this host galaxy as a compact dwarf and not a massive, aggressively star-forming galaxy. Finally, the SFRs of GRB host galaxies, estimated using various techniques immune to dust obscuration, including our CO luminosity measurements, are compared with the SFRs of the same galaxies estimated using extinction-corrected optical/UV tracers. We show that most of the SFRs measured in extinction-free wavelengths, including positive detections and upper limits, are larger by from 1 to a few orders of magnitude compared with the SFRs of the same galaxies measured by optical/UV tracers.

- Ezawa, H., and the ASTE team [2005a], "Progress and Current Status of the Atacama Submillimeter Telescope Experiment (ASTE)," Proc. of the 9th Asian-Pacific Regional IAU Meeting, pp.278-279.

➢ The Atacama Submillimeter Telescope Experiment (ASTE) is a project to operate a 10 m submillimeter telescope at the high altitude site in the Atacama desert of northern Chile. The telescope was transported to Chile in 2002, and following the extensive studies, ASTE has started its astronomical observation since 2004. The main reflector of the telescope has a high accuracy with its error within 19 μm r.m.s. The 345 GHz band receiver employing the plug-in cryogenics, realizes a good performance with T_{sys} as well as 130 K. The spectrometer consists of four XF-type auto-correlators each with 1024 spectral channels covering bandwidth of 512 MHz. The entire telescope system can be controlled remotely from our operation base in San Pedro de Atacama or even from Japan through the satellite link and network connection.

- Ezawa, H., R. Kawabe, K. Kohno, S. Yamamoto, and the ASTE team [2005b], "ASTE: The Atacama Submillimeter Telescope Experiment," Proc. at the XXVIIIth General Assembly of the URSI, October 2005, India. (CD-ROM : JB2.1)

➢ Not Available

- Fujii, T., S. Deguchi, Y. Ita, H. Izumiura, O. Kameya, A. Miyazaki, and Y. Nakada [2006], "SiO Maser Survey of the Inner Bar of the Galactic Bulge," Publ. Astron. Soc. Japan, vol.58, pp.529-561.

➢ We surveyed 291 MSX/2MASS infrared objects in the 7°x 2° area of the galactic center in the 43GHz SiO J = 1-0 ν = 1 and 2 mass lines, obtaining accurate radial velocities of 163 detected objects. The surveyed area is the region where the IRAS catalog is incomplete due to contamination by high source density. The objects in the present MSX/2MASS sample were chosen to have similar infrared characteristics to those of the previous SiO-maser-survey

samples based on the color-selected IRAS sources. The sampling based on the 2MASS catalog causes a bias to the foreside objects of the bulge due to heavy obscuration by interstellar dust; the detections considerably leaned on the $V_{lsr} < 0$ side. The l=V diagram reveals two conspicuous feature, which were not present or tenuous with $|l| < 1°.5$, which is likely to be associated with the inner bar, and the other feature having considerably eccentric velocities, more then those of the normal x_1 -orbit family feature. The extinction-corrected K magnitudes (if used as a distance modulus) tend to show a sequential deposition of these objects along the line of sight toward the galactic center, depending on their radial velocities. The tendency that appeared in the distance measures is consistent with the bulge-bar dynamical model utilizing the periodic orbit families in the bar potential.

- Fukushi, H., N. Matsunaga, T. Tanabe, Y. Nakada, S. Deguchi, A. Ishihara, N. Kusakabe, M. Tamura, and IRSF/SIRPOL team [2007], "Near-IR Scattered Light in V838 Monocerotis," Proc. of the "The Nature of V838 Mon and its Light Echo", eds. R. L. M. Corradi and U. Munari, ASP Conf. Ser. vol.363, pp.181-183.

➤ A J-band polarimetric image was taken for V838 Monocerotis with the imaging polarimeter SIRPOL on the IRSF 1.4-m telescope at the South African Astronomical Observatory. A diffuse nebulosity is seen in the north-east and the south-west directions of the central star in the PI image. The polarization vectors reveal a circular feature indicating that the nebulous light is the scattered light from the central star. The polarization degree reaches up to 40-percent in the outer part of the nebula.

- Furuya, R. S., R. Cesaroni, S. Takahashi, M. Momose, L. Testi, H. Shinnnaga, and C. Codella [2005a], "Relative Evolutionary Timescale of Hot Molecular Cores with Respect to Ultracompact HII Regions," Astrophys. J., vol.624, pp.827-831.

➤ Using the Owens Valley and Nobeyama Radio Observatory interferometers, we carried out an unbiased search for hot molecular cores and ultracompact (UC) H II regions toward the high-mass star-forming region G19.61-0.23. In addition, we performed 1.2 mm imaging with SIMBA and retrieved 3.5 and 2 cm images from the VLA archive database. The newly obtained 3 mm image brings information on a cluster of high-mass (proto)stars located in the innermost and densest part of the parsec-scale clump detected in the 1.2 mm continuum. We identify a total of 10 high-mass young stellar objects: one hot core (HC) and nine UC H II regions, whose physical parameters are obtained from model fits to their continuum spectra. The ratio between the current and expected final radii of the UC H II regions ranges from 0.3 to 0.9, which leaves the possibility that all O-B stars formed simultaneously. Under the opposite assumption, namely, that star formation occurred randomly, we estimate that the HC lifetime is less than ~1/3 of that of UC H II regions on the basis of the source number ratio between them.

- Furuya, R. S., Y. Kitamura, A. Wootten, M. J. Claussen, and R. Kawabe [2005b], "Proper Motion of H_2O Masers in IRAS 20050+2720 MMS1: an AU Scale Jet Associated with an Intermediate-Mass Class 0 Source," Astron. Astrophys., vol.438, pp.571-583.

➤ We conducted a 4 epoch, 3 month, VLBA proper motion study of H_2O masers toward an intermediate-mass class 0 source IRAS 20050+2720 MMS1 (d = 700 pc). The region of IRAS 20050+2720 contains at least 3 bright young stellar objects at millimeter to submillimeter wavelengths and shows three pairs of CO outflow lobes: the brightest source MMS1, which shows an extremely high velocity (EHV) wing emission, is believed to drive the outflow(s). From milli-arcsecond (mas) resolution VLBA images, we found two groups of H_2O maser spots at the center of the submillimeter core of MMS1. One group consists of more than ~ 50 intense maser spots; the other group consisting of several weaker maser spots is located at 18 AU south-west of the intense group. Distribution of the maser spots in the intense group shows an arc-shaped structure which includes the maser spots that showed a clear velocity gradient. The spatial and velocity structures of the maser spots in the arc-shape did not significantly change through the 4 epochs. Furthermore, we found a relative proper motion between the two groups. Their projected separation increased by 1.13±0.11 mas over the 4 epochs along a line connecting them (corresponding to a transverse velocity of 14.4 km s^{-1}). The spatial and velocity structures of the intense group and the relative proper motions strongly suggest that the maser emission is associated with a protostellar jet. Comparing the observed LSR velocities with calculated radial velocities from a simple biconical jet model, we conclude that the most of the maser emission is

likely to be associated with an accelerating biconical jet that has large opening angle of about 70°. The large opening angle of the jet traced by the maser would support the hypothesis that poor collimation is an inherent property of luminous (proto)stars.

- Furuya, R. S., Y. Kitamura, and H. Shinnaga [2006], "The Initial Conditions for Gravitational Collapse of a Core: An Extremely Young Low-Mass Class 0 Protostar GF 9-2," Astrophys. J., vol.653, pp.1369-1390.

➤ We present a study of the natal core harboring the low-mass Class 0 protostar GF 9-2 in the filamentary dark cloud GF 9 using the Nobeyama 45 m and CSO 10.4 m telescopes and the OVRO millimeter array. GF 9-2 is unique in the sense that it show H_2O masers, a clear signpost of protostar formation, but dose not have a high-velocity large-scale outflow. These facts indicate that the GF 9-2 core is early enough after star formation that it still retains some information of initial conditions for collapse. Our 350 mum dust continuum image identified a protostellar envelope with an extent of $\cong$5400 AU in the center of the molecular core $\cong$0.08 pc in size. The envelope mass is estimated to be $\cong$0.6 M_{solar} from the 350 mum flux density, while the LTE mass of the core is $\cong$3 M_{solar} from molecular line. We found that the core has a radial density profile of rho(r)~r^{-2} for the 0.003 <~r/pc<~0.08 region and that the velocity width of the core gas increases inward, while the outermost region maintains a velocity dispersion of a few times the ambient sound speed. If we interpret the broadened velocity width as infall, the core collapse can be well described by an extension of the Larson-Penston solution for the period after formation of a central star. We derived the mass accretion rate of $\cong$3 x 10^{-5} M_{solar} yr^{-1} from infall velocity of $\cong$ 0.3 km s^{-1} at r 7000 AU. Furthermore, we found evidence that a protobinary is being formed at the core center. All of the results suggest that the GF 9-2 core has been undergoing gravitational collapse for <~5000 yr since the protostar formation and that the unstable state unitiated the collapse $\cong$2 x 10^5 yr (the free-fall time) ago.

- Gelfreikh, G. B., K. Shibasaki, E. Yu. Nagovitsyna, andYu. A. Nagovitsyn [2004], "Analysis of Quasi-Periodic Oscillations of Position and Brightness of Details of the Radio Sources of the Solar Active Regions Based on Observations Made with the Radio Heliograph Nobeyama," Proc. of the IAU Symp. 223, "Multi-Wavelength Investigations of Solar Activity", eds. A. V. Stepanov, E. E. Benevolenskaya, and A. G. Kosovivhev, pp.245-246.

➤ As based on analysis of radio maps at the wavelength of 1.76 cm obtained from observations at the radio heliograph Nobeyama the parameters of oscillation processes in solar active regions were studied. As a technique for data processing wavelet analysis was used. The inherent periodicity in oscillations submits the existence of a resonance structure for some kinds of MHD waves in the plasma of the solar atmosphere.

- Golub, L., E. DeLuca, G. Austin, J. Bookbinder, D. Caldwell, P. Cheimets, J. Cirtain, M. Cosmo, P. Reid, A. Sette, M. Weber, T. Sakao, R. Kano, K. Shibasaki, H. Hara, S. Tsuneta, K. Kumagai, T. Tamura, M. Shimojo, J. McCracken, J. Carpenter, H. Haight, R. Siler, E. Wright, J. Tucker, H. Rutledge, M. Barbera, G. Peres, and S. Varisco [2007], "The X-Ray Telescope (XRT) for the Hinode Mission," Solar Phys., vol.243, pp.63-86.

➤ The X-ray Telescope (XRT) of the Hinode mission provides an unprecedented combination of spatial and temporal resolution in solar coronal studies. The high sensitivity and broad dynamic range of XRT, coupled with the spacecraft's onboard memory capacity and the planned downlink capability will permit a broad range of coronal studies over an extended period of time, for targets ranging from quiet Sun to X-flares. This paper discusses in detail the design, calibration, and measured performance of the XRT instrument up to the focal plane. The CCD camera and data handling are discussed separately in a companion paper.

- Grechnev, V. V., A. M. Uralov, V. G. Zandanov, G. V. Rudenko, V. N. Borovik, I. V. Grigorieva, V. A. Slemzin, S. A. Bogachev, S. V. Kuzin, I. A. Zhitnik, A. A. Pertsov, K. Shibasaki, and M. A. Livshits [2006a], "Plasma Parameters in a post-Eruptive Arcade Observed with CORONAS-F/SPIRIT, Yohkoh/SXT, SOHO/EIT, and in Microwaves," Publ. Astron. Soc. Japan, vol.58, pp.55-68.

➤ The SPectroheliographIc X-Ray Imaging Telescope (SPIRIT) aboard the CORONAS-F spacecraft sometimes observes in the Mg XII 8.42Å line (T_{max} ~ 9 MK) large, bright features existing for many hours high in the corona. This fact suggests that plasma beta there might not

be small. We identify such a feature observed on 2001 October 22 at a height of 100Mm with a hot part of a post-eruptive arcade. Using multi-spectral data and radio astronomy methods, we estimate the plasma parameters in the arcade and reveal the coronal magnetic configuration. Several hours after the eruption, the temperature in the arcade was 6-8MK, and the plasma density was $(5-10) \cdot 10^9$ cm^{-3}. We confirm the results by the accord of the quantities obtained from different observations using different methods and by the extrapolation of the photospheric magnetograms into the corona, from which we have obtained a magnetic field strength of about 7G at that height. Hence, indeed beta ≥ 1 in the post-eruptive arcade. The high-beta possibility had previously been stated, e.g., by Ichimoto et al. (1994), but still not investigated. We address this issue in terms of the "standard flare model" elaborated by Shibata and Yokoyama. During this event, Yohkoh/SXT observed McKenzie-Hudson dark moving features. Those features are filled with cold material, if they are not empty, and may affect the arcade.

- Grechnev, V. V., A. M. Uralov, V. G. Zandanov, N. Y. Baranov, and K. Shibasaki [2006b], "Observations of Prominence Eruptions with Two Radioheliographs, SSRT, and NoRH," Publ. Astron. Soc. Japan, vol.58, pp.69-84.

➢ We address simultaneous observations of eruptive prominences with two radioheliographs, SSRT at 5.7GHz and NoRH at 17 and 34GHz. Three events are presented: 1997 September 27, 2000 September 4, and 2001 January 14. We analyze them using images observed in microwaves, Halpha, images from Extreme ultraviolet Imaging Telescope on board Solar and Heliospheric Observatory (SOHO), and white-light images from Large Angle and Spectrometric Coronagraph (SOHO/LASCO). We address three stages of the eruptive process: 1) pre-eruptive ascent, 2) rapid acceleration, 3) free expansion, and the overall kinematics of the ejecta. We estimate the densities and kinetic temperatures of prominences, and also the velocities and accelerations of ejecta. The main body of a prominence is surrounded by low-density cool extensions mixed with the coronal plasma, but the transition from the cool prominence to the hot plasma is sharp. From microwave and LASCO observations with overlapping fields of view we identify a radio prominence and a core of a coronal mass ejection (CME). Their temperature remains at about 5000K, while the brightenings observed in extreme ultraviolet are probably due to only skin-heating. We discuss the observations in terms of our Dual-Filament CME initiation model.

- Haba, A., S. Kameno, S. Sawada-Satoh, and N. Sato [2004], "The H_2O Maser from the AGN of NGC 1052," Proc. of the 7th symposium of the European VLBI Network on New Developments in VLBI Sciences and Technology, eds. R. Bachiller, F. Colomer, J.-F. Desmurs, and P. de Vicente, pp.153-154.

➢ We report observations of H_2O maser emission from the AGN of NGC 1052. The velocity range of the maser emission is 1450 ≤ V_{LSR} ≤ 1850 km s^{-1}, the most redshifted ever seen from this source. We detected a narrow component with a FWHM of 21 km s^{-1} in the maser spectrum profile for the first time. The peak flux density of the narrow feature is 47 mJy at $V_{LSR} = 1787$ km s^{-1}. Over a short time interval of 3 x 10^5 sec, the peak flux density and the velocity width of the narrow feature appeared to change by $16 \pm 9\%$ and $-30 \pm 12\%$, respectively, with the peak flux density of the continuum emission simultaneously varying by 21 %. We assume that the new narrow component is located within 0.05 pc of the AGN. The increasing of the peak flux density and the narrowing of the velocity width of the narrow component imply an increase in the gain of the maser through the excited molecular cloud. Since the continuum and the narrow components brightened simultaneously, the continuum are regarded as the seed photon of the maser, running behind the excited molecular gas. The masers are generated through the XDR where the knots of the continuum jet are amplified. Another possible interpretation is the interaction between the jet from the AGN and the molecular gas.

- Hachisuka, K., A. Brunthaler, Y. Hagiwara, M. K. Menten, H. Imai, M. Miyoshi, and T. Sasao [2004], "Distance of W3(OH) by VLBI Annual Parallax Measurement," Proc. of the 7th symposium of the European VLBI Network on New Developments in VLBI Sciences and Technology, eds. R. Bachiller, F. Colomer, J.-F. Desmurs, and P. de Vicente, pp.317-320.

➢ The most powerful tool for measuring distances within our Galaxy is the annual parallax. We carried out phase-referencing VLBI observations of H_2O masers in the star forming region W3(OH) with respect to the extragalactic continuum source ICRF 0244+624 to measure their

absolute proper motions. The measured annual parallax is 0.484 ± 0.004 milli-arcseconds which corresponds to a distance of $2.07^{+0.01}_{-0.02}$ kpc from the sun. This distance is consistent with photometric and kinematic distances from previous observations.

- Hachisuka, K., N. Mochizuki, Y. Asaki, M. Miyoshi, and S. Horiuchi [2005], "Towards an Understanding of the Dynamics of the Milky Way," Proc. of the "Future Directions in High Resolution Astronomy: A Celebration of the 10th Anniversary of the VLBA", eds. J. D. Romney, and M. J. Reid, ASP Conf. Ser. vol.340, p.520.

➢ We report on the proper motions of Galactic water masers relative to an adjacent extragalactic continuum source measured by VLBA multi-epoch phase referencing observations for two interstellar regions. We estimated the distance to these Galactic maser sources by their proper motions. The distance to W3(OH) are 2.05 ± 0.23 and 2.26 ± 0.09 kpc by annual parallax of each maser feature, and IRAS 21008+4700 is 5.26 kpc by the rms deviation from the least squares method fitting for its proper motion. These results provide us a first step of an understanding of the dynamics of the Milky Way.

- Hachisuka, K., A. Brunthaler, K. M. Menten, M. J. Reid, H. Imai, Y. Hagiwara, M. Miyoshi, S. Horiuchi, and T. Sasao [2006], "Water Maser Motions in W3(OH) and a Determination of Its Distance," Astrophys. J., vol.645, pp.337-344.

➢ We report phas-referencing VLBA observations of H_2O masers near the star-forming region W3(OH) to measure their parallax and absolute proper motions. The measured annual parallax is 0.489±0.017 mas (2.04±0.07 kpc), where the error is dominated by a systematic atmospheric contribution. This distance is consistent with photometric distances from previous observations and with the distance determined from CH_3OH maser astrometry presented in a related paper. We also find that the source driving the H_2O outflow, the "TW-object," moves with a three-dimensional velocity of > 7 km s^{-1} relative to the ultracompact HII region W3(OH).

- Hagiwara, Y., W. A. Baan, and P. Hofner [2007a], "HI and OH Absorption toward NGC 6240," New Astron. Rev., vol.51, pp.58-62.

➢ We present results of HI and OH absorption imaging of the merging galaxy of NGC 6240 using the very large array at 1 arcsec resolution. HI absorption is found across the extended radio continuum structure with a significant concentration towards the two nuclei, while the OH absorption is confined mostly between the nuclei. The OH velocity gradients around the nuclei confirm earlier results of radio molecular emission lines in defining the central gas peak between the nuclei and the kinematics of the nuclear region. The HI velocity gradients might trace remnants of the two interacting galaxies and the characteristics of a symmetric superwind outflow. The absorbing gas provides a key to solve kinematics of two merging galaxies.

- Hagiwara, Y. [2007b], "Low-Luminosity Extragalactic Water Masers toward M82, M51, and NGC 4051," Astron. J., vol.133, pp.1176-1186.

➢ Subarcsecond observations using the Very Large Array (VLA) are presented for low-luminosity H_2O maser emission in M82, M51, and NGC 4051. New maser features have been detected within the M82 starburst complex. They are largely associated with star-forming activity such as optically identified starburst-driven winds, HII regions, or the early phase of star formation in the galaxy. The H_2O maser M51 consists of blueshifted and redshifted features relative to the systemic velocity of the galaxy. The redshifted features are measured to the northwest of the nuclear radio source, while the location of the blueshifted counterpart is displaced by ~2" from the radio source. A small velocity gradient closely aligned with the radio jet is detected from the redshifted features. The redshifted maser most likely amplifies the background radio continuum jet, while the blueshifted counterpart marks off-nuclear star formation in the galaxy. All of the detected maser features in the narrow-line Seyfert 1 galaxy NGC 4051 remain unresolved by new VLA observations. Due to the low luminosity of the maser. the maser excitation is not directly related to the active galactic nucleus.

- Hanada, H., T. Iwata, N. Namiki, N. Kawano, K. Asari, T. Ishikawa, F. Kikuchi, Q. Liu, K. Matsumoto, H. Noda, J. Ping, S. Tsuruta, K. Iwadate, O. Kameya, S. Kuji, Y. Tamura, X. Hong, Y. Aili, and S. Ellingsen [2005a], "Gravimetric Missions in Japanese Lunar Explorer, SELENE," Proc. at the XXVIIIth General Assembly of the URSI, October 2005, India. (CD-ROM : J05-P.4)

➢ SELENE (SElenological and Engineering Explorer), is a mission preparation for launch in 2007 by JAXA (Japan Aerospace Exploration Agency), it carried 15 emissions, two of which (RSAT

and VRAD) are gravimetric experiments using radio waves. The RSAT (Relay Satellite Transponder) mission will undertake 4-way Doppler measurements of the main orbiter through the Rstar sub-satellite. This is in addition to 2-way Doppler and ranging measurements of the satellite and will realize the first direct observation of the gravity fields on the far side of the Moon. The VRAD (Differential VLBI Radio Source) emission involves observing the trajectories of Rstar and Vstar using differential VLBI with both a Japanese network (VERA), and an international network. We have already finished development of the onboard instruments and are carrying out proto-flight tests under various conditions. We have also performed test VLBI observations of orbiters with the international network.

- Hanada, H., T. Iwata, N. Namiki, N. Kawano, K. Asari, T. Ishikawa, F. Kikuchi, Q. Liu, K. Matsumoto, H. Noda, and S. Tsuruta [2005b], "Gravimetric Missions by VLBI and Doppler in SELENE," American Geophysical Union, Fall Meeting, abstract #G51A-0809.

- SELENE is a mission in preparation for launch in 2007 by JAXA (Japan Aerospace Exploration Agency). It execute 15 experiments, two of which (RSAT and VRAD) are gravimetric experiments using radio waves. RSAT (Relay Satellite Transponder) mission will undertake 4-way Doppler measurements of the main orbiter through the Rstar sub-satellite. This is in addition to 2-way Doppler and ranging measurements of the satellites and will realize the first direct observation of the gravity fields on the far side of the Moon. VRAD (Differential VLBI Radio Source) mission involves observing the trajectories of Rstar and Vstar sub-satellites using differential VLBI with both a Japanese network (VERA), and an international network. We have already finished development of the onboard instruments and are carrying out proto-flight tests under various conditions. We have also performed test VLBI observations of orbiters with the international network.

- Handa, T., M. Sakano, S. Naito, M. Hiramatsu, and M. Tsuboi [2006a], "Thermal SiO and H13CO+ Line Observations of the Dense Molecular Cloud G0.11-0.11 in the Galactic Center region," Astrophys. J., vol.636, pp.261-266.

- We obtained the first view in $H^{13}CO^+$ J=1-0 and a high-resolution map in thermal SiO lines of G0.11-0.11, which is a molecular cloud situated between the Galactic Center radio arc and Sgr A. From a comparison with previous line observations, we found that the $H^{13}CO^+$ J=1-0 line is optically thin, whereas the thermal SiO lines are optically thick. The line intensity in $H^{13}CO^+$ J=1-0 shows that the cloud has a large column density, up to $N(H_2)=(6-7)$ 10^{23} cm^{-2}, which corresponds to about 640-740 mag in AV or 10-12 mag in A_{25mum}. The estimated column density is the largest known of any even in the Galactic center region. We conclude from the intensity ratio of SiO J=1-0 to CS J=1-0 that emitting gas is highly inhomogeneous for SiO abundance on a scale smaller than the beam width ~35".

- Handa, T., M. Sakano, S. Naito, M. Hiramatsu, and M. Tsuboi [2006b], "An Extremely Large Density Cloud G0.11-0.11 in the Galactic Center Region," J. Physics: Conference Series, vol.54, pp.47-51.

- We obtained the detail map in $H^{13}CO^+$ and in thermal SiO lines of G0.11-0.11, which is a molecular cloud located between the Galactic Center Arc and Sgr A. From line intensity rotios we found $H^{13}CO^+$ line is optically thin, whereas the thermal SiO lines are optically thick for this cloud. The cloud has a large column density up to $N(H_2)=(6-7)$ x 10^{23} cm^{-2}, which corresponds to about 640-740 mag in Av or 10-12 mag in A_{25mum}. This is the largest known even in the Galactic Center region. The intensity ratio of SiO to CS lines suggests that emitting gas is highly inhomogeneous for SiO abundance on a scale smaller than the beam with about 35'.

- Hatsukade, B., K. Kohno, A. Endo, T. Tosaki, K. Ohta, S. Sakamoto, N. Kawai, J. R. Corets, K. Nakanishi, T. Okuda, K. Muraoka, T. Sakai, P. M. Vreeswijk, H. Ezawa, N. Yamaguvhi, K. Kamegai, and R. Kawabe [2007a], "A Search for CO (J = 3-2) Emission from the Host Galaxy of GRB 980425 with the Atacama Submillimeter Telescope Experiment," Publ. Astron. Soc. Japan, vol.59, pp.67-72.

- We report on a deep search for ^{12}CO (J=3-2) line emission from the host galaxy GRB 980425 with the Atacama Submillimeter Telescope Experiment (ASTE). We observed five points of the galaxy, covering the entire region. After combining all of the spectra we obtained a global spectrum with a rms noise level of 3.3 mK in the Tmb scale at a velocity resolution of 10 km s^{-1}. No significant emission was detected, though we found a marginal emission feature in the

velocity range corresponding to the redshift of the galaxy. We derived 3 σ upper limits on the global properties: the velocity-integrated CO (3-2) intensity of I_{CO} (3-2) < 0.26 K km s^{-1}, by adopting a velocity width of 67 km s^{-1}; an H_2 column density of $N(H_2)$ < 3 x 10^{20} cm^{-2}; a molecular gas mass of $M(H_2)$ < 3 x 10^8 M , by assuming a CO line luminosity to H_2 molecular gas mass conversion factor of X_{CO} = 5.0 x 10^{20} cm^{-2} (K km s^{-1})$^{-1}$; and a star-formation rate of SFR < 0.1 M yr-1, based on the Schmidt law. The SFR is consistent with the previous results of Hα and mid-IR observations, thereby suggesting that there is a variety of significant obscured star formation in the host galaxy of GRB 980425. This result implies that there is a variety of GRB hosts with regard to the presence of obscured star formation.

- Hatsukade, B., K. Kohno, A. Endo, T. Tosaki, K. Ohta, S. Sakamoto, N. Kawai, J. R. Cortes, K. Nakanishi, T. Okuda, K. Muraoka, T. Sakai, H. Ezawa, N. Yamaguchi, K. Kamegai, and R. Kawabe [2007b], "A Possible Detection of CO (J=3-2) Emission from the Host Galaxy of GRB 980425 with Atacama Submillimeter Telescope Experiment," Proc. of the IAU Symp. 235, "Galaxy evolution across the Hubble Time", eds. F. Combes & J. Palous, p.312.

➢ Long-duration gamma-ray bursts (GRBs) are considered to be due to the death of massive stars. Therefore, GRBs are closely associated with the star formation of host galaxies. Since GRBs can be detected at cosmological distances, they are expected to be probes of the star formation history of the Universe. In order to determine the use of GRBs, it is essential to understand the star formation of their hosts. Multi-wavelength observations have shown that the star formation rates (SFRs) of GRB hosts derived from submillimeter/radio observations are generally higher than those from optical/UV observations (Berger et al. 2003). This implies that GRB hosts have a large amount of molecular gas and massive star formation obscured by dust. In order to solve this problem, it is necessary to derive the SFRs in a method which is independent of existing methods and not affected by dust extinction. We observed ^{12}CO (J = 3-2) line emission from the host galaxy of GRB 980425 using the Atacama Submillimeter Telescope Experiment (ASTE). Five points were observed covering the entire region of the galaxy, and we find possible emission features (S/N ~ 3σ) at the velocity range corresponding to the redshift of the galaxy. By combining all spectra of five points, we obtain a global spectrum with a ~4σ emission feature. If the features are real, this is the first detection of CO among GRB hosts. We derive the total gas mass of $M(H_2)$=7 ± 2 x10^{8}M assuming a CO-to-H_2 conversion factor of α_{CO} = 8.0M (K km s^{-1} pc^2)$^{-1}$, which is deduced using the correlation between the α_{CO} and the metallicity. The dynamical mass is calculated to be M_{dyn}=2x10^{10}M , and $M(H_2)/M_{dyn}$~3% is consistent with those of nearby dwarfs and normal spirals. The derived SFR is 0.5 ± 0.1 M yr 1 based on the Schmidt law. This SFR agrees with the results of previous Hα observations, suggesting that there is no significant obscured star formation in this host galaxy. This result implies that there is a variety of GRB hosts in terms of the presence of obscured star formation.

- Haupt, C., R. Stramek, and K.-I. Morita [2006], "System Engineering in the ALMA Project," Proc. of the SPIE, vol.6271, pp.62710E.

➢ The Atacama Large Millimeter and Submillimeter Array (ALMA) is a submillimeter-wavelength radio telescope under construction in northern Chile at an altitude of 5,000 meters. The ALMA telescope will be composed of 66 to 80 high-precision antennas plus their electronics systems, all of which operate as a single instrument. This telescope will observe the cold regions of the Universe with unprecedented depth and clarity. These regions, which are often optically dark, shine brightly in the submillimeter portion of the electromagnetic spectrum. ALMA is a partnership between institutions in Europe, North America, Japan and the Republic of Chile and is currently one of the largest ground-based astronomy projects under construction. ALMA is a complex and technically challenging instrument and the development and construction is dispersed over four continents. Such a project requires a strong system engineering team if it is to come together as a complete system and meet its performance objectives. ALMA System Engineering activities can be divided into; System Design and Analysis, Product Assurance, Prototype System Integration, and System Integration in Chile. This paper reports on these System Engineering activities and achievements. It also describes how the System Engineering team is staffed and organized and reports on some early technical achievements.

- Hayakawa, T., M. Hiramatsu, K. Kamegai, K. Tatematsu, A. Mizuno, T. Onishi, and T. Hasegawa [2007], "350GHz Band Emission Lines OBservations of Chamaeleon Star Forming

Regions," Proceedings in "Protostars and Planets V", LPI contribution no. 1286, p.8591.

➢ Not Available

● Hirabayashi, H., Y. Murata, P. G. Edwards, Y. Asaki, N. Mochizuki, M. Inoue, T. Umemoto, S. Kameno, and Y. Kono [2004], "On the Near-Term Space VLBI Mission VSOP-2," Proc. of the 7th Symposium of the European VLBI Network on New Developments in VLBI Science and Technology, eds. R. Bachiller, F. Colomer, J.-F. Desmurs, and P. de Vicente, pp.285-288.

➢ A second generation near-term space VLBI mission, VSOP-2, is being planned for a launch in 2010 or soon after. The scientific objectives are very high angular resolution imaging of astrophysically exotic regions, including the cores, jets, and accretion disks of active galactic nuclei (AGN), water maser emissions, micro-quasars, coronae of young stellar objects, etc. A highest angular resolution of about 40μ as is achieved in the 43 GHz band. Engineering developments are in progress for the deployable antenna, antenna pointing, high data rate transmission, cryogenic receivers, accurate orbit determination, etc., to realize this mission. International collaboration will be as important as it has been for VSOP.

● Hirabayashi, H., Y. Murata, P. G. Edward, Y. Asaki, N. Mochizuki, M. Inoue, T. Umemoto, S. Kameno, L. I. Gurvits, and A. P. Lobanov [2006], "Design of the Near-term Next Generation Space-VLBI Mission VSOP-2," ESO Astrophysics Symposia, "Exploring the Cosmic Frontier: Astrophysical Instruments for the 21st Century", eds. A. P. Labonov, J. A. Zensus, C. Cesarsky, and P. J. Diamond, pp.37-38.

➢ A second generation space VLBI mission, VSOP-2, is being planned for a launch in 2010 or soon after. The scientific objectives are very high angular resolution imaging of astrophysically exotic regions, including the cores, jets, and accretion disks of active galactic nuclei (AGN), water maser emissions, micro-quasars, coronae of young stellar objects, etc. A highest angular resolution of about 40 muas is achieved in the 43 GHz band. Engineering developments are in progress for the deployable antenna, high data rate transmission, cryogenic receivers, antenna pointing, accurate orbit determination, etc., to realize this mission. International collaboration will be as important as it has been for VSOP.

● Hiramatsu, M., K. Kamegai, T. Hayakawa, K. Tatematsu, T. Onishi, A. Mizuno, and T. Hasegawa [2007a], "ASTE Submillimeter Observations of a YSO Condensation in Cederblad 110," Proc. of the IAU Symp, 237, "Triggered Star Formation in a Turbulent Interstellar Medium", eds. B. G. Elmegreen & J. Palous, p.426.

➢ Outflow-cloud interaction is an important issue in discussions about star formation in clusters because it could generate turbulence and restrain star formation activities, as well as it causes outflow-triggered star formation.

● Hiramatsu, M., T. Hayakawa, K. Tatematsu, K. Kamegai, T. Onishi, A. Mizuno, N. Yamaguchi, and T. Hasegawa [2007b], "ASTE Submillimeter Observations of a Young Stellar Object Condensation in Cederblad 110," Astrophys. J., vol.664, pp.964-974.

➢ We present results of submillimeter observations of a low-mass young stellar object (YSO) condensation in the Cederblad 110 region of the Chamaeleon I dark cloud with the Atacama Submillimeter Telescope Experiment. Our HCO^+(J=4-3) map reveals a dense molecular gas with an extent of ~0.1 pc, which is a complex of two envelopes associated with class I sources Ced 110 IRS 4 and IRS 11 and a very young object Cha-MMS 1. The other two class I sources in this region, IRS 6 and NIR 89, are located outside the clump and have no extended HCO^+ emission. HCO^+ abundance is calculated to be 2.6×10^{-10} for MMS 1 and 3.4×10^{-9} for IRS 4, which are comparable to the reported value for other young sources. Bipolar outflows from IRS 4 and IRS 6 are detected in our ^{12}CO(J=3-2) map. The outflow from IRS 4 seems to collide with Cha-MMS 1. The outflow has enough momentum to affect gas motion in MMS 1, although no sign has been detected to indicate that a triggered star formation has occurred.

● Hirota, T., H. Maezawa, and S. Yamamoto [2004a], "Molecular Line Observations of Carbon-Chain-Producing Regions L1495B and L1521B," Astrophys. J., vol.617, pp.399-405.

➢ We present the first comprehensive study of physical and chemical properties of quiescent starless cores L1495B and L1521B, which are known to be rich in carbon-chain molecules like the cyanopolyyne peak of TMC-1 and L1521E. We have detected radio spectral lines of various carbon-chain molecules, such as CCS, C_3S, C_4H, HC_3N, and HC_5N. On the other hand, the NH_3 lines are weak and the N_2H^+ lines are not detected. According to our mapping observations of the

HC$_3$N, CCS, and C$_3$S lines, the dense cores in L1495B and L1521B are compact, with radius 0.063 and 0.044 pc, respectively, and have a simple elliptical structure. The distributions of CCS seem to be different from those of well-studied starless cores, L1498 and L1544, where the distribution of CCS shows a shell-like structure. Since the H^{13}CO$^+$, HN^{13}C, and C^{34}S lines are detected in L1495B and L1521B, the densities of these cores are high enough to excite the NH$_3$ and N$_2$H$^+$ lines. Therefore, the abundances of NH$_3$ and N$_2$H$^+$ relative to carbon-chain molecules are apparently deficient, as observed in L1521E. We found that longer carbon-chain molecules, such as HC$_5$N and C$_4$H, are more abundant in TMC-1 than in L1495B and L1521B, while those of sulfur-bearing molecules, such as C^{34}S, CCS, and C^{3}S, are comparable. Both distributions and abundances of the observed molecules in L1495B and L1521B are quite similar to those in L1521E, strongly suggesting that L1495B and L1521B are in a very early stage of physical and chemical evolution.

● Hirota, T., and VERA Project Team [2004b], "Observations of H$_2$O maser sources in Orion-Monoceros Molecular Clouds with VERA," Proc. of the 7th Symposium of the European VLBI Network on New Developments in VLBI Science and Technology, eds. R. Bachiller, F. Colomer, J.-F. Desmurs, and P. de Vicente, pp.201-202.

➢ We present results of phase-referencing VLBI observations of H$_2$O maser sources in Orion-Monoceros Molecular Clouds with VERA (VLBI Exploration of Radio Astrometry), which is newly constructed Japanese VLBI network. Main topics of this poster are (1) the aim of one of the first scientific projects for VERA "3-Dimensional Structure and Kinematics of Orion-Monoceros Molecular Cloud Complex"; (2) current status (sensitivity and astrometric accuracy) of phase-referencing VLBI observations with VERA; and (3) results of VLBI observations of H2O maser sources in Orion-Monoceros Molecular Clouds with VERA.

● Hirota, T., and S. Yamamoto [2006], "Molecular Line Observations of Carbon-Chain-Rich Core L492," Astrophys. J., vol.646, pp.258-268.

➢ We report on molecular abundances and distributions in a starless dense core, L492. We have found that the abundances of carbon-chain molecules such as CCS, C$_3$S, HC$_3$N, HC$_5$N, and HC$_7$N are comparable to those in chemically young dark cloud cores called "carbon-chain-producing regions," such a L1495B, L1521B, L1521E, and TMC-1. This is the first dark cloud core extremely rich in carbon-chain molecules that is found outside the Taurus in carbon-chain-producing regions, being significantly lower than those in the evolved prestellar cores such as L1498 and L1544. On the other hand, the abundances of NH$_3$ and N$_2$H$^+$ are systematically higher than those in carbon-chain-producing regions. Our mapping observations reveal that the central hole of molecular distributions, which were reported for CCS and C^{34}S in evolved prestellar cores, is not significant in L492, indicating that the depletion factor of molecules is not very high. Furthermore, L492 is dynamically more evolved than carbon-chain-producing regions, and the protostellar collapse has started like in L1498 and L1544. Therefore, it is likely that the chemical and dynamical evolutionary stage of L492 is intermediate between carbon-chain-producing regions (L1495B, L1521B, L1521E, and TMC-1) and evolved prestellar cores (L1498 and L1544).

● Hirota, T., T. Bushimata, Y. K. Choi, M. Honma, H. Imai, K. Iwadate, T. Jike, S. Lameno, O. Kameya, R. Kamohara, Y. Kan-ya, N. Kawaguchi, M. Kijima, M. K. Kim, H. Kobayashi, S. Kuji, T. Kurayama, S. Manabe, K. Maruyama, M. Matsui, N. Matsumoto, T. Miyaji, T. Nagayama, A. Nakagawa, K. Nakamura, C. S. Oh, T. Omodaka, T. Oyama, S. Sakai, T. Sasao, K. Sato, M. Sato, K. M. Shibata, M. Shintani, Y. Tamura, M. Tsushima, and K. Yamashita [2007], "Distance to Orion KL Measured with VERA," Publ. Astron Soc. Japan, vol.59, pp.897-903.

➢ We present the initial results of multiepoch VLBI observations of 22 GHz H$_2$O masers in the Orion KL region with VERA (VLBI Exploration of Radio Astrometry). With the VERA dual-beam receiving system, we carried out phase-referencing VLBI astrometry, and successfully detected the annual parallax of Orion KL to be 2.29±0.10 mas, corresponding to a distance of 437±19 pc from the Sun. The distance to Orion KL was determined for the first time with the trigonometric parallax method in these observations. Although this value is consistent with that previously reported, 480±80 pc, which was estimated from a statistical parallax method using the proper motions and radial velocities of the H$_2$O maser features, our new results provide a much more accurate value with an uncertainty of only 4%. In addition to the annual parallax,

we detected an absolute proper motion of the maser feature, suggesting an outflow motion powered by the radio source I along with the systematic motion of source I itself.

- Hofner, P., W. A. Baan, and S. Takano [2006], "H_2O Maser Emission in the Starburst Galaxy NGC 253," Astronomical J., vol.131, pp.2074-2077.

➢ We report Very Large Array CnB- and A-configuration observations of the 22 GHz H_2O maser line toward the starburst galaxy NGC 253. We detect a broad, highly blueshifted (V_{LSR}=120.5 km s^{-1}) H_2O line coincident with the continuum source TH4, which is believed to be a supernova remnant. The H_2O maser emission arises from an area whose size is smaller than 0.9 pc. A weaker feature at V_{LSR}=60.0 km s^{-1} is also seen at the same position. We also detect the extended 1.3 cm continuum along the galactic disk of NGC 253, as well as the two central continuum sources TH2 and TH4.

- Honma, M., T. Bushimata, I. K. Choi, T. Fujii, T. Hirota, K. Horiai, H. Imai, N. Inomata, J. K. Ishitsuka, K. Iwadate, T. Jike, O. Kameya, R. Kamohara, Y. Kanya, N. Kawaguchi, N. Kobayashi, S. Kuji, T. Kurayama, S. Manabe, T. Miyaji, A. Nakagawa, K. Nakashima, R. Nagayoshi, T. Omodaka, T. Oyama, M. Rioja, S. Sakai, S. Sakakibara, K. Sato, T. Sasao, K. M. Shibata, R. Shimizu, K. Sora, H. Suda, Y. Tamura, and K. Yamashita [2004a], "Studying Black Holes with VERA," Proc. of the "Stellar-Mass, Intermediate-Mass, and Supermassive Black Holes", eds. S. Mineshige and K. Makishima, Porg. Theore. Phys. Supple., No.155, pp.339-340.

➢ In this paper we discuss the potential use of VERA (VLBI exploration of radio astrometry) to study black holes based on phase-referencing VLBI astrometry. First we present a brief overview of the project, from system design to scientific targets, and then we discuss the possibilities to investigate black holes and other high energy phenomena that are possibly linked to black holes.

- Honma, M., T. Bushimata, Y. K. Choi, T. Fujii, T. Hirota, K. Horiai, H. Imai, N. nomata, J. Ishitsuka, K. Iwadate, T. Jike, O. Kameya, R. Kamohara, Y. Kan-Ya, N. Kawaguchi, H. Kobayashi, S. Kuji, T. Kurayama, S. Manabe, T. Miyaji, A. Nakagawa, K. Nakashima, T. Omodaka, T. Oyama, S. Sakai, K. Sato, T. Sasao, K. M. Shibata, R. Shimizu, K. Sora, H. Suda, Y. Tamura, and K. Yamashita, [2004b], "Astrometry of W49N - OH43.8-0.1 H_2O maser pair with VERA," Proc.of the 7th Symposium of the European VLBI Network on New Developments in VLBI Science and Technology, Edited by R. Bachiller, F. Colomer, J.-F. Desmurs, and P. de Vicente, pp.203-204.

➢ We present the results of multi-epoch VERA observations of W49N OH43.8-0.1 H_2O maser pair. Based on the dual-beam VLBI observation with VERA, we successfully obtained the phase-referenced maps of OH43.8-0.1 with respect to the W49N reference spot for 3 epochs with a time span of 6 months. The maps were in good agreement with previous studies obtained with a single-beam VLBI, and were also consistent with each other with an accuracy of about 0.2 mas. Moreover, there are systematic, rather linear displacements of maser feature positions, which may be the relative proper motions of maser features caused by the Galactic rotation as well as internal motions of individual maser features.

- Honma, M., T. Bushimata, Y. K. Choi, T. Fujii, T. Hirota, K. Horiai, H. Imai, N. Inomata, J. Ishitsuka, K. Iwadate, T. Jike, O. Kameya, R. Kamohara, Y. Kan-ya, N. Kawaguchi, M. Kijima, H. Kobayashi, S. Kuji, T. Kurayama, S. Manabe, T. Miyaji, A. Nakagawa, K. Nakashima, C. S. Oh, T. Omodaka, T. Oyama, M. Rioja, S. Sakai, K. Sato, T. Sasao, K. M. Shibata, R. Shimizu, K. Sora, H. Suda, Y. Tamura, and K. Yamashita [2005a], "Multi-Epoch VERA Observations of H_2O Masers in OH 43.8-0.1," Publ. Astron. Soc. Japan, vol.57, pp.595-603.

➢ We report on multi-epoch observations of H_2O maser emission in the star-forming region OH 43.8-0.1, carried out with VLBI Exploration of Radio Astrometry. The large-scale maser distributions obtained by single-beam VLBI mapping reveal new maser spots scattered over the area of 0".7x1".0, in addition to a `shell-like' structure with a scale of 0".3x0".5, which was mapped previously. Proper motions were also obtained for 43 spots based on 5-epoch monitoring with a time span of 281 days. The distributions of the proper motions show a systematic outflow in the north-south direction with an expansion velocity of ~ 8 km s^{-1}. The overall distributions of the maser spots as well as the proper motions are better represented by a bipolar flow plus a central maser cluster with a complex structure, rather than a shell with uniform expansion, such as those found in Cep A R5 and W75N VLA2. The distance to OH 43.8-0.1 was also estimated based on the statistical parallax, yielding D = 2.8 ± 0.5 kpc. This distance is consistent with a

near kinematic distance, and rules out a far kinematic distance (~ 9kpc). Also, the radial velocity of the OH 43.8-0.1 combined with the distance provides a constraint on the flatness of the galactic rotation curve, indicating that there is no systematic difference in the rotation speeds at the Sun and at the position of OH 43.8-0.1, which is located at a galacto-centric radius of ~ 6.3 kpc.

- Honma, M., T. Bushimata, T. Fujii, T. Hirota, K. Horiai, H. Ishitsuka, K. Iwadate, T. Jike, O. Kameya, R. Kamohara, Y. Kan-ya, N. Kawaguchi, H. Kobayashi, S. Kuji, T. Kurayama, S. Manabe, T. Miyaji, A. Nakagawa, K. Nakashima, T. Omodaka, T. Oyama, M. Rioja, S. Sakai, S. Sakakibara, K. Sato, T. Sasao, K. M. Shibata, R. Shimizu, H. Suda, and Y. Tamura [2005b], "The VERA Project," Baltic Astronomy, vol.14, pp.455-457.
- ➤ VERA (VLBI Exploration of Radio Astrometry) is the first VLBI array dedicated to phase-referencing astrometry. The construction of the VERA array has been started in 2000 and completed in 2002 April; currently it is the system evaluation phase. In this paper, we present a brief overview of the system and report the recent status of the project.
- Honma, M., T. Bushimata, T. Fujii, T. Hirota, K. Horiai, H. Ishitsua, K. Iwadate, T. Jike, O. Kameya, R. Kamohara, Y. Kan-ya, N. Kawaguchi, H. Kobayashi, S. Kuji, T. Kurayama, S. Manabe, T. Miyaji, A. Nakagawa, K. Nakashima, T. Omodaka, M. Rioja, S. Sakai, S. Sakakibara, K. Sato, T. Sasao, K. M. Shibata, R. Shimizu, H. Suda, and Y. Tamura [2005c], "Dual-Beam Phase Referencing with VERA," Proc. of the "Future Directions in High Resolution Astronomy: A Celebration of the 10th Anniversary of the VLBA", eds. J. D. Romney, and M. J. Reid, ASP Conf. Ser. Vol.340, pp.569-571.
- ➤ We present the recent results of phase-referencing observations with VERA's dual-beam system. Since the first fringe detection with the dual-beam system in May 2002, several observations have been made to check the system performance and in particular to test how the VERA's dual-beam system works in phase-referencing observation. Among these observations, we mainly focus on the observations of a pair of strong maser sources W49N and OH43.8-0.1, and discuss the phase-referencing capability as well as potential astrometric accuracy of VERA.
- Honma, M., T. Bushimata, Y. K. Choi, T. Hirota, H. Imai, K. Iwadate, T. Jike, O. Kameya, R. Kamohara, Y. Kan-ya, N. Kawaguchi, M. Kijima, H. Kobayashi, S. Kuji, T. Kurayama, S. Manabe, T. Miyaji, T. Nagayama, A. Nakagawa, C. S. Oh, T. Omodaka, T. Oyama, S. Sakai, K. Sato, T. Sasao, M. Shintani, H. Suda, Y. Tamura, M. Tsushima, and K. Yamashita [2007], "Astrometry of Galactic Star-Forming Region Sharpless 269 with VERA: Parallax Measurements and Constration on Outer Rotation Curve," Publ. Astron Soc. Japan, vol.59, pp.889-895.
- ➤ We have performed high-precision astrometry of H_2O maser sources in the Galactic star-forming region Sharpless 269 (S269) with VERA. We successfully detected a trigonometric parallax of 189 ± 8 μ as, corresponding to a source distance of $5.28^{+0.24}_{-0.22}$ kpc. This is the smallest parallax ever measured, and the first one detected beyond 5 kpc. The source distance as well as the proper motions were used to constrain the outer rotation curve of the Galaxy, demonstrating that the difference of rotation velocities at the Sun and at S269 (which is 13.1 kpc away from the Galaxy's center) is less than 3%. This gives the strongest constraint on the flatness of the outer rotation curve, and provides a direct confirmation of the existence of a large amount of dark matter in the Galaxy's outer disk.
- Huang, G., and H. Nakajima [2005], "Location and Parameters of a Microwave Millisecond Spike Event," Astrophys. Sp. Sci., vol.295, pp.423-442.
- ➤ A typical microwave millisecond spike event on November 2, 1997 was observed by the radio spectrograph of National Astronomical Observatories (NAOs) at 2.6--3.8 GHz with high time and frequency resolution. This event was also recorded by Nobeyama Radio Polarimeters (NoRP) at 1 35 GHz and Radio Heliograph (NoRH) at 17 GHz. The source at 17 GHz is located in one foot-point of a small bright coronal loop of YOHKOH SXT and SOHO EIT images with strong photospheric magnetic field in SOHO MDI magnetograph. It is assumed that the electron cyclotron maser instability and gyro-resonance absorption dominate, respectively, the rising and decay phase of the spike event. For different harmonic number of gyro-frequency or magnetic field strength, a fitting program with free plasma parameters is used to minimize the difference between the observational and theoretical values of the exponential growth and decay rates for a

given spike. The plasma parameters at third harmonic number are more comparable to their typical values in solar corona. Hence, it is able to provide a diagnosis for the source parameters (magnetic field, density, and temperature), the properties of radiations (wave vector and propagation angle), and the properties of non-thermal electrons (density, pitch angle, and energy). The results are also comparable with the diagnosis of the gyro-synchrotron radiation model, the frequency drift rates and a dipole magnetic field model, as well as the YOHKOH SXT and SOHO MDI data.

- Huang, G., H. Nakajima, S. Masuda, K. Kobayashi, and M. Kubo [2006], "Source Structures of the 1998 November 28 X-Class Flare and Electron Acceleration," Publ. Astron. Soc. Japan, vol.58, pp.37-45.

➢ We studied the 1998 November 28 X-class flare, which showed long-duration, two-ribbon alpha emission. (1) A soft X-ray loop system developed along the major magnetic neutral line in the impulsive phase. Hard X-ray and microwave emissions due to nonthermal electrons were located in some limited regions. While the compact hard X-ray loop was associated with weak, diffuse soft X-ray emission, two large microwave loops did not have soft X-ray counterparts. (2) Time profiles of two large microwave loops were similar to that of hard X-ray total emission, which emanated mostly from the compact source, even in the fine time structure in the rising phase. (3) A super-hot thermal hard X-ray source appeared around the impulsive peak and was located along the major magnetic neutral line in the declining phase, coinciding with the bright soft X-ray emission. The thermal component can be explained within the standard reconnection model to the extent that the super-hot thermal plasma was heated in the large soft X-ray loop. However, the nonthermal electrons were accelerated in a localized region where three loops interacted with each other. The inferred configuration may be a more complicated form of the double-loop interaction model proposed by Hanaoka (1996) and Nishio et al. (1997).

- Huang, J., G. Fazio, J. Younger, D. Wilner, M. Yun, G. Wilson, T. Webb, M. Gurwell, K. Lai, A. Peck, G. Petitpas, D. Iono, K. Kohno, R. Kawabe, D. Sanders, D. Hughes, A. Martinez-Sansiger, and S. Kim [2007], "SMA/AzTEC Observations of Submillimeter Galaxies in the Cosmos Field," American Astronomical Society Meeting 210, #39.10.

➢ We present results of SMA/AzTEC observations of seven bright submillimeter galaxies (SMGs) in the COSMOS field. All 7 objects were detected by the SMA at 345 GHz with 2 arcsec resolution and position accuracies of 0.2 arcsec. Most of the SMGs in the sample have no optical, 24 micron, and radio counterparts, but were detected in the Spitzer/IRAC bands. This suggests that the objects are at a higher redshift ($z > 3.5$) when compared to the existing well studied SMG sample. This is a pioneer study in the exploraton of SMGs in the early universe with high resolution observations, and an indication of what ALMA can do in the future

- Iguchi, S., T. Kurayama, N. Kawaguchi, and K. Kawakami [2005a], "Gigabit Digital Filter Bank: Digital Backend Subsystem in the VERA Data-Acquisition System," Publ. Astron. Soc. Japan, vol.57, pp.259-271.

➢ The VERA terminal is a new data-acquisition system developed for the VERA project, which is a project to construct a new Japanese VLBI array dedicated to make a 3-D map of our Milky Way Galaxy in terms of high-precision astrometry. New technology, a gigabit digital filter, was introduced in the development. The importance and advantages of a digital filter for radio astronomy have been studied as follows: (1) the digital filter can realize a variety of observation modes and maintain compatibility with different data-acquisition systems (Kiuchi et al. 1997 and Iguchi et al. 2000a), (2) the folding noise occurring in the sampling process can be reduced by combination with a higher-order sampling technique (Iguchi, Kawaguchi 2002), (3) and an ideal sharp cut-off bandedge and a flat amplitude/phase responses are approached by using a large number of taps available to use LSI of a large number of logic cells (Iguchi et al. 2000a). We developed the custom Finite Impulse Response filter chips and manufactured the Gigabit Digital Filter Banks (GDFBs) as a digital backend subsystem in the VERA terminal. In this paper, the design and development of the GDFB are presented in detail, and the performances and demonstrations of the developed GDFB are shown.

- Iguchi, S. [2005b], "Radio Interferometer Sensitivities for Three Types of Receiving Systems: DSB, SSB, and 2SB Systems," Publ. Astron. Soc. Japan, vol.57, pp.643-677.

➢ The purpose of this paper is to study the detection sensitivity suitable to the practical situation

for a radio interferometer. For the radio interferometer, the three types of receiving systems are a double-sideband (DSB), a single-sideband (SSB), and a two-single-sideband (2SB) systems. The evaluation of these receiving systems is of significance to explore the best performance for a radio interferometer. In this paper, the signal-to-noise ratios of these three-type receiving systems are newly derived to investigate the performance and key features of each system. We demonstrate the system noise temperatures of SSB, 2SB, and DSB receiving systems by using the ALMA-specification receiver noise temperature and the atmosphere condition measured at the ALMA site, and present the relative sensitivities between the 2SB and DSB receiving systems at the ALMA site. From these results, we recommend the 2SB receiving system for all bands of ALMA.

- Ikeda, N., K. Sunada, and Y. Kitamura [2007], "A Survey of Dense Cores in the Orion A Cloud," Astrophys. J., vol.665, pp.1194-1219.

➤ We have carried out an $H^{13}CO^+$(J=1-0) core survey in a large area of 1.5^{deg} x0.5^{deg}, covering the whole region of the Orion A molecular cloud, using the Nobeyama 45 m radio telescope with the 25 Beam Array Receiver System (BEARS). This survey is unique in that a large area (~48 pc2) of the cloud was covered with a high spatial resolution of 21" (0.05 pc) and with a deep integration (1 sigma~0.1 K in T*A), resulting in a core mass detection of 1.6 Msolar. The morphology of the $H^{13}CO^+$(J=1-0) emission is very similar to that of the 850 mum continuum emission. We identified 236 dense cores from our data with the clumpfind algorithm. The cores are close to virial equilibrium, independent of whether they are thermal or turbulent. We predict an initial mass function (IMF) from the core mass function, considering binary formation and confusion along the line of sight, and find that this IMF agrees well with the Orion Nebula cluster IMF for a star formation efficiency of ~40%. Therefore, we suggest that the IMF is determined at the time of the dense core formation. Furthermore, we discovered three cores with large velocity widths, significantly wider than those of the other cores, only toward the M42 H II region, suggesting that the energy input from the H II region increases the velocity width. Since the three cores can produce the most massive stars, owing to their large mass accretion rates, massive star formation in the next generation in the Orion A cloud is likely to be caused by nearby stellar activity.

- Imai, H., J.-I. Nakashima, P. J. Diamond, A. Miyazaki, and S. Deguchi [2005a], "Biconically Expanding Flow in W43A Traced by SiO Maser Emission," Astrophys. J. (Letters), vol.622, pp.L125-L128.

➤ We report Very Long Baseline Array and Very Large Array observations of 22 GHz H_2O and 43 GHz SiO (v=1, J=1-0) maser emission as well as 7 mm continuum emission in W43A, which exhibits a highly collimated jet of molecular gas and a spherically expanding envelope very similar to that of an OH/IR star. The spatiokinematical structure of the H_2O masers is well fitted to a processing jet model with an expansion velocity of 150 km s^{-1} and a dynamical age of ~50 yr. The spatiokinematical structure of the SiO masers is well fitted to a biconically expanding flow model, whose axis is parallel to the direction of the collimated jet. Astrometry of the H_2O and SiO masers suggests that these maser sources have a common dynamical center, possibly as part of a binary system, within 70 AU. The SiO masers may be excited on the surface of the cone that has significant deceleration and interacts with the jet. A 7 mm continuum emission source is located ~1300 AU away from these maser sources at a position angle of about -60° from the jet axis. The physical relation of the continuum to the maser sources is still unclear.

- Imai, H., O. Kameya, M. Miyoshi, T. Sasao, S. Deguchi, S. Horiuchi, and Y. Asaki [2005b], "Kinematics, Physical Condition, and Magnetic Field of the W3 IRS 5 Region Traced by Water Masers," Proc. of the "Future Directions in High Resolution Astronomy: A Celebration of the 10th Anniversary of the VLBA", eds. J. D. Romney, and M. J. Reid, ASP Conf. Ser. vol.340, pp.358-360.

➤ Not Available

- Imai, H., K. B. Marvel, K. M. Shibata, T. Sasao, M. Miyoshi, M. Inoue, P. J. Diamond, V. Migenes, and Y. Murata [2005c], "The 3-D Kinematics of Water Masers around the Semiregular Variable R Virginis," Proc. of the "Future Directions in High Resolution Astronomy: A Celebration of the 10th Anniversary of the VLBA", eds. J. D. Romney, and M. J. Reid, ASP Conf. Ser. vol.340, pp.407-409.

- ➢ Not Available
- Imai, H., T. Omodaka, T. Hirota, T. Umemoto, K. Sorai, and T. Kondo [2006], "A Collimated Jet and an Infalling-Rotating Disk in G192.16-3.84 Traced by H_2O Maser Emission," Publ. Astron. Soc. Japan, vol.58, pp.883-892.
- ➢ We report on H_2O masers associated with the massive-star forming region G192.16-3.84 observed with the new Japanese VLBI network at three epochs spanned for two months, which have revealed the three-dimensional kinematical structure of the H_2O maser region in G192.16-3.84, containing two young stellar objects separated by ~ 1200 AU. The maser spatio-kinematical structure has well persisted since previous observations, in which the masers are expected to be associated with a highly collimated bipolar jet and an infalling-rotating disk in the northern and southern clusters of H_2O maser features, respectively. We estimated a jet expansion speed of ~ 100 km s^{-1} and re-estimated the dynamical age of the whole jet to be 5.6 x 10^4 yr. We investigated the spatial distribution of the Doppler velocities during the previous and present observations and the relative proper motions of H_2O maser features in the southern cluster, as well as the relative bulk motion between the two maser clusters. They are well explained by a model of an infalling-rotating disk with a radius of ~ 1000 AU and a central stellar mass of 5-10 M , rather than by a model of a bipolar jet perpendicular to the observed CO outflow. Based on the derived H_2O maser spatio-kinematical parameters, we discuss the formation mechanism of the massive young stellar objects and the outflow development in G192.16-3.84.
- Imanishi, M., K. Nakanishi, N. Kuno, and K. Kohno [2004], "Near-Infrared and Millimeter Constraints on the Nuclear Energy Source of the Infrared-luminous Galaxy NGC 4418," Astron. J., vol.128, pp.2037-2047.
- ➢ We present near-infrared and millimeter investigations of the nucleus of the infrared-luminous galaxy NGC 4418, which previous observations suggest possesses a powerful buried active galactic nucleus (AGN). We find the following main results: (1) The infrared K-band spectrum shows CO absorption features at 2.3-2.4 μm from stars and very strong H_2 emission lines. The luminosity ratios of H_2 emission lines are suggestive of a thermal origin, and the equivalent width of the H_2 1-0 S(1) line is the second largest observed to date in an external galaxy, after the well-studied strong H_2-emitting galaxy NGC 6240. (2) The infrared L-band spectrum shows a clear polycyclic aromatic hydrocarbon (PAH) emission feature at 3.3 μm, which is usually found in star-forming galaxies. The estimated star formation luminosity from the observed PAH emission can account for only a small fraction of the infrared luminosity. (3) Millimeter interferometric observations of the nucleus reveal a high HCN (1-0) to HCO$^+$ (1-0) luminosity ratio of ~1.8, as has been previously found in pure AGNs. (4) The measurements of HCN (1-0) luminosity using a single-dish millimeter telescope show that the HCN (1-0) to infrared luminosity ratio is slightly larger than the average, but within the scattered range, for other infrared-luminous galaxies. All of these results can be explained by the scenario in which, in addition to energetically insignificant, weakly obscured star formation at the surface of the nucleus, a powerful X-ray-emitting AGN deeply buried in dust and high-density molecular gas is present.
- Imanishi, M., K. Nakanishi, and K. Kohno [2006a], "Millimeter Interferometric Investigations of the Energy Sources of Three Ultraluminous Infrared Galaxies, UGC 5101, Markarian 273, and IRAS 17208-0014, Based on HCN-to-HCO+ Ratios," Astron. J., vol.131, pp.2888-2899.
- ➢ We present interferometric observations of three ultraluminous infrared galaxies (ULIRGs; UGC 5101, Mrk 273, and IRAS 17208-0014) in the 3 mm wavelength range, using the Nobeyama Millimeter Array. Both the HCN (J=1-0) and HCO$^+$ (J-1-0) molecular lines were observed simultaneously. HCN emission was clearly detected at the nuclear positions of these ULIRGs, and HCO+ emission was detected at the nuclear positions of UGC 5101 and IRAS 17208-0014. The HCN-to-HCO$^+$ brightness-temperature rations toward the nuclei of the three ULIRGs were derived and compared with those of lower luminosity galaxies known to be dominated by active galactic nuclei (AGNs) or starbursts. In UGC 5101 and Mrk 273, where is evidence for obscured AGNs from previous observations at other wavelengths, we found high HCN/HCO$^+$ ratios (> 1.8) that are in the range found for AGN-dominated galaxies. IN IRAS 17208-0014, where the presence of a powerful obscured AGN has been unclear, the ratio (~1.7) is

brightness-temperature ratios in UGC 5101 and Mrk 273 cloud be the consequence of an HCN abundance enhancement, which is expected from chemical effects of the central X-ray-emitting AGN on the surrounding dense molecular gas. Our proposed millimeter interferometric methods base on HCN/HCO$^+$ ratios may be an effective tool for unveiling elusive buried AGNs at the cores of ULIRs, especially because of the negligible dust extinction at these wavelengths.

- Imanishi, M., and K. Nakanishi [2006b], "Infrared 2-4 Micrometer Spectroscopy and Millimeter Interferometric HCN and HCO$^+$ Observations of the Individual Merging Components of Arp 299," Publ. Astron. Soc. Japan, vol.58, pp.813-828.

➢ We present ground-based infrared K - (2-2.5 μm) and L-band (2.8-4.1 m) spectroscopy, as well as interferometric observations at λ ~ 3mm, for the individual merging components (A, B and C) of the luminous infrared galaxy Arp 299. The presence and location of a buried active galactic nucleus (AGN) are investigated. Our sub-arcsec-resolution infrared spectra clearly reveal the putative buried AGN resides in the nucleus B1 (a subcomponent of B), based on a very low equivalent width of 3.3 μm polycyclic aromatic hydrocarbon emission, a weak 2.3 μm CO absorption feature, and a large time variation of the K- and L-band continuum fluxes. Our interferometric observations simultaneously obtain HCN (J=1-0) and HCO$^+$ (J=1-0) emission lines with ~ 4" resolution, and we find the HCN to HCO$^+$ brightness-temperature ratios to be as low as those found in starburst nuclei in all of the major merging components of Arp 299. The low ratio even in the AGN-hosting nucleus B may be due to the presence of a large amount of high-density molecular gas whose chemistry is dominated by coexisting starbursts and/or shocks, rather than by the central strong X-ray-emitting AGN.

- Imanishi, M. [2007], "Millimeter Interferometric Observations of Nearby Luminous Infrared Galaxies," Proc. of the "The Central Engine of Active Galactic Nuclei", eds. Luis C. Ho and Jian-Min Wang, ASP Conf. Ser., vol.373, pp.614-615.

➢ We present interferometric observations at 3 mm, using the Nobeyama Millimeter Array, of luminous infrared galaxies (LIRGs) with and without luminous buried AGN signatures in infrared spectra. Both HCN (J=1-0) and HCO$^+$ (J=1-0) molecular lines are observed simultaneously. The HCN to HCO$^+$ brightness temperature ratios toward the nuclei of these LIRGs are derived and are compared with those of galaxies known to be dominated by active galactic nuclei (AGNs) or starbursts. LIRGs with (without) luminous buried AGN signatures tend to distribute in the range occupied by AGN-dominated (starburst-dominated) galaxies, suggesting that this millimeter interferometric method is potentially an effective tool to find elusive buried AGNs, because dust extinction is negligible in this wavelength range.

- Inomata, N., H. Imai, and T. Omodaka [2007], "A Pole-on Bipolar Outflow from the AGB Star WX Piscium," Publ. Astron. Soc. Japan, vol.59, pp.799-809.

➢ We report on H_2O masers around the asymptotic giant branch (AGB) star WX Piscium (WX Psc IRC 10011), observed with the Japanese VLBI Network (JVN) at three epochs during a span of 2 months. The H_2O maser spectrum of WX Psc consists of double peaks with a separation of 30 km s^{-1} centered at the systemic velocity of the star. The maser features are found to split roughly in two concentrations separated by about 60 mas from north to south. The northern concentration involves both blueshifted and redshifted components from both of the double peaks, suggesting that it is near the star driving the outflow. The maser spatiokinematics is well approximated by a radial expansion of a thick shell, except for the blueshifted features in the southern concentration. The spatiokinematics is compared with a fan-shaped morphology found in near-infrared emission, suggesting the existence of a bipolar outflow. Two different models are proposed for explaining the observed maser proper motions: one is a biconically expanding flow with a large opening angle ($2\theta_{cone}$= 70。-120°); the other is a collimated outflow with precession. The complicated spatiokinematics of the H_2O maser features indicates that the star is currently in the process of launching a bipolar outflow in the final stage of the AGB phase, shaping a planetary nebula in the next stage.

- Inoue, M. [2004], "East Asian VLBI Activities," Proc. of the 7th symposium of the European VLBI Network on New Developments in VLBI Sciences and Technology, eds. R. Bachiller, F. Colomer, J.-F. Desmurs, and P. de Vicente, pp.279-280.

➢ The VLBI activities in the East Asia region are planning to coordinate among VLBI groups and

institutes in China, Japan, and Korea. In these countries, some new projects are going to start or discussed, and some types of collaboration have been already done individually. These new projects are briefly introduced. Under these circumstances, an organization has been discussed for the coordinated efforts to produce fruitful results more effectively.

- Inoue, M. [2005], East Asia VLBI Consortium and its Committee, J. Korean Astron. Soc., vol.38, pp.77-79.
- ➢ We had the first committee meeting of the East Asia VLBI Consortium during the EAMA6 meeting held in Seoul. A VLBI network composed of telescopes in the East Asia region could provide extreme properties, and the coordination of them has been expected. The Committee of the East Asia VLBI Consortium is a standing committee to promote activities of the consortium, in which participating countries at present are China, Japan, and Korea over eight institutes/observatories. Here we introduce the Consortium and Committee.
- Inoue, M., K. Asada, and H. Nagai [2007a], "Possible Detection of Faraday Screen," Proc. of the "The Central Engine of Active Galactic Nuclei", eds. Luis C. Ho and Jian-Min Wang, ASP Conf. Ser., vol.373, pp.209-210.
- ➢ We pointed out a possible way to investigate a plasma sheath, Faraday screen, which has been revealed by recent Faraday rotation studies of AGN jets. A high-angular resolution observation of VSOP reveals a sharp absorption feature which suggests free-free absorption by the plasma sheath. The spiral jet configuration could provide, in general, an opportunity to investigate the sheath surrounding AGN jets.
- Inoue, M., Y. Murata, The Next-Generation Space VLBI Working G. [2007b], "The Next-Generation Space VLBI Project: VSOP-2," Proc. of the "The Central Engine of Active Galactic Nuclei", eds. Luis C. Ho and Jian-Min Wang, ASP Conf. Ser., vol.373, pp.715-716.
- ➢ The space VLBI project VSOP-2 offers superior spatial resolution to enable imaging of the accretion discs, the regions where jets are produced and collimated in active nuclei, and the magnetosphere around protostars.
- Iono, D., M. S. Yun, M. Elvis, A. B. Peck, P. T. P. Ho, D. J. Wilner, T. R. Hunter, S. Matsushita, and S. Muller [2006a], "A Detection of [CII] Line Emission in the z = QSO BR 1202-0725," Astrophys. J. (Letters), vol.645, pp.L97-L100.
- ➢ We present ~3" resolution of the z=4.7 QSO BR 1202-0725 at 900 μm from the Submillimeter Array. The two submillimeter continuum components are clearly resolved from each other, and the positions are consistent with previous lower frequency images. In addition, we detect [CII] line emission from the northern component at $L[CII]=4.5 \times 10^9$ L_{solar}. The ratio of [C ii} to far-infrared luminosity is 0.04% for the northern component, and an upper limit of <0.03% is obtained for the southern component. These ratios are similar to the low values found in local ultraluminous galaxies, indicating that the excitation conditions are different from those found in local field galaxies. X-ray emission is detected by Chandra from the southern component at $L_{0.5-2keV}=3 \times 10^{45}$ ergs s^{-1} and, at 99.6% confidence, from the northern component at $L_{0.5-2keV} \sim 3 \times 10^{44}$ ergs s^{-1}, supporting the idea that BR 1202-0725 is a pair of interacting galaxies at z=4.7 and that each harbors an active nucleus.
- Iono, D., Y. Tamura, K. Nakanishi, R. Kawabe, K. Kohno, T. Okuda, K. Yamada, B. Hatsukade, and M. Sameshima [2006b], "CO (3-2) and CO (2-1) Detections in a z = 1.3 Hyper-Luminous Starburst Galaxy," Publ. Astron. Soc. Japan, vol.58, pp.957-963.
- ➢ We present an ~ 2" resolution image of the CO (2-1) emission and an ~ 4" resolution image of the CO (3-2) emission in the z = 1.3 hyper-luminous starburst galaxy MIPS J142824.0+352619, obtained at the Nobeyama Radio Observatory. One new CO (3-2) and CO (2-1) emission detections yield $L'_{CO(3-2)}$ = 1.4 (±0.5) x 10^{11} and $L'_{CO(2-1)}$ (±0.3) x 10^{11} K km s^{-1} pc^2, which translate to a molecular gas mass of ~ 10^{11} M , assuming a CO to H_2 conversion factor appropriate for ULIRGs. The derived high CO luminosities place this source as being one of the brightest galaxies detected in CO to date. The CO (3-2) and CO (2-1) derived redshifts are 1.3248±0.0002 and 1.3250±0.0002. If the bulk of the molecular gas traced in these lines is completely thermalized, as suggested by $L'_{CO(3-2)}/L'_{CO(2-1)}$ ~ 1, a constraint to the gas density of n >/~ 10^3 cm^{-3} is obtained from our Large Velocity Gradient (LVG) analysis. If a significant fraction of the bright FIR luminosity of LFIR = (3.2±07) x 10^{13} L arises from starburst activity, then the Star Formation Efficiency (SFE) is 320 L M $^{-1}$. The size constraint of 1".3 given by the

CO (2-1) map provides an upper limit to the lensing magnification factor of µ</~8, which further supports the earlier claim that the magnification of this source is only modest.

● Iono, D., C. Wilson, M. Yun, S. Takakuwa, A. Peck, G. Petitpas, P. Ho, Z. Wang, and Y. Pihlstrom [2007a], "High Resolution CO(3-2) and HCO$^+$(4-3) Imaging of the Luminous Infrared Galaxy NGC 6240," Proc. of the IAU Symp. 235, "Galaxy evolution across the Hubble Time", eds. F. Combes & J. Palous, p.309.

➢ We present interferometric CO(3-2), HCO$^+$(4-3) and 870 micron continuum images of the luminous infrared galaxy NGC 6240 obtained at the Submillimeter Array (SMA). Our spatially resolved CO(3-2) and HCO$^+$(4-3) emission peaks between the two nuclear components that are known to both harbor AGNs. The kinematical information provided by the CO(3-2) emission shows a rotating disk centered around the northern AGN and a possible face-on disk around the southern AGN, but the kinematics of gas between the two nuclei is extremely turbulent.

● Iono, D., S. Takakuwa, R. Kawabe, B. Vila-Vilaro, M. Saito, and Y. Tamura [2007b], "ALMA Imaging Simulations of Nearby and Distant Colliding Galaxies," Proceedings in "From Z-Machines to ALMA:(Sub)Millimeter Spectroscopy of Galaxies", eds. Andrew J. Baker, Jason Glenn, Andrew I. Harris, Jeffrey G. Mangum and Min S. Yun, ASP Conf. Ser. vol.375, pp.242-245.

➢ We present preliminary ALMA (12 m array + ACA) imaging simulations of nearby (D = 300 Mpc) and distant (z = 3) colliding galaxy systems. It is found that the addition of the ACA will significantly improve the image quality for nearby systems, but the expected improvements in image quality from adding the ACA for high-z observations are limited for this particular model observed at 345 GHz. Improvements are, however, seen when the target source is more extended than the model used here, or when higher frequency bands are used. These imaging simulations are especially important for investigating the characteristics of existing imaging techniques, and for optimizing the pipelining of ALMA data.

● Iono, D., M. S. Yun, M. Elvis, A. B. Peck, P. T. P. Ho, D. J. Wilner, T. R. Hunter, S. Matsushita, and S. Muller [2007c], "A Tentative Detection of [C II] Line Emission in the z=4.7 QSO BR1202-0725," Proceedings in "From Z-Machines to ALMA:(Sub)Millimeter Spectroscopy of Galaxies", eds. Andrew J. Baker, Jason Glenn, Andrew I. Harris, Jeffrey G. Mangum and Min S. Yun, ASP Conf. Ser. vol.375, pp.246-249.

➢ Our new SMA ~ 3" resolution 900 µm image of the z=4.7 QSO BR1202-0725 shows two submillimeter continuum components, consistent with previously published mm images. We further tentatively detect the redshifted [C II] line emission from the northern component BR1202N. The derived [C II]-to-FIR luminosity ratio (0.03%) is comparable to the ratios found in local ULIRGs. In addition, by analyzing archival Chandra data, we detect X-ray emission in both submm components. We conclude that BR1202-0725 is likely a pair of AGN host galaxies at z = 4.7, with both galaxies forming stars at exceedingly high rates.

● Iono, D., C. Wilson, S. Takakuwa, M. Yun, G. Petitpas, A. Peck, P. T. P. Ho, S. Matsushita, Y. Pihlstrom, and Z. Wang [2007d], "High Resolution Imaging of Warm and Dense Molecular Gas in the Nuclear Region of the Luminous Infrared Galaxy NGC6240," Astrophys. J., vol.659, pp.283-295.

➢ We present ~2" resolution CO (3-2), HCO$^+$(4-3), and 880 µm continuum images of the luminous infrared galaxy NGC 6240 obtained at the Submillimeter Array. We find that the spatially resolved CO (3-2), HCO$^+$ (4-3), and the 880 mum emission peaks between the two nuclear components that are both known to harbor AGNs. Our large velocity gradient (LVG) analysis performed on each velocity channel suggests that the peak of the molecular gas emission traced in our observations is warm (T=20-100 K), dense ($n_{H2}=10^{5.0}-10^{5.4}$ cm^{-3}), and moderately optically thin (tau=0.2-2) in the central 1 kpc. We also find large column densities of ~10^{23} cm^{-2}. Such extreme conditions are observed over ~300 km s^{-1} centered around the CO-derived systemic velocity. The derived molecular gas mass from the CO (3-2) emission and a CO-to-H$_2$ conversion factor commonly used for ULIRGs is (6.9±1.7) 10^9 M$_{solar}$, and this is consistent with the mass derived from previous CO (2-1) observations. The gas is highly turbulent in the central kpc (Δv_{FWZI}~1175 km s^{-1}). Furthermore, possible inflow or outflow activity is suggested from the CO (3-2) velocity distribution. We tentatively state that 3.5×10^8 M$_{solar}$ of isolated CO (3-2) emission seen west of the northern disk may be associated with outflows from starburst

superwinds, but the gas outflow scenario from one of the central AGN is not completely ruled out. Piecing all of the information together, the central region of NGC 6240 harbors 2 AGNs, ~10^{10} M$_{solar}$ of molecular gas mass, 5x10^7 M$_{solar}$ of dust mass, and has possible evidence of inflow and outflow activity.

- Ishitsuka, J., M. Ishitsukam, N. Kaifu, S. Miyama, M. Inoue, M. Tsuboi, M. Ohishi, K. Fujisawa, T. Kasuga, K. Miyazawa, and S. Horiuchi [2004], "A 32 m Parabolic Antena in Pery at 3,370 m of Altitude," Proc. of the 7th Symposium of the European VLBI Network on New Developments in VLBI Science and Technology, Edited by R. Bachiller, F. Colomer, J.-F. Desmurs, and P. de Vicente, pp.295-296.

- ➢ At the altitude of 3,370 m on the Peruvian Andes, a 32m antenna owned by the telecommunications company Telef nica del Per will be transformed to a Radio Telescope, it would be transferred to the Geophysical Institute of Peru (IGP). The parabolic antenna was constructed in 1984 by Nippon Electric Co. (NEC) and worked as an INTELSAT station until 2000. A team of the National Observatory of Japan (NAOJ) evaluated the antenna in 2003 and reported its availability to be used as a Radio Telescope. In collaboration of the NAOJ a 6.7 GHz receiver is under construction and will be installed within this year. Initially the telescope as a single dish will monitor and survey Methanol Maser of YSO, higher frequencies equipment and VLBI instruments will be considered. The antenna will be managed by the IGP and used by universities in Peru, becoming a VLBI station will be a grate contribution to astronomy and geodetic community.

- Ishitsuka, J. K., M. Ishitsuka,M. Inoue, N. Kaifu, S. Miyama, M. Tsuboi, M. Ohishi, K. Fujisawa, T. Kasuga, T. Kondo, S. Horiuchi, T. Umemoto, M. Miyoshi, K. Miyazawa, T. Bushimata, and E. D. Vidal [2006], "A New Astronomical Facility for Peru: Converting a Telecommunication's 32 Meter Parabolic Antenna into a Radio Telescope," International Astronomical Union XXVIth General Assembly, Pragua, 14-25 August, 2006, abstract book, p.477 (SPS5-55 Oral presentation).

- ➢ In 1984 Nippon Electric Company constructed an INTELSAT antenna at 3,370 meters the sea level on the Peruvian Andes. Entel Peru, the Peruvian telecommunications company, managed the antenna station until 1993. This year the government transferred the station to a private telecommunications company, Telefonica del Peru. Since the satellite communications were rapidly replaced by transoceanic fiber optics, the beautiful 32 meters parabolic antenna has been unused since 2002. In cooperation with the National Astronomical Observatory of Japan we began to convert the antenna into a radio telescope. Because researches on interstellar medium around Young Stellar Objects (YSO) will be able to observe the methanol masers that emit at 6.7 GHz, initially we will monitor the 6.7 GHz methanol masers and survey the southern sky. An ambient temperature receiver with Trx=60K was developed at Nobeyama Radio Observatory and is ready to be installed. The antenna control system is the Field System FS9 software installed in a Linux PC. An interface between the antenna and the PC was developed at Kashima Space Center in Japan. In the near future we plan to install the 2 GHz, 8GHz, 12GHz, and 22GHz receivers. The unique location and altitude of the Peruvian Radio Observatory will be useful for VLBI observations in collaboration with global arrays such as the VLBA array for astronomical observation and geodetic measurements. For Peru where few or almost no astronomical observational instruments are available for research, the implementation of the first radio observatory is a big and challenging step, and foster sciences at graduate and postgraduate levels of universities. Worldwide telecommunications antenna possibly are unused and with relative few investment could be transformed into a useful observational instrument.

- Ishitsuka, J. K., Ishitsuka, M. Kaifu, N., Inoue, M., Tsuboi, M., Ohishi, M., Kondo, T., Koyama, Y., Kasuga, T., Fujisawa, K., Miyazawa, K., Miyoshi, M., Umemoto, T., Bushimata, T., Horiuchi, S., and Vidal, E. D.:A New Astronomical Facility for Peru: Converting a Telecommunication's 32 Meter Parabolic Antenna into a Radio Telescope,Proc. of the "Astronomy for the Developing World: IAU 26th General Assembly in Pragua". eds. J. B. Hearnshaw and P. Martinez, 77-82, 2007.

- ➢ Not Available

- Ita, Y., S. Deguchi, N. Matasunaga, and H. Fukushi [2006], "Search for SiO Masers in Nearby Miras Pulsating in the First Overtone Mode," Proc. of the conference "Stellar Pulsation and

Evolution", eds. A. R. Walker and G. Bono, Mem. Soc. Astr. It., vol.77, pp.85-88.

➢ We studies the period-K magnitude (P-K) relations of nearby Mira and Mira-like variables with relatively good Hipparcos parallaxes. They form at least two prominent sequences on the P-K plane, corresponding to the sequences C (Mira variables pulsating in the fundamental mode) and C' (Mira variables pulsating in the 1st overone mode), that were found in the LMC. As a part of an ongoing study to see the differences between the Mira variables pulsating in the fundamental and the 1st overone mode, we searched for SiO masers in the nearby variables on the sequences C' and C using the Nobeyama 45m radio telescope. We observed 28 selected nearby Mira and Mira-like variables without previous maser observations, and found 3 new emitters. The observational result shows that there is few or no SiO maser emitters pulsating in the 1st overone mode.

● Iwata, I., K. Ohta, K. Nakanishi, P. Chamaraux, and A. Roman [2005], "The Growth of the Local Void and the Origin of the Local Velocity Anomaly," Proc. of the "Nearby Large-Scale Structures and the Zone of Avoidance", eds. A. P. Fairall and P. A. Woudt, ASP Conf. Ser. vol.329, pp.59-66.

➢ The Local Void is the nearest void from us and is thought to be playing an important role in the kinematics of the local universe, especially as one of the suspected source of the motion of the Local Group. The imbalance between the mass in the Local Void region and that contained in the concentration at the opposite side might contribute to the velocity of the Local group perpendicular to the Supergalactic plane, and this would be a prototype of the evolution of the large-scale structure. The proximity of the Local Void provides us the exclusive opportunity to investigate the kinematics around a void. Here we report the results of our observational study of the peculiar velocities of about 40 galaxies at the far-side of the Local Void, using the near-infrared Tully-Fisher relation. The galaxies at the boundary of the void shows an excess of receding motion, suggesting the expansion of the Local Void. We examined the effect of selection biases on the peculiar velocity distribution, and concluded that the excess of receding motion could not fully attribute to selection biases.

● Kamazaki, T., H. Ezawa, K. Tatematsu, N. Yamaguchi, N. Kuno, K.-I. Morita, K. Yanagisawa, O. Horigome, and J. Maekawa [2005], "The Remote Control System for the ASTE Telescope," Proc. of the "Astronomical data analysis software and system XIV", eds. P. Shopbell, M. Britton, and R. Ebert, ASP Conf. Ser. vol.347, pp.533-537.

➢ The Atacama Submillimeter Telescope Experiment (ASTE) is a project to operate a 10-m submillimeter telescope at a high altitude site (4,800 m) in the Atacama desert in northern Chile. The key to successful telescope operation under the severe environment of the observing site is to realize a stable remote control system. The remote control system for ASTE consists of a newly developed operating software capable of remote observation and a satellite network facility (56-64 kbps), which connects the telescope site to the outside world including the operation base in San Pedro de Atacama (altitude 2,400 m) or institutes in Japan. The control software was developed based on the existing COSMOS3 system, which has been used for the 45-m telescope and the Millimeter Array (NMA) of the Nobeyama Radio Observatory (NRO) in Japan. The telescope operation with N-COSMOS3 in Chile started in April 2002. We have succeeded in the first remote observation from the base in San Pedro de Atacama in July 2002, followed by the first successful remote observation from Japan in October 2003.

● Kamegai, K., M. Hiramatsu, T. Hayakawa, K. Tatematsu, T. Hasegawa, T. Onishi, and A. Mizuno [2007], "Submillimeter-Wave Observations of Outflow and Envelope around the Low Mass Protostar IRAS 13036-7644," Proc. of the IAU Symp, 237, "Triggered Star Formation in a Turbulent Interstellar Medium", eds. B. G. Elmegreen & J. Palous, p.432.

➢ The interaction between molecular outflow from a protostar and ambient molecular cloud would play an important role in dissipating circumstellar envelope, changing chemical composition, and triggering next generation star formation. In order to investigate the interaction in submillimeter wavelength, we have made line observations toward the low mass protostar IRAS 13036-7644 (Class 0/I) in the Cha II dark cloud. Although millimeter observations found CO outflow and evidence of mass infall toward the protostar (e.g. Lehtinen 1997), no submillimeter observation has been reported so far.

● Kameno, S., M. Inoue, Z.-Q. Shen, S. Sawada-Satoh, and K. Wajima [2004], "Multi-Frequency

VLBI Observations of GHz-Peaked Spectrum Sources," Proc. of the 7th symposium of the European VLBI Network on New Developments in VLBI Sciences and Technology, eds. R. Bachiller, F. Colomer, J.-F. Desmurs, and P. de Vicente, pp.157-158.

➢ We report results of pentachromatic VLBI survey for 18 GHz-peaked spectrum sources. Spectral fitting at every pixel across five frequencies allows us to illustrate distribution of optical depth in terms of free-free absorption or synchrotron self absorption. Quasars and Seyfert 1 sources show one-sided morphology with a core at the end where the optical depth peaks. Radio galaxies and Seyfert 2 show symmetric double-sided jets with a optically thick core at the center.

● Kameno, S., N. Nakai, S. Sawada-Satoh, N. Sato, and A. Haba [2005a], "Emergence of a Narrow H_2O Maser Feature in NGC 1052," Astrophys. J., vol.620, pp.145-150.

➢ We report the emergence of a narrow H_2O maser feature with an FWHM of 21 km s^{-1} in the LINER NGC 1052, which has been known to show only a broad (FWHM>100 km s^{-1}) maser line profile with relatively bright continuum radio emission. The new narrow maser feature with a peak flux density of 47 mJy at V_{LSR}=1787 km s^{-1} is redshifted by 328 km s^{-1} with respect to the systemic velocity. Broad features with peak velocities of 1510 and 1704 km s^{-1}, more redward than ever observed before, are also detected. The profile of the new narrow feature possibly shows brightening by 16%±9% and narrowing by 30%±12% between 2003 May 30 and June 2. During the same time, the continuum flux density has increased by 21%. Synchronous variation of maser and continuum flux densities on a timescale of days resembles that in Mrk 348, which is also a broad megamaser source with a bright radio continuum. Continuum and maser brightening and narrowing indicate that an increase of the background seed photon and an increase of maser gain have occurred simultaneously. A jet component running behind a mixture of ionized regions and X-ray dissociation regions at a subrelativistic velocity can produce such short-time variation. Another explanation is an interaction between the jet and molecular clouds.

● Kameno, S., and VSOP-2 Science Working Group [2005b], "VSOP-2 Science Case," Proc. at the XXVIIIth General Assembly of the URSI, October 2005, India. (CD-ROM : J04-P.5)

➢ VSOP-2 is a space VLBI project, following the VSOP (VLBI Space Observatory Programme), organized by the space VLBI working group consisting of the Japan Aerospace Exploration Agency (JAXA), the National Astronomical Observatory of Japan (NAOJ), and the university interest group. We aim synthesis imaging with the angular resolutions of 38, 75, and 205 microarcsec at 43, 22, and 8 GHz, respectively, to unveil extremely compact celestial objects. Phase referencing capability, 1-Gbps wideband downlink, and dual polarization receivers will be able to provide high sensitivity, with the minimum detectable brightness temperature of a few 10^8 K. Dual polarization observations are supported for 4-Stokes-parameter imaging. The VSOP-2 science working group have continued discussion on VSOP-2 science case. The main astronomical targets are active galactic nuclei (AGNs) and young stellar objects (YSOs). VSOP-2 will image accretion disks, roots of jets, and circumnuclear regions of nearby AGNs with a resolution of ~ 10 Schwarzschild radii. It also allows us to investigate magnetospheres, protoplanetary disks, and roots of outflows of YSOs with a resolution of ~ 1 solar radius in nearby star-forming regions.

● Kameno, S., M. Inoue, K. Wajima, Z.-Q. Shen, and S. Sawada-Satoh [2005c], "Free-Free Absorption towards Active Galactic Nuclei," Proc. of the "Future Directions in High Resolution Astronomy: A Celebration of the 10th Anniversary of the VLBA", eds. J. D. Romney, and M. J. Reid, ASP Conf. Ser. vol.340, pp.145-149.

➢ We report results from multifrequency observations for 18 GHz-Peaked Spectrum (GPS) sources, which show convex radio spectra due to Free-Free Absorption (FFA). Trichromatic VLBA observations showed that radio galaxies and Seyfert-2 sources tend to show symmetric opacity distributions along double-sided jets while asymmetric profiles are found in QSO and Seyfert-1. The significant difference can be related to the orientation of the jets. Pentachromatic VSOP and VLBA observations for the nearest object, NGC 1052, revealed spatial distribution of cold dense plasma around the nucleus are obtained via opacities of FFA. The density distribution indicates a dense disk or torus of ~ 1 pc in radius.

● Kameno, S., Y. Murata, H. Hirabayashi, Y. Hagiwara, and M. Inoue [2006], "The Space VLBI VSOP-2 to Image 10-Schwartzschild-Radii Vicinity of AGN Engines," International Astronomical Union XXVIth General Assembly, Pragua, 14-25 August, 2006, abstract book,

p.178 (S238-115 Poster).

- ➢ VSOP-2 is a space VLBI mission using the ASTRO-G satellite to be launched in 2012 by the Japan Aerospace Exploration Agency (JAXA) and collaborated ground radio telescopes. It will bring synthesis imaging capability with the angular resolutions of 44, 87, and 240 μas at 43, 22, and 8 GHz, respectively. Cooled on-board dual polarization receivers, 1-Gbps wideband downlink, and phase referencing capability will be able to provide highsensitivity, with the minimum detectable flux densities of 6, 8, and 11 mJy or brightness temperatures 7, 13, and 21 x 10^8 K, when correlated with 25-m ground telescopes. Dual polarization observations are supported for 4-Stockes-parameter imaging. The primary aim of the VSOP-2 is to image accretion disks around supermassive black holes in Active Galactic Nuclei (AGNs). Accretion disks are considered to generation all of AGN power in ~10 - 100 Schwartzschild radii (r[s]). The disk size of nearby AGNs corresponds to tens of as, comparable to resolutions of the VSOP-2. The best target object is the radio galaxy M87, which hosts a massive black hole of $3.2x10^9$ solar masses, where VSOP-2 resolution corresponds to 10 r[s]. There are at least three objects in which the VSOP-2 beam is sharper than 20 r[s] and at least 13 objects for 200 r[s] within 20 Mpc. The VSOP-2 is the most promising telescope to image AGN directly. Relativistic AGN jets are also main targets of the VSOP-2. It will image fine structures in the jet formation region to clarify the acceleration mechanism. Polarization imaging capabilities of VSOP-2 is essential to illustrate magnetic fields which are related to physics of jets. In this presentation we introduce a sneak preview of the extremely high-resolution universe brought by the VSOP-2.

- ● Kameya, O., T. Kurayama, H. Suda, and Vera Members [2004], "H_2O Maser Observations of W3OH Using VERA," Proc.of the 7th Symposium of the European VLBI Network on New Developments in VLBI Science and Technology, Edited by R. Bachiller, F. Colomer, J.-F. Desmurs, and P. de Vicente, pp.195-198.

- ➢ We have started multi-epoch differential VLBI observations towards W3(OH) H_2O maser source and a reference source J0244+6228 using VERA (VLBI Exploration of Radio Astrometry), which has a dual beam VLBI system. Some results of the observations will be shown. The H_2O maser positions are basically consistent to the former ones indicating that the mapping capability of VERA is available for conventional mapping observations. The reference source J0244+6228 was also detected with good S/N ratio and point-like indicating this source is good for reference of differential VLBI. Our VERA system probably has a good performance for VLBI imaging.

- ● Kamikura, M., Y. Tomimura, Y. Sekimoto, S. Asayama, W. Shan, N. Satou, Y. Iizuka, T. Ito, T. Kamba, Y. Serizawa, and T. Noguchi [2006], "A 385-500 GHz Sideband-Separating (2SB) SiS Mixer Based on a Waveguide Split-Block Coupler," Int. J. of IR and MM Waves, vol.27, pp.37-53.

- ➢ We have developed a 385 - 500 GHz sideband-separating (2SB) mixer, which is based on a waveguide split-block coupler at the edge of the H-plane of the 508 μm x 254 μm (WR 2.0) waveguide, for the Atacama Large Millimeter/submillimeter Array (ALMA). An RF/LO coupler, which contains an RF quadrature hybrid, two LO couplers, and an in-phase power divider, was designed with the issue of mechanical tolerance taken into account. The RF/LO coupler was measured optically with a microscope and electrically with a submillimeter vector network analyzer. The image rejection ratio (IRR) and the single-sideband (SSB) noise temperature of the receiver using the RF/LO coupler have also been measured. The IRR was found to be larger than 8 dB and typically ~ 12 dB in the 385 - 500 GHz band. The SSB noise temperature of this receiver is 80 K at the band center, which corresponds to 4 times the quantum noise limit (hf/k) in SSB, and 250 K at the band edges.

- ● Kamohara, R., S. Deguchi, M. Miyoshi, and Z.-Q. Shen [2005], "Time Variation of SiO Masers in VX Sagittarii over an Optically Quiescent Phase," Publ. Astron. Soc Japan, vol.57, pp.341-345.

- ➢ The time variation of SiO masers in a semi-regular variable, VX Sgr, was investigated in the period between 1994 and 2004 when the optical light curve exhibited an ~6-yr quiescent phase intercepting a regularly pulsating era. The quiescent period occurred with a delay of several years after a decrease in the SiO maser flux. VLBA observations of SiO masers made during this period showed no drastic spatial variation except for emission features being shifted from south-west to north-east. The SiO maser flux decrease, and a succeeding optical quiescent phase,

may indicate that the stellar mass-loss rate diminished over a few years around 1994. A SiO maser flare occurring in 1999 may be a reminiscence of a final gas blow, which resulted in the optically quiescent period.

- Kandori, R., Y. Nakajima, M. Tamura, K. Tatematsu, Y. Aikawa, T. Naoi, K. Sugitani, H. Nakaya, T. Nagayama, T. Nagata, M. Kurita, D. Kato, C. Nagashima, and S. Sato [2005], "Near-Infrared Imaging Survey of Bok Blobules: Density Structure," Astron. J., vol.130, pp.2166-2184.

➢ On the basis of near-infrared imaging observations, we derived the visual extinction (AV) distribution toward 10 Bok globules through measurement of both the color excess (EH-K) and the stellar density at J, H, and Ks (star count). Radial column density profiles for each globule were analyzed with the Bonnor-Ebert sphere model. Using the data of our 10 globules and four globules in the literature, we investigated the stability of globules on the basis of ξmax, which characterized the Bonnor-Ebert sphere, as well as the stability of the equilibrium state against gravitational collapse. We found that more than half the starless globules are located near the critical state (ξmax = 6.5±2). Thus, we suggest that a nearly critical Bonnor-Ebert sphere characterizes the typical density structure of starless globules. The remaining starless globules show clearly unstable states (ξmax > 10). Sine unstable equilibrium states are not long maintained, we expect that these globules are on the way to gravitational collapse or that they are stabilized by nonthermal support. It was also found that all the star-forming globules show unstable solution of ξmax > 10, which is consistent with the fact that they have started gravitational collapse. We investigated the evolution of a collapsing gas sphere whose initial condition is a nearly critical Bonnor-Ebert sphere. We found that the column density profiles of the collapsing sphere mimic those of the static Bonnor-Ebert spheres in unstable equilibrium. The collapsing gas sphere resembles marginally unstable Bonnor-Ebert spheres for a long time. We found that the frequency distribution of ξmax for the observed starless globules is consistent with that from model calculations of the collapsing sphere. In addition to the near-infrared observations, we out radio molecular line observations ($C^{18}O$ and H_2N^+) toward the same 10 globules. We confirmed that most of the globules are dominated by thermal support. The line width of each globule was used to estimate the cloud temperature including the contribution from turbulence, with which we estimated the distance to the globules from the Bonnor-Ebert model fitting.

- Kano, R., H. Hara, M. Shimojo, and S. Tsuneta [2004], "Solar-B X-Ray Telescope (XRT)," Proc. of the 5th Solar-B Science Meeting, "The Solar-B Mission and the Forefront of Solar Physics : Dedicated to the Memory of Yutaka Uchida", ASP Conf. Ser., vol.325, pp.15-25.

➢ The Soft X-ray Telescope (XRT) aboard SolarB is a grazing incidence X-ray telescope equipped with 2kx2k CCD. XRT has 1 arcsec resolution with wide field-of-view of 34x34 arcmin. It is sensitive to <1 MK to 30 MK, allowing us to obtain TRACE-like low temperature images as well. Co-alignment with SOT and EIS is realized through the XRT visible light telescope and with temperature overlap with EIS. Spacecraft mission data processor (MDP) controls XRT through the sequence tables with versatile autonomous functions such as exposure control, region-of-interest tracking, flare detection and flare location identification. Data are compressed either with DPCM or JPEG, depending on the purpose. This results in higher cadence and/or wider field-of-view for given telemetry bandwidth. With focus adjust mechanism, higher resolution of Gaussian focus may be available on-axis.

- Kasai, Y., E. Kagi, and K. Kawaguchi [2007], "Analysis of Radio Astronomical Data of the Negative Ion C_6H^- in IRC +10 213," Astrophys. J. (Letters), vol.661, pp.L61-L64.

➢ Radio astronomical data of C_6H^- observed with the Nobeyama 45 m and IRAM 30 m telescopes have been analyzed by the local thermodynamic equilibrium approximation to give the column density of $(6.1-8.0)x10^{12}$ cm^{-2} and the excitation temperature of 32±3 K, with an assumed source size of 30"±3". The abundance of C_6H^- was estimated to be 8.6% of C_6H. The observed line shapes of C_6H^- and C_6H indicate that the distribution of C_6H^- is more present in the inner region than C_6H. The production mechanism of C_6H^- is discussed.

- Kasuga, T., and M. Tsuboi [2005], "Upgrading at the 40 GHz 6-beam SIS Receiver for Snuyaev-Zel'dovich Observations," Proc. at the XXVIIIth General Assembly of the URSI, October 2005, India. (CD-ROM : JB-P.10)

➢ We conducted Snuyaev-Zel'dovich observation over 7 years using the Nobeyama 45m telescope

and the 40 GHz 6-beam SIS receiver. In 1998 the receiver dedicated to the high-sensitivity continuum observation was constructed and boarded on the 45 m telescope. The multi beams and sensitive SIS receiver made it possible for us to observe distant sources. In 2003 we started to reconstruct and upgrade the receiver for deeper and more rapid observations   and for mapping high-z source. The points of this up-grade are the use of the cooled HEMT IF amplifier with more wider bandwidth and stable SIS bias supplies that resist noise environments.

- Kato, D., C. Nagashima, T. Nagayama, M. Kurita, J. F. Koerwer, T. Kawai, T. Yamamuro, T. Zenno, S. Nishiyama, D. Baba, R. Kadowaki, Y. Haba, H. Hatano, H. Shimizu, M. Nishimura, T. Nagata, S. Sato, Y. Murai, T. Kawazu, Y. Nakajima, H. Nakaya, R. Kandori, N. Kusakabe, A. Ishihara, N. Kaneyasu, J. Hashimoto, M. Tamura, T. Tanab*, Y. Ita, N. Matsunaga, Y. Nakada, K. Sugitani, K. Wakamatsu, I. S. Glass, M. W. Feast, J. W. Menzies, P. A. Whitelock, P. Fourie, J. Stoffels, G. P. Evans, and T. Hasegawa [2007], "The IRSF Magellanic Clouds Point Source Catalog," Publ. Astron. Soc. Japan, vol.59, pp.615-641.

➢ We present a near-infrared (JHKs) photometric catalog, including 14811185 point sources for a 40 deg^2 area of the Large Magellanic Cloud, 2769682 sources for an 11 deg^2 area of the Small Magellanic Cloud, and 434145 sources for a 4 deg^2 area of the Magellanic Bridge. The 10 limiting magnitudes are 18.8, 17.8, and 16.6 mag at J, H, and Ks, respectively. The photometric and astrometric accuracies for bright sources are 0.03-0.04 mag and 0".1, respectively. Based on the catalog, we also present (1) spatial distributions, (2) luminosity functions, (3) color-color diagrams, and (4) color-magnitude diagrams for point sources toward the Magellanic Clouds.

- Kawabe, R. [2005], "Progress Report in the Japanese ALMA Project," Proc. of the "The Cool Universe: Observing Cosmic Dawn", eds. C. Lidman and D. Alloin, ASP Conf. Ser. vol.344, pp.237-241.

➢ We report here on the progress of the Japanese ALMA project (ALMA-J). The Japanese ALMA project culminates 20 years of development. There are two main Japanese contributions to the ALMA project, commonly called "enhancements". One is the design and construction of the Atacama Compact Array (ACA). ACA is composed of a total power array with four 12 m antennas and a 7 m array with twelve 7 m antennas. The main role of ACA is to guarantee high fidelity imaging by combining total power data and short baseline data with data that are taken with the larger 64 antenna array. The other enhancement is the production of 80 receiver cartridges for each of three bands, bands 4, 8, and 10, to be installed into both the 64 antenna array and the 16 ACA antennas. The construction budget for these enhancements has been funded since April 2004.

- Kawaguchi, K., R. Fujimori, S. Aimi, S. Takano, E. Y. Okabayashi, H. Gupta, S. Brunken, C. A. Gottlieb, M. C. McCarthy, and P. Thaddeus [2007], "Observation of H_8H^- toward IRC+10216," Publ. Astron. Soc. Japan, vol.59, pp.L47-L50.

➢ Five rotational lines of the C_8H^- ion were observed in the circumstellar envelope of IRC+10216 with the Nobeyama 45m telescope. An improved value of the column density of the C_8H radical yielded a $[C_8H^-]/[C_8H]$ ratio of 37% - nearly 4 times larger than the $[C_6H^-]/[C_6H]$ ratio (8.6%) and nearly 1500 times the $[C_4H^-]/[C_4H]$ ratio (0.024%), which may indicate more efficient formation of longer carbon chain anions. The excitation temperature of C_8H^- (16±2K) derived here is somewhat lower than that of the two smaller anions C_6H^- (32K) and C_4H^- (23K) in IRC+10216.

- Kawaguchi, N., Y. Kono, and H. Suda [2005], "Detection of Faint Radio Sources by Using an Optical Fiber Connected VLBI Array," Proc. at the XXVIIIth General Assembly of the URSI, October 2005, India. (CD-ROM : J06-P.4)

➢ Not Available

- Kawamura, A., T. Minamidani, Y. Mizuno, N. Mizuno, T. Onishi, A. Mizuno, Y. Fukui, M. Filipovic, L. Staveley-Smith, L. E. B. Johansson, S. Nikoloc, R. S. Booth, A. Heikkila, L.-A. Nyman, M. Lerner, K. Tatematsu, T. Hasegawa, and M. Ikeda [2007a], "Molecular Clouds and Star Formation in the Large Magellanic Cloud," Proceedings in "Protostars and Planets V", LPI contribution no. 1286, p.8300.

➢ Not Available

- Kawamura, A., T. Minamidani, Y. Mizuno, T. Onishi, N. Mizuno, A. Mizuno, and Y. Fukui [2007b], "Giant Molecular Clouds and Star Formation in the Large Magellanic Cloud," Proc. of

the IAU Symp, 237, "Triggered Star Formation in a Turbulent Interstellar Medium", eds. B. G. Elmegreen & J. Palous, pp.101-105.

- ➢ In order to elucidate star formation in the Large Magellanic Cloud, a complete survey of the molecular clouds was carried out by NANTEN. In this work, we compare 230 giant molecular clouds (GMCs), whose physical quantities are well determined, with young clusters and HII regions. We find that about 76% of the GMCs are actively forming stars or clusters, while 24% show no signs of massive star or cluster formation. Effects of supergiant shells (SGSs) on the formation of GMCs and stars are also studied. The number and surface mass densities of the GMCs are higher by a factor of 1.5-2 at the edge of the SGSs than elsewhere. It is also found that young stellar clusters are more actively formed in the GMCs facing to the center of the SGSs. These results are consistent with the previous studies by Yamaguchi et al. and suggest the formation of GMCs and the cluster is triggered by dynamical effects of the SGSs

- ● Kikuchi, F., J. Ping, X. Hong, Y. Aili, Q. Liu, K. Matsumoto, K. Asari, S. Tsuruta, Y. Kono, H. Hanada, and N. Kawano [2005], "VLBI Observations of Narrow Bandwidth Signals from the Spacecraft," 36th Ann. Lunar & Planetary Sci. Conf., abstract no. 1551.

- ➢ We carried out a VLBI observation of GEOTAIL by using a narrow bandwidth system. A few carrier waves with frequency interval of 1.5 MHz were correlated by software. As a result, the group delay was estimated within an error of less than 1 ns.

- ● Kinoshita, D., K. Ohtsuka, T. Sekiguchi, J. Watanabe, T. Ito, H. Arakida, T. Kasuga, S. Miyasaka, R. Nakamura, and H.-C. Lin [2007], "Surface Heterogeneity of 2005 UD from Photometric Observations," Astron. Astrophys., vol.466, pp.1153-1158.

- ➢ Context. The recently discovered Apollo-type near-Earth asteroid 2005 UD has been suggested to be a fragment of (3200) Phaethon. Aims. To test this hypothesis, we carried out photometric observations of 2005 UD using the 1-m telescope at Lulin Observatory. Methods. Multi-color photometry was used to compare the surface properties of (3200) Phaethon and 2005 UD. Surface-color variation due to the rotation was also examined. Results. The time-resolved differential photometry showed clear brightness variation, and the lightcurve was fitted with a rotation period of 5.23 h and an amplitude of 0.44 mag. Using this rotational lightcurve, we derived the surface colors of 2005 UD. The surface of 2005 UD exhibits colors similar to those of F- and B-type asteroids, which is consistent with (3200) Phaethon. Furthermore, the (R-I) color of 2005 UD shows variation during the rotation of the body. Conclusions. The similarity of surface colors between (3200) Phaethon and 2005 UD observationally supports the hypothesis that 2005 UD is likely to be a fragment of (3200) Phaethon. A simple explanation for the inhomogeneity of the surface is that we see the surface and subsurface of the precursor object. Another explanation is the topographical structure that such as a large crater causes on this heterogeneous surface.

- ● Kiuchi, H. [2005], "Parallel Bit Stream Correlation System for Very Long Baseline Interferometry," Radio Science, vol.40, p.RS5013.

- ➢ Improvements in sampling and recording technology have made it possible to acquire data at rates of higher than 1 Gbit/s. In very long baseline interferometry, the use of wide-bandwidth data produces a high SNR, which is proportional to $\sqrt{2BT}$ (B is bandwidth and T is integration time). In astronomical applications, wide-bandwidth data acquisition can be used to detect very small flux densities of cosmic radio sources. It is also useful in geodetic applications. The signal processing of the current correlation processing algorithm is bit serial. The data-processing speed, however, is restricted by the correlation device clock in serial data processing, and as a result, the device speed prevents the whole (channel) bandwidth from being used for observations. To overcome this problem, a new correlation processing algorithm for parallel bit stream set processing has been developed. This article focuses on how to derive serial data processing algorithms for parallel bit stream.

- ● Kiuchi, H., T. Kawanishi, M. Yamada, T. Sakamoto, M. Tsuchiya, J. Amagai, and M. Izutsu [2007a], "High Extinction Ratio Mach-Zehnder modulator Applied to a Highly Stable Optical Generator," IEEE Trans. on Microwave Theory and Techniques, vol.55, pp.1964-1972.

- ➢ Research into optical modulators has made remarkable progress in recent years. This paper discusses the possibility of applying the high extinction ratio optical modulator to a high-stability and high-frequency (over 100 GHz) optical reference signal generator. High-frequency reference

signals are generated by a highly stable optical two-tone generator, which is used for high-rate communication and astronomical application. One method to generate two optical signals is producing them from a pair of laser sources using an optical phase-locked loop for feed back control; however, the optical phase-locked loop has a stability problem in its operation. A good alternative method to the optical phase-locked scheme is the LiNbO$_3$ Mach-Zehnder (MZ) optical intensity modulator, which is capable of generating two highly stable optical signals (upper sideband and lower sideband components) by applying a sinusoidal microwave signal to an input laser signal. The two optical signals require phase stability better than 10^{-13} in the Allan standard deviation, vibration robustness, and polarization maintaining capability. The signal coherence loss estimated from the phase stability of the two optical signals generated by the MZ modulator shows that the optical MZ modulator has the ability to generate highly stable optical signals.

- Kiuchi, H., S. Okumura, J. Amagai, S. Iguchi, and T. Kondo [2007b], "Directory Controlled Reference Frequency Wavefront Clock Method Applied to 100-GHz Radio Interferometry and Fringe Simulator," Radio Science, vol.42, p.RS3012 (1 of 11).

➢ Currently, there are tow types of interferometers in the world: One is the conventional interferometer using the fixed local signal as a reference signal, and the other interferometer using the wavefront clock. In this paper, we propose a new method of the wavefront clock system under development. The new wavefront clock system has a great advantage for the Doppler compensation. The Doppler shift,which is caused by the Earth's rotation, is compensated for during the correlation processing or when signals are received in order to detect fringes (interferometer patterns). Also, the proposed interferometry. The main feature of this method is that the reference signals for the front end and back end of the interferometer system are directly controlled from the observing site according to a calculated a priori delay rate. In this method, fringe stopping and delay tracking can be simultaneously performed on all received frequencies as well as on frequency-converted signals in both the upper sideband (USB) and lower sideband (LSB). Furthermore, this method can be introduced with just a slight modification to the current interferometer systems (including very long baseline interferometry) and can also be applied to a pseudofringe (Doppler shift and delay) simulator to check the correlation processor.

- Knapen, J. H., R. J. Allen, H. I. Heaton, N. Kuno, and N. Nakai [2006], "CO Emission from Candidate Photo-Dissociation Regions in M 81," Astron. Astrophys., vol.455, pp.897-902.

➢ Context: At least a fraction of the atomic hydrogen inspiral galaxies is suspected to be the result of molecular hydrogen which has been dissociated by radiation from massive stars.
Aims: In this paper, we extended our earlier set of data from a small region of the Western spiral arm of M 81 with CO observations on order to study the interplay between the radiation filed and the molecular and atomic hydrogen.
Methods: We report CO(1-0) observations with the Nobeyama 45 m dish and the Owens Valley interferometer array of selected regions in the Western spiral arm of M 81.
Results: From our Nobeyama data, we detect CO(1-0) emission at several locations, coinciding spatially with HI features near a far-UV source. The levels and widths of the detected CO profiles are consistent with the CO(1-0) emission that can be expected from several large photo-dissociation regions with typical sizes of some 50 x 150 pc located within our telescope beam. We do not detect emission at other pointings, even though several of those are near far-UV sources and accompanied by bright HI. This non-detection is likely a consequence of the marginal area filling factor of photo-dissociation regions in our observations. We detect no emission in our Owens Valley data, consistent with the low intensity of the CO emission detected in that field by the Nobeyama Dish.
Conclusions: We explain the lack of CO(1-0) emission at positions farther from far-UV sources as a consequence of insufficient heating and excitation of the molecular gas at these positions, rather than as an absence of molecular hydrogen.

- Kobayashi, H., N. Kawaguchi, S. Manabe, T. Omodaka, O. Kameya, K. M. Shibata, T. Miyaji, M. Honma, Y. Tamura, T. Hirota, H. Imai, S. Kuji, K. Horiai, K. Sakai, K. Sato, K. Iwadate, Y. Kan-ya, T. Jike, T. Fujii, and T. Kasuga [2004], "VERA System," Proc. of the 7th Symposium of the European VLBI Network on New Developments in VLBI Science and Technology, eds. R.

Bachiller, F. Colomer, J.-F. Desmurs, and P. de Vicente, pp.275-278.

- ➢ VERA is the first VLBI array to be designed to be free from the atmosphere phase fluctuations. It has four VLBI station with 2,300 km maximum baseline length within Japan islands. To compensate phase fluctuations of interferometer visibilities, which are mainly caused by the atmosphere and local oscillators, VERA antenna has two receivers and observes two objects simultaneously. By the comparison the visibility phase between these two objects, simultaneous phase referencing VLBI will be achieved. The goal accuracy of astrometry observations is 10 micro arcseconds. . Currently the construction of four stations was complete. And test observations are undergoing and phase fluctuations are ideally compensated between two objects. We show the scientific goal, instrumental accuracy and some results of VERA.

- ● Kobayashi, H., N. Kawaguchi, S. Manabe, T. Omodaka, K. M. Shibata, M. Honma, Y. Tamura, O. Kameya, T. Hirota, and H. Imai [2005a], "The VERA Project (VLBI Exploration of Radio Astrometry)," Proc. of the IAU Colloq. 196, "Transits of Venus: New Views of the Solar System and Galaxy", ed. D. W. Kurtz, p.496.

- ➢ VLBI - Very Long Baseline Interferometry - is a radio interferometry technique which provides the highest spatial resolution observations to human kind. But at the present, the accuracy of the astrometry observations is limited by the atmospheric light path variations and instrumental phase errors, and only group delay measurements are used. To overcome these error factors, we have developed the VERA system, which has the first dual beam system. VERA is the first VLBI array to be free from the atmospheric phase fluctuations. It has four VLBI stations with 2300-km maximum baseline length in Japan. To compensate phase fluctuations of interferometer visibilities, which are mainly caused by the atmosphere, the VERA antenna observes two objects simultaneously. In order to do observations, VERA has a two-receiver system, which tracks a focal plane according to a separation angle between observing objects. By comparing the visibility phase between two beams, simultaneous phase referencing VLBI will be achieved. The goal accuracy astrometry observations is 10 micro-arcseconds, which makes parallax and proper motion measurements of galactic maser possible. 10 micro-arcsecond accuracy is equivalent to 10% distance accuracy for the galactic centre. This becomes 20% accuracy at the opposite side of the galaxy. The main scientific targets of VERA are to make a 3-dimensional maser object map of the galaxy and reveal the velocity field of the galaxy. This will show the mass distribution of the galaxy. Currently, construction of four stations is complete, and test observations are underway. We show the scientific goal, current results and instrumental accuracy of VERA.

- ● Kobayashi, H., N. Kawaguchi, S. Manabe, T. Omodaka, K. M. Shibata, T. Miyaji, M. Honma, O. Kameya, Y. Tamura, T. Hirota, H. Imai, S. Kuji, K. Horiai, S. Sasaki, K. Iwadate, Y. Kan-ya, T. Jike, T. Fujii, T. Oyama, and T. Kurayama [2005b], "Progress of VERA Project," Proc. at the XXVIIIth General Assembly of the URSI, October 2005, India. (CD-ROM : J01.3)

- ➢ VERA is the first VLBI array, which is designed to be free from the atmosphere phase fluctuations. It has four VLBI station with 2,300 km maximum baseline length within Japan islands. And observing frequency bands are 2. 8. 22. and 43 GHz. 22 and 43 GHz bands are mainly used for H2O and SiO maser objects observations, respectively. And 2 and 8 GHz bands are mainly used for geometric observations to determine the station positions. And VERA uses a 1Gbps recording system with cassette magnetic tapes. They are correlated by the VSOP correlator at Mitaka.

- ● Kobayashi, H., Z.-Q. Shen, and H. Minh [2005c], "Activities of East Asia VLBI Network," Proc. at the XXVIIIth General Assembly of the URSI, October 2005, India. (CD-ROM : J01.4)

- ➢ The consortium of East Asia VLBI network was established on November of 2004. And the committee members are elected from China, Japan and Korea. At the meeting of the millimeter VLBI in 2003, which was held on Shanghai, a preparation committee was established to organize the consortium committee.

- ● Kobayashi, K., K. Ogata, S. Tsunekawa, and S. Takano [2007], "Torsionally Excited Methyl Formate in Orion KL," Astrophys. J., vol.657, pp.L17-L19.

- ➢ We report the first detection of rotational transitions of methyl formate ($HCOOCH_3$) in the first torsionally excited state (v_t =1). Recent progress on the assignment of laboratory spectra of methyl formate made it possible for us to assign about 20 unidentified lines in Orion KL from

previous line surveys below 200 GHz to the first torsionally excited methyl formate. The rotational temperature and column density obtained in the first torsionally excited state were 44 ± 10 K and $(8.6\pm3.2) \times 10^{14}$ cm^{-2}, respectively. They were compared with those in the ground state.

- Kobayashi, N., C. Yasui, A. T. Tokunaga, and M. Saito [2007], "Embedded Stellar Clusters in the Most Distant Molecular Cloud in Far Outer Galaxy: a Laboratory for Supernova Triggered Star Formation," Proceedings in "Protostars and Planets V", LPI contribution no. 1286, p.8639.

➢ Not Available

- Koda, J., T. Okuda, K. Nakanishi, N. Kuno, S. K. Okumura, K. Kohno, and S. Ishizuki [2004a], "Interferometer SO Survey of Early-Type Spiral Galaxies," Proc. of "The Neutral ISM in Starbust Galaxies", eds. S. Aalto, S. Huttemeiister, and A. Pedlar, ASP Conf. Ser. vol.320, pp.42-43.

➢ We report an on-going interferometer CO survey of early-type spiral galaxy (S0-Sab). We have observed 5 targets with HII region-like nuclei. Distinct nature of nuclear star formation from global ones in disk galaxies has been reported in many studies (Kennicutt 1998 for review). In contrast to low global star formation in early-type disks, vigorous circumnuclear star formation is sometimes found in early-type galaxies. Ho, Filippenko, & Sargent (1997a) reported (1) that the occurrence for hosting HII-nuclei (HII regions-like spectra) is less frequent in early-type spirals than in late-type spirals, (2) however that among the galaxies with HII-nuclei, the average H -luminosity in early-type spirals is higher than that in late-types. Therefore, assuming a constant star formation efficiency, it is expected that early-type spirals would have larger gas mass in circumnuclear regions than late-types. However, our survey so far indicates the opposite trend: our early-type samples have smaller gas masses than the late-type (collected from the literature), although both samples shows similar dynamical masses and star formations rates.

- Koda, J., and T. Sawada [2004b], "Preferential Direction of Supersonic Motion in Molecular Clouds," American Astronomical Society Meeting 205, #59.08.

➢ CO data are analyzed to understand the shape and internal motion of molecular clouds in the Milky Way. For a sample of more than five hundreds molecular clouds, we find on a statistical basis that they are preferentially elongated toward the Galactic plane. The elongations are not supported by internal spins but by internal supersonic motions. It has been known that an external driving mechanism for the supersonic velocity dispersion is necessary to prevent their rapid decay. The mechanism must also account for the preferential direction of molecular clouds. This constraint excludes some suggested mechanisms, such as supernovae and stellar winds, because they do not produce the preferential direction along the Galactic plane.

- Koda, J., T. Okuda, K. Nakanishi, K. Kohno, S. Ishizuki, N. Kuno, and S. K. Okumura [2005a], "Starbursting Nuclear CO Disks of Early-Type Spiral Galaxies," Astron. Astrophys., vol.431, pp.887-891.

➢ We have initiated the first CO interferometer survey of early-type spiral galaxies (S0-Sab). We observed five early-type spiral galaxies with HII nuclei (indicating circumnuclear starburst activities). These observations indicate gas masses for the central kiloparsec of $\sim1\sim5\%$ of the dynamical masses. Such low gas mass fractions suggest that large-scale gravitational instability in the gas is unlikely to be the driving cause for the starburst activities. We estimated Toomre Q values and found that these galaxies have Q>1 (mostly >3) within the central kiloparsec, indicating that the gas disks are globally gravitationally stable. From the brightness temperatures of the CO emission we estimated the area filling factor of the gas disks within the central kiloparsec to be about 0.05. This small value indicates the existence of lumpy structure, i.e. molecular clouds, in the globally-gravitationally stable disks. The typical surface density of the molecular clouds is as high as ~3000 M pc^{-2}. In the light of these new observations, we reconsider the nature of the Toomre Q criterion, and conclude that the Toomre Q parameter from CO observations indicates neither star formation nor molecular cloud formation. This argument should be valid not only for the circumnuclear disks but also for any region in galactic disks. We tentatively explore an alternative model as an initiating mechanism of star formation. Cloud-cloud collisions might account for the active star formation.

- Koda, J., and T. Sawada [2005b], "Results from the Nobeyama/CSO/ASTE Galactic Plane CO Survey," American Astronomical Society Meeting 207, #81.24.

- We present the first results from our Galactic CO survey. We observed a test region in the Galactic plane (0.35deg x 0.5deg) in 12 & 13 CO J=1-0, 2-1, 3-2 lines. We used the Nobeyama 45m telescope, Caltech Sumbillimeter Observatory (CSO), and Atacama Submillimeter Telescope Experiment (ASTE). We found that the molecular gas in interarm regions don't have clumpy structure and is largely extended, although the gas in arms is clumpy. The ratio analyses among the transitions indicate that the interarm gas is cooler than the arm gas.

- Koda, J., T. Sawada, T. Hasegawa, and N. Scoville [2006a], "The Elongations and Supersonic Motions of Molecular Clouds," Astrophys. J., vol.638, pp.191-195.

- New ^{13}CO data from the BU-FCRAO Milky Way Galactic Ring Survey (GRS) are analyzed to elucidate the shape and internal motions of molecular clouds. For a sample of more than 500 molecular clouds, we find that they are preferentially elongated along the Galactic plane. On the other hand, their spin axes are randomly oriented. We therefore conclude that the elongation is not supported by internal spin but by internal velocity anisotropy. It has been known that some driving mechanisms are necessary to sustain the supersonic velocity dispersion within molecular clouds. The mechanism for generating the velocity dispersion must also account for the preferred elongation. This excludes some driving mechanisms, such as stellar winds and supernovae, because they do not produce the systemic elongation along the Galactic plane. Driving energy is more likely to come from large-scale motions, such as Galactic rotation.

- Koda, J., and Y. Sofue [2006b], "The Virgo High-Resolution CO Survey: VI. Gas Dynamics and Star Formation along the Bar in NGC 4303," Publ. Astron. Soc. Japan, vol.58, pp.299-312.

- We present CO interferometer observations of the barred galaxy NGC 4303 (M 61). This galaxy has a strong gas concentration at the central region and prominent offset ridges at the leading sides of the bar. Sharp velocity gradients are apparent across the ridges. The brightness temperature in the ridges is low, indicating the existence of unresolved molecular clouds. Additionally, an analysis of the newborn stellar clusters revealed in HST images suggests that the parent molecular clouds had masses of 10^{4-6}M . The observed shear velocity gradient across the ridges is too small to break up giant molecular clouds. Therefore, the clouds are likely to survive passage through the ridges. We discuss a cloud orbit model in a bar potential for understanding the gas distribution, dynamics, and star formation in NGC 4303. The model reproduces the narrow offset ridges and sharp velocity gradients across the ridges, although no shock is associated with the ridges. We discuss cloud-cloud collisions (and close interactions) as a possible triggering mechanism for star formation. The newborn stellar clusters in NGC 4303 are located predominantly at the leading sides of the offset ridges. Cloud orbits are densely populated in the region where the clusters are found, suggesting a high collisional frequency and possibly a high rate of triggered star formation. Cloud-based dynamics is less dissipative than smooth hydrodynamic models, possibly extending the timescales of gas dynamical evolution and gas fueling to central regions in barred galaxies.

- Kohno, K., T. Tosaki, T. Okuda, K. Nakanishi, T. Kamazaki, K. Muraoka, S. Onodera, Y. Sofue, S. K. Okumura, N. Kuno, N. Nakai, K. Ohta, S. Ishizuki, R. Kawabe, and N. Kawai [2005a], "Nobeyama Millimeter Array Observations of GRB 030329: a Decay of Afterglow with Bumps and Molecular Gas in the Host Galaxy," Publ. Astron. Soc. Japan, vol.57, pp.147-153.

- Nobeyama Millimeter Array was used to observe millimeter-wave afterglow of GRB 030329 at 93GHz and 141GHz from 2003 April 6 (8.23 days after the burst) to 2003 May 30 (61.97 days). A sensitive search for CO (J=1-0) emission/absorption from the host galaxy of GRB 030329 was also carried out. Unresolved millimeter continuum emission at the position of GRB 030329 was detected until 2003 April 21. We found a steep decline of continuum flux ($t^{-2.0}$) during this period, in accord with a previous report. Moreover, our data implies that the decay was accompanied by possible plateaus phases, or bumps, on a time scale of several days. From an integrated spectrum, produced by summing up the data from 2003 April 10 to 2003 May 30, we found a possible emission feature, which could be a redshifted CO (J=1-0) line. Its position and redshift coincide well with those of GRB 030329, though further observations are required to confirm the detection. If the emission feature is real, the observed CO flux is 1.4±0.52Jykm s^{-1}, corresponding to a large molecular gas mass of M(H$_2$) >10^9 M$_{solar}$. This implies that the host galaxy, which is optically faint, is highly obscured due to a rich interstellar medium.

- Kohno, K. [2005b], "The Atacama Submillimeter Telescope Experiment," Proc. of the "The Cool

Universe: Observing Cosmic Dawn", eds. C. Lidman and D. Alloin, ASP Conf. Ser. vol.344, pp.242-247.

- ➤ The Atacama Submillimeter Telescope Experiment (ASTE) is a joint project between Japan and Chile to install and operate a high-precision, 10 m telescope in the Atacama desert for exploration of the southern sky in the sub-millimeter. Currently, we have achieved a main reflector surface accuracy of 19 mum (RMS) and a pointing accuracy of 1.2 arcsec (RMS). A new 350 GHz cartridge-type receiver, installed in September 2004, shows good performance, with a typical system noise temperature of 200 K (DSB (Double Sideband)) and a main beam efficiency of up to 0.8 during winter nights. Four banks of 512 MHz (or 128 MHz) width digital spectrometers with 1024 channels are available. Extensive sub-millimeter observations of various objects such as massive star forming regions in our Galaxy have been started with ASTE.

- ● Kohno, K., K. Muraoka, K. Nakanishi, T. Tosaki, N. Kuno, R. Miura, T. Sawada, K. Sorai, T. Okuda, K. Kamegai, K. Tanaka, A. Endo, B. Hatsukade, H. Ezawa, S. Sakamoto, J. Cortes, N. Yamaguchi, H. Matsuo, and R. Kawabe [2007a], "ASTE Observations of Dense Molecular Gas in Galaxies," Proc. of the IAU Symp, 237, "Triggered Star Formation in a Turbulent Interstellar Medium", eds. B. G. Elmegreen & J. Palous, p.436.

- ➤ Atacama Submillimeter Experiment (ASTE) is a joint project between Japan and Chile for installing and operating a 10 m high precision telescope in the Atacama Desert in order to explore the southern sky through the submillimeter wavelength. We have achieved an accuracy of 90 micron m (rms) for the main reflector surface and a stable radio pointing accuracy of about 2 arcsec (rms). A 350 GHz cartridge type SIS mixer receiver achieves good performance with a typical system noise temperature of 150 - 250 K in DSB and a main beam efficiency of 0.6 - 0.7 during winter nights. Four banks of a 512 MHz (or 128 MHz) digital spectrometer with 1024 channels have been installed. Recent scientific results obtained with ASTE, such as a wide area CO(3-2) mapping of nearby spiral galaxies (M 83, M 33, NGC 1672 etc.) and a possible detection of CO(3-2) emission toward the host galaxy of GRB 98042, are reported.

- ● Kohno, K., K. Nakanishi, and M. Imanishi [2007b], "Compact Starburst in the Central Regions of Seyfert Galaxies," Proc. of the "The Central Engine of Active Galactic Nuclei", eds. Luis C. Ho and Jian-Min Wang, ASP Conf. Ser., vol.373, pp.647-650.

- ➤ We have conducted a high-resolution "3D" imaging survey of the CO(1-0), HCN(1-0), and HCO^+(1-0) lines toward the central a few kpc regions of the Seyfert and starburst galaxies in the local universe using the Nobeyama Millimeter Array. We detected luminous HCN(1-0) emissions toward a considerable fraction of these Seyfert galaxies (10 of 12 in our sub-sample), which indicated that some of these Seyfert galaxies, such as NGC 3079, NGC 3227, NGC 4051, NGC 6764, and NGC 7479, are indeed accompanied with compact nuclear starburst, given the tight correlation between the HCN(1-0) luminosity and the star formation rate among star-forming galaxies. However, we suggest that the elevated HCN(1-0) emission from some of these Seyfert galaxies, including NGC 1068, NGC 1097, NGC 5033, and NGC 5194, does not signify the presence of massive starbursts there. This is because these Seyfert nuclei show abnormally high HCN(1-0)/HCO^+(1-0) ratios (2-3), which were never observed in the starburst nuclei in our sample. This could be attributed to the overabundance of HCN molecules in the X-ray dominated regions (XDRs) at the centers of these Seyfert galaxies.

- ● Komugi, S., Y. Sofue, H. Nakanishi, S. Onodera, and F. Egusa [2005], "The Schmidt Low at High Molecular Densities," Publ. Astron. Soc. Japan, vol.57, pp.733-741.

- ➤ We combined Hα and recent high-resolution ^{12}CO(J=1-0) data to consider the quantitative relation between the gas mass and the star-formation rate, or the so-called Schmidt law in nearby spiral galaxies at regions of high molecular density. The relation between the gas quantity and the star-formation rate has not been previously studied for high-density regions, but using high-resolution CO data obtained at the Nobeyama Millimeter Array, we found that the Schmidt law is valid at densities as high as 10^3 M_{odot} pc^{-2} for sample spiral galaxies, which is an order of magnitude denser than what has been known to be the maximum density at which the empirical law holds for non-starburst galaxies. Furthermore, we obtained a Schmidt law index of N = 1.33 ± 0.09 and a roughly constant star-formation efficiency over the entire disk, even within several hundred parsecs of the nucleus. These results imply that the physics of star formation does not

change in the central regions of spiral galaxies. Comparisons with starburst galaxies are also given. We find a possible discontinuity in the Schmidt law between normal and starburst galaxies.

- Komugi, S., Y. Sofue, K. Kohno, H. Nakanishi, S. Onodera, F. Egusa, T. Tosaki, K. Muraoka, and J. Young [2006], "CO(J=1-0) and CO(J=3-2) Survey of Nearby Galactic Centers: The Schmidt Law as a Function of Galactic Properties," International Astronomical Union XXVIth General Assembly, Pragua, 14-25 August, 2006, abstract book, pp.133-134 (S237-149 Poster).

➢ The relation between molecular gas quantity and star formation rate (SFR), known as the Schmidt law, has been a long debated but poorly understood subject regarding its properties and implications. Although previous studies have assumed that galaxies of a wide range of morphology and activity follows a common law, sample size and angular resolution has limited a comprehensive study of the physical parameters that are indicative of the underlying physics of the Schmidt law. We have conducted a large scale survey of the CO(J=1-0) emission in nearby galaxies, with emphasis on the form of the Schmidt law at high molecular densities. High resolution (16 arcsec.) single dish observations of 69 galaxies (mainly spirals) were done at the NRO 45m telescope, and compiled with previous surveys with similar resolution. The final dataset is comprised of 176 galaxies observed at the central positions. Which is the largest size to date with such resolution. These data were compared to SFR derived using internal extinction corrected H alpha. The Schmidt law index N, given SFRΣ^N, is found to vary considerably with inclination and distance between 0.7 to 1.4. After accounting for these "unphysical" parameters, the Schmidt law is categorized according to type (early/late) and the presence of bars. Consequently, we find that barred galaxies occupy the denser regime of the Schimdt law, but with no apparent difference in the star formation efficiency (SFE), indicating that bars stimulate central inflow of gas, but that star formation still occurs along a common star formation law as with non-barred galaxies. A possible categorization of the Schmidt law with galaxy type. is also suggested. We have also conducted a survey in CO(J=3-2) emission for some of the galaxies above using ASTE. A striking correlation between CO(J=3-2) intensity and H alpha derived SFR is found for the first time, with N=1.0. This indicates that even in dusty environments, H alpha emission can be a reliable tracer of massive SF if the internal extinction is accounted for.

- Komugi, S., K. Kohno, T. Tosaki, H. Nakanishi, S. Onodera, F. Egusa, and Y. Sofue [2007], "ASTE Observations of Nearby Galaxies: A Tight Correlation between CO (J = 3-2) Emission and Hα," Publ. Astron. Soc. Japan, vol.59, pp.55-60.

➢ Star formation rates (SFRs) obtained via extinction corrected Hα are compared to dense gas, as traced by ^{12}CO(J=3-2) emission at the centers of nearby galaxies, observed with the ASTE telescope. It is found that, although many of the observed positions are dusty and therefore heavily absorbed at Hα, the SFR shows a striking correlation with dense gas in the form of the Schmidt law with an index 1.0. The correlation is also compared between gas traced by ^{12}CO(J=1-0) and application of H alpha extinction correction. We find that dense gas produces a far better correlation with SFR in view of surface density values.

- Kono, Y., Y. Murata, H. Hirabayashi, K. Wajima, N. Mochiduki, T. Toda, and N. Kawaguchi [2005], "Broadband VLBI Data Downlink of VSOP-2," Proc. at the XXVIIIth General Assembly of the URSI, October 2005, India. (CD-ROM : CP5.10)

➢ Following the success of the VLBI Space Observatory Programme (VSOP), a next generation space VLBI mission, currently called VSOP-2, is being planned. The mission will provide a downlink data rate of 1 Gbps to improve sensitivity in observing continuum emission. A possible band based on frequency allocation regulations is 37-38 GHz for this data transfer. The uplink frequency for frequency and phase transfer. on the other hand, will be 40 GHz. We adopt an OFDM (Orthogonal Frequency Division Multiplex) method for the data transfer to reduce the outband emission. The link budget is more severe than that of VSOP, but the reasonable design is possible.

- Kosugi, T., K. Matsuzaki, T. Sakao, T. Shimizu, Y. Sone, S. Tachikawa, T. Hashimoto, K. Minesugi, A. Ohnishi, T. Yamada, S. Tsuneta, H. Hara, K. Ichimoto, Y. Suematsu, M. Shimojo, T. Watanabe, S. Shimada, J. M. Davis, L. D. Hill, J. K. Owens, A. M. Title, J. L. Culhane, L. K. Harra, G. A. Doschek, and L. Golub [2007], "The Hinode (Solar-B) Mission: An Overview," Solar Phys., vol.243, pp.3-17.

➢ The Hinode satellite (formerly Solar-B) of the Japan Aerospace Exploration Agency's Institute of Space and Astronautical Science (ISAS/JAXA) was successfully launched in September 2006. As the successor to the Yohkoh mission, it aims to understand how magnetic energy gets transferred from the photosphere to the upper atmosphere and results in explosive energy releases. Hinode is an observatory style mission, with all the instruments being designed and built to work together to address the science aims. There are three instruments onboard: the Solar Optical Telescope (SOT), the EUV Imaging Spectrometer (EIS), and the X-Ray Telescope (XRT). This paper provides an overview of the mission, detailing the satellite, the scientific payload, and operations. It will conclude with discussions on how the international science community can participate in the analysis of the mission data.

● Krips, M., R. Neri, A. Eckart, R. Barvainis, A. Peck, D. Downes, P. Planesas, J. Martin-Pintado, D. Iono, and G. Petitpas [2007], "Differential Lensing Effects in High-z Sources: Constraining the Size and Shape of the Emitting Regions," Proceedings in "From Z-Machines to ALMA:(Sub)Millimeter Spectroscopy of Galaxies", eds. Andrew J. Baker, Jason Glenn, Andrew I. Harris, Jeffrey G. Mangum and Min S. Yun, ASP Conf. Ser. vol.375, pp.250-253.

➢ One of the greatest obstacles in determining the physical parameters of galaxies in the early universe is our inability to accurately constrain the sizes of the sources detected. Current cutting-edge mm/submm interferometers such as the Submillimeter Array (SMA) and the Plateau de Bure Interferometer IRAM (PdBI) yield angular resolutions of about 1", which is in most cases not sufficient to resolve the observed emission at high z. However, if the high-redshift source is gravitationally lensed by an intervening galaxy, the angular resolution can be improved by up to two orders of magnitude, as demonstrated in the case of the Cloverleaf galaxy. Light from extended regions is deflected in a different way than light from compact structures, so that the lensed images set tight constraints on their true sizes and shapes. We will discuss the use of such differential lensing effects for three gravitationally lensed high-redshift quasars: Q0957+561 (z=1.41), SBS1520+530 (z=1.86), and APM08279+5255 (z=3.9). We have recently detected molecular gas emission traced by CO in the first two sources, doubling the number of CO detections in this mostly unexplored redshift range of z=1-2. We will be able to use this technique as well to place even tighter constraints on the size of the dust emission in APM08279+5255, using the new very extended configurations of the SMA and PdBI with their angular resolutions of 0.3"-0.4".

● Kundu, M. R., E. J. Schmahl, P. C. Grigis, V. i. Garaimov, and K. Shibasaki [2006], "Nobeyama Radio Heliograph Observations of RHESSI Microflares," Astron. Astrophys., vol.451, pp.691-707.

➢ Aims.We present a summary of the analysis of thirty microflares, observed simultaneously by the Ramaty High Energy Solar Spectroscopic Imager (RHESSI) in hard X-rays and by Nobeyama RadioHeliograph (NoRH) in microwaves (17 GHz).
Methods. We used microflares observed by RHESSI in the energy range 3-25 keV, and for larger events, up to 35 keV. The observations were made 2002, May 2-6.
  Results. We describe the imaging characteristics of these microflares including their locations in hard X-rays and microwaves and the relative positions of the micro-flaring sources. We discuss the brightness temperatures, emission measures and their hard X-ray spectral properties. We see small (mini) flaring loops clearly in NoRH and RHESSI images. The microwave emission often seems to come from the RHESSI foot points (for higher energies), and from the entire small (mini) flaring loop (for lower energies). Sometimes the two (microwave and hard X-ray) sources coincide, at other times they are at opposite ends of a mini flaring loop. Typically, the hard X-ray spectrum of the microwave associated RHESSI microflares can be fit by an isothermal component at low energies (below 10 or 12 keV) and a nonthermal component at higher energies (above 12 keV).
  Conclusions: .Microflares in hard X-rays and in microwaves behave like normal flares in many respects. They can have both thermal and nonthermal components appearing in bremsstrahlung and gyrosynchrotron radiation.

● Kuno, N., H. Mikoshiba, A. Hirota, K. Maruyama, T. Kasuga, K. Sunada, and A. Mori [2005a], "Wind Effects on the Nobeyama 45-m Telescope," Proc. at the XXVIIIth General Assembly of the URSI, October 2005, India. (CD-ROM : JB-P.1)

- We investigated the wind effects on the Nobeyama 45-m telescope. We measured the movement of the sub-reflector and the deformation of the main reflector by wind. We found a tight correlation between the pointing offset and the deformation of the main reflector. It is confirmed that the change of the beam shape is more significant at higher frequency when the wind is so strong.

- Kuno, N., N. Sato, H. Nakanishi, A. Hirota, T. Tosaki, Y. Shioya, N. Nakai, K. Sorai, K. Nishiyama, Y. Ishihara, and B. Vila-Vilaro [2005b], "Nobeyama CO Atlas of Nearby Spiral Galaxies," Proc. at the XXVIIIth General Assembly of the URSI, October 2005, India. (CD-ROM : JB-P.7)

- We present the preliminary results of CO mapping survey of nearby spiral galaxies. The survey was performed by using the multi-beam receivers mounted on the Nobeyama 45-m telescope. The data are used to investigate distribution and kinematics of molecular gas in spiral galaxies.

- Kuno, N., N. Sato, K. Nakanishi, A. Hirota, T. Tosaki, Y. Shioya, K. Sorai, N. Nakai, K. Nishiyama, and B. Vila-Vilaro [2007a], "Nobeyama CO Atlas of Nearby Spiral Galaxies: Distribution of Molecular Gas in Barred and Non-Barred Spiral Galaxies," Publ. Astron. Soc. Japan, vol.59, pp.117-166.

- The data from a CO (J=1-0) mapping survey of 40 nearby spiral galaxies, performed with the Nobeyama 45 m telescope, are presented. The criteria of the sample selection were: (1) RC3 morphological type ranging from Sa to Scd, (2) distance of less than 25 Mpc, (3) inclination angle less than 79° (RC3), (4) flux at 100 μm higher than ~ 10 Jy, and (5) spiral structure not destroyed by any interaction. The maps of CO cover most of the optical disk of the galaxies. We investigated the influence of bars on the distribution of molecular gas in spiral galaxies using these data. We confirmed that the degree of the central concentration is higher in barred spiral than in nonbarred spirals, as shown by previous studies. Furthermore, we present observational evidence that bars are efficient in driving molecular gas that lies within the bar length toward the center, while the role in bringing gas in from the outer parts of the disks is small. The transported gas accounts for about half of the molecular gas within the central region in barred spiral galaxies. We found a correlation between the degree of central concentration and the bar strength. Galaxies with stronger bars tend to have a higher central concentration. The correlation implies that stronger bars accumulate molecular gas toward the center more efficiently. These results are consistent with long-lived bars.

- Kuno, N., K. Nakanishi, K. Sorai, and T. Shibatsuka [2007b], "Central Structure of Molecular Gas in Maffei 2," Astrophysics and Space Science Proceedings, "Island Universes", ed. R. S. de Jong, pp.379-382.

- We present results of CO observations of the barred spiral galaxy Maffei 2 with Nobeyama Millimeter Array (NMA). The distribution of the molecular gas in the central regionshows elongated structure with two peaks as shown in the previous data. We found that theelongated structure resolved into spiral arms that continue from the offset ridges along the bar to a radius of less than 50 pc.

- Kuno, N., N. Sato, H. Nakanishi, A. Hirota, T. Tosaki, Y. Shioya, K. Sorai, N. Nakai, K. Nishiyama, and B. Vila-Vilaro [2007c], "Distribution of Molecular Gas in Barred Spiral Galaxies," Proc. of the IAU Symp. 235, "Galaxy evolution across the Hubble Time", eds. F. Combes & J. Palous, p.116.

- We made a CO(1 - 0) mapping survey of 40 nearby spiral galaxies with the Nobeyama 45-m telescope to provide useful data for detailed and systematic studies of molecular gas in the galaxies (Kuno et al. 2006). Using these data we have compared the distribution of molecular gas in barred and non-barred spirals and investigated the influence of the bar. We confirmed that the degree of the central concentration of molecular gas within the radial distances of the order of a bar length in barred spirals is significantly higher than that in non-barred spirals as shown by Sakamoto et al. (1999) and Sheth et al. (2005). This is contrast with the degree of the concentration of the total molecular gas mass within the radial distances of the order of the bar, which is similar for both barred and non-barred spirals. This implies that the bars appear to be efficient in driving gas that lies within their radial scales toward the center of the host galaxies, but that they play quite a smaller role at larger spatial scales on the disks. Thus the characteristic feature of the radial distribution of molecular gas seen in barred spirals, i.e. the strong intensity

peaks at their centers, the shallow gradients within the bar regions or/and the secondary peaks at the radius of the bar-ends, can be explained by the accumulation of molecular gas within the bar regions. The accumulated gas by bars accounts for about half of molecular gas mass within the central region. We also found a correlation between the degree of central concentration of molecular gas and the bar strength. Galaxies with stronger bars tend to have higher central concentrations. The result indicates that stronger bar accumulate molecular gas toward the center more efficiently. The correlation between the degree of central concentration of molecular gas and the strength seems to be consistent with long-lived bars rather than short-lived ones which are destroyed by the gas accumulation toward the center many times in the Hubble time.

- Kurayama, T., T. Sasao, and H. Kobayashi [2005a], "Parallax Measurements of the Mira-Type Star UX Cygni with Phase-Referencing VLBI," Astrophys. J. (Letters), vol.627, pp.L49-L52.

➢ We have measured the annual parallax of the Mira-type variable star UX Cyg at ϖ=0.54±0.06 mas from phase-referencing VLBI observations of its circumstellar water masers with the VLBA. The corresponding distance is $1.85^{+0.25}_{-0.19}$ kpc. This is the first measurement of an annual parallax based on observations of water masers. It is important to calibrate the period-luminosity relation of Mira variables because it is an important distance indicator in astronomy. We discuss the distance to the Large Magellanic Cloud by comparing our results with the period-luminosity relation in the Large Magellanic Cloud. We obtained the three-dimensional position and velocity of UX Cyg in our Galaxy: (R,θ,z)=(8.20±0.01 kpc, $12°.4^{+1°.7}_{-1°.3}$, $-0.30^{+0.03}_{-0.04}$ kpc), (V_R,V_θ,V_z)=($-81.6^{+14.0}_{-15.3}$, $204.0^{+3.6}_{-3.4}$, $-12.1^{+10.2}_{-10.3}$) km s^{-1}. We also discuss the origin of UX Cyg.

- Kurayama, T., H. Kobayashi, and T. Sasao [2005b], "Annual Parallax Measurements of Mira-Type Variable with Ohase-Referencing VLBA Observation," Proc. of the "Future Directions in High Resolution Astronomy: A Celebration of the 10th Anniversary of the VLBA", eds. J. D. Romney, and M. J. Reid, ASP Conf. Ser. vol.340, pp.471-476.

➢ We have measured an annual parallax of water masers around a Mira-type variable, UX Cyg, 0.8 ± 0.1 mas with phase-referencing VLBI observations. This parallax needs for the establishment of period-luminosity relation of Miras, which is a cosmic distance scale.

- Kurono, Y., R. Kawabe, M. Saito, Y. Kitamura, S. Yokogawa, T. Tsukagoshi, and N. Ikeda [2007], "Observations of CB244 - Binary System of Protostellar and Prestellar Cores?," Proceedings in "Protostars and Planets V", LPI contribution no. 1286, p.8427.

➢ Not Available

- Lee, J.-J., B.-C. Koo, and K. Tatematsu [2004a], "The Environment of Tycho: Possible Interaction with Molecular Clouds," Proc. of the IAU Symp. 218, "Young Neutron Stars and Their Environments", edited by Fernando Camilo and Bryan M. Gaensler, pp.71-72.

➢ We have conducted ^{12}CO observations with the Nobeyama 45-m telescope in the area of Tycho's supernova remnant. These high-resolution (16") data show that the molecular cloud surrounds the SNR along the northeastern boundary. We suggest that Tycho's SNR and the molecular cloud are located at comparable distances within the Perseus arm and that they are physically interacting. We also discuss the possible connection between the molecular cloud and the Balmer-dominated optical filaments and propose that the preshock gas may be accelerated within the cosmic-ray and/or fast neutral precursor.

- Lee, J.-J., B.-C. Koo, and K. Tatematsu [2004b], "The Environment of Tycho: Possible interaction with a Molecular Clouds," J. Korean Astron. Soc., vol.37, pp.223-224.

➢ The Tycho supernova remnant (SNR), as one of the few historical SNRs, has been widely studied in various wavebands and previous observations have shown evidence that Tycho is interacting with a dense ambient medium toward the northeast direction, In this paper, we report our high-resolution (16 arcsec) ^{12}CO observation of the remnant using the Nobeyama 45m radio telescope. The Nobeyama data shows that a large molecular cloud surrounds the SNR along the northeastern boundary. We suggest that the Tycho SNR and the molecular cloud are both located in the Perseus arm and that the dense medium interacting with the SNR is possibly the molecular cloud. We also discuss the possible connection between the molecular cloud and the Balmer-dominated optical filaments, and suggest that the preshock gas may be accelerated within the cosmic ray and/or fast neutral precursor.

- Lim, J., and S. Takakuwa [2005], "Circumstellar/Protoplanetary Disks and Bipolar Jets at 5AU

Resolution," Proc. of the "The Cool Universe: Observing Cosmic Dawn", eds. C. Lidman and D. Alloin, ASP Conf. Ser. vol.344, pp.200-211.

➢ We present images of LDN 1551 IRS 5 at angular resolutions as high as ~30 mas, corresponding to a spatial resolution of ~5 AU, made at 7 mm with the VLA. Previously known to be a binary protostellar system, we show that LDN 1551 IRS 5 is probably a triple protostellar system. The primary and secondary components have a projected separation of ~46 AU, whereas the tertiary component has a projected separation of ~11 AU from the primary component. The circumstellar dust disks of all three components have dimensions of ~10-15 AU. Their major axes are closely, but not perfectly, aligned with each other and with the major axis of the surrounding flattened, rotating, and contracting molecular condensation (pseudodisk). Furthermore, the orbital motions of the primary and secondary components are in the same direction as the rotational motion of this pseudodisk. We suggest that all three protostellar components formed as a result of the fragmentation of the central region of the molecular pseudodisk. Both the primary and secondary components, but apparently not the tertiary component, exhibit a bipolar ionized jet that is centered on and emerges perpendicular to its associated dust disk. Neither jets are resolved along their base, implying that they are driven within a radial distance of ~2.5 AU from their central protostars. Our images provide an exciting preview of what ALMA is likely to obtain for many more protostellar systems.

● Lim, J., and S. Takakuwa [2006], "Properties and Formation of the Multiple Protostellar System L1551 IRS 5," Astrophys. J., vol.653, pp.425-436.

➢ We present an observation of L1551 IRS 5 at 7 mm with an angular resolution as high as ~0".04 (5 AU). Apart from the two main components oriented north-south with a projected separation of 47 AU, we discover a third component lying 13 AU to the southeast of the northern component, thereby making L1551 IRS 5 a triple protostellar system. The two main components comprise circumstellar dust disks with dimensions of ~ 17 AU, together with bipolar ionized jets collimated within a radial distance of <~3 AU from their central protostars. The third component likely has an even smaller circumstellar dust disk with a dimension of ~9 AU. The relative proper motion of the two main components is consistent with a circular coplanar orbit with an orbital separation of ~50 AU, orbital period of ~380 yr, and total mass of ~90 Msolar. Their measured disk sizes are smaller than the predicted gravitationally truncated sizes of ~26 AU. Together with the predicted minimum size for a circumbinary gap, noncircular coplanar orbits are constrained to an eccentricity <~0.3. The disks of the two main components are accurately aligned with each other, as well as with a surrounding molecular pseudodisk. Furthermore, the clockwise orbital motion of these components coincides with the clockwise rotational motion of the pseudodisk. These attributes constitute a smoking gun for the formation of the two main components as a result of fragmentation within the inner regions of their parent pseudodisk. By contrast, the disk of the third component is significantly misaligned; measurements of its relative proper motion are required in order to help deduce its origin.

● Lim, J., N. Hirano, N. Ohashi, and S. Takakuwa [2007], "Observational Tests of Binary/Multiple Protostellar Formation," Proceedings in "Protostars and Planets V", LPI contribution no. 1286, p.8380.

➢ Not Available

● Liu, Q., M. Nishio, K. Yamamura, T. Miyazaki, M. Hirata, T. Suzuyama, S. Kuji, K. Iwadate, O. Kameya, and N. Kawano [2005], "Statistical Characteristics of Atmospheric Phase Fluctuations Observed by a VLBI System Using a Beacon Wave from a Geostationary Satellite," IEEE Tran. on Antennas & Propagation, vol.53, pp.1519-1527.

➢ This paper reports the statistical characteristics of phase fluctuations obtained by a very long baseline interferometry, which received beacon waves from a geostationary satellite. Observations wave made in different weather conditions by the 6-m Kagoshima and the 10-m Mizusawa radio telescopes, which were 1284 km apart from one another. Atmospheric phase fluctuations ranging from 0.2 to about 1000 s were detected. To study a variety of statistical characteristics of these phase fluctuations, the Allan standard deviation, $\sigma y(\tau)$, the temporal structure function, $D(\tau)$, and the square root of power spectrum, $G(f)$, were calculated from the observation results. These qualities were found to depend on the time interval or the frequency f ($f = 1/2\tau$) as follows:$\sigma(\tau)$ τ-0.6, τ-0.3, $D(\tau)$ τ0.9, τ1.3 for 0.2 s <τ< 1.5 s and 1.5 s <τ< 400 s.

G (f)   f-0.8 for 2.5 Hz > f > 0.33 Hz and G (f)   f-1.3 for 0.33 Hz > f > 0.00125 Hz. The curves of σy(τ) and D (τ) exhibited shifts whose magnitudes   followed the weather order clear, cloudy, and rainy. For τ > 1.5 s (or f < 0.33 Hz), the experimental results were consistent with the theoretical values predicted by Kolmogorov!s turbulence theory and a frozen-screen model. But for τ< 1.5 s (or f > 0.33Hz), the model has to be modified to explain the experimental results.

- Liu, Q., F. Kikuchi, S. Tsuruta, K. Matsumoto, H. Hanada, O. Kameya, Y. Tamura, K. Asari, and N. Kawano [2007a], "Effects of Phase Characteristics of Telescopes on Same-Beam Differential VLBI," IEEE Trans. Antenna & Propagation, vol.55, pp.1466-1470.

➢ Phase characteristics, which are systematic phase offsets across the main beam of an actual telescope, may be a problem for achieving the same-beam differential very long baseline interferometer (VLBI) technique. This technique is essential for differential phase delay measurements such as those used in the Japanese Selenological and Engineering Explorer (SELENE) project, where the phase has to be determined to an accuracy of 0.075 radians arms. Accurate measurement and correction of phase characteristics are very important. The phase characteristics at 2.2375 and 2.2807 GHz of the 20-m and 10-m telescopes at Mizusawa were measured to an error of approximately 0.04 radians rms. The phase characteristics were 0.06 radians rms for the 20-m and 0.055 radians rms for the 10-m telescopes in the main beams, and the post-fit residuals decreased to 0.03 and 0.04 radians rms, respectively, after correcting by using quadratic formulas. These results confirmed the effectiveness of the same-beam differential VLBI technique for VLBI observations of SELENE.

- Liu, Q., F. Kikuchi, K. Matsumoto, K. Asari, S. Tsuruta, J. Ping, H. Hanada, and N. Kawano [2007b], "Erro Analysis of Sama-Beam Differential VLBI Techinique using Two SELENE Satellite, Adv, Space Res., vol.40, pp.43-50.

➢ The Japanese SELENE project consists of a main satellite, a relay sub-satellite (Rstar), and a VLBI sub-satellite (Vstar). Rstar will relay the Doppler ranging signal between the main satellite and the ground station for the world's first direct measurement of the gravity field on the far side of the Moon. The differential VLBI radio sources onboard Rstar and Vstar will be used to determine the gravity field of the Moon precisely, especially near the rim. Rstar and Vstar only transmit three pairs of carriers in the S-band and one pair of carriers in the X-band, and the difference in phase delays of Rstar and Vstar will be obtained from the relation between correlation phase and frequency of four pairs of carriers. In particular, the difference in correlation phase at each frequency has to be estimated without the 2pi ambiguity, and this imposes strict conditions; e.g., the correlation phase error must be lower than 4.3° and the error of differences in total electron content in the ionosphere must be less than 0.23 TECU. To resolve the 2pi ambiguity problem, we use the same-beam differential VLBI technique, in which Rstar and Vstar are simultaneously observed by using the same beam of the receiving antenna. In this case, the influences of the atmosphere, ionosphere, and receivers can nearly be canceled in the difference in correlation phases, the difference in delay can be obtained with an accuracy of several picoseconds from the correlation phases, and the relative positions of Rstar and Vstar can be determined with a very high sensitivity (tens of cm). In this paper, we estimate the chance for same-beam differential VLBI observations in SELENE. We give a procedure and conditions for the obtaining differential phase delay, and predict the measurement errors in same-beam differential VLBI by using GPS techniques and by observing three satellites, Shuangxing, Geotail, and a geostationary satellite.

- Lu, R.-S., Z.-Q. Shen, T. P. Krichbaum, W. Alef, S. Iguchi, S. Kameno, S., and M. Titus [2007], "Millimeter VLBI Observations of PKS 1749+096," Proc. of the "The Central Engine of Active Galactic Nuclei", eds. Luis C. Ho and Jian-Min Wang, ASP Conf. Ser., vol.373, pp.237-238.

➢ We present preliminary results of the two 3mm and one 7mm high-resolution millimeter VLBI observations of PKS 1749+096. These observations reveal a consistent core-dominated morphology with a bending jet to the north-east of the core. We also show an approximate fit to the overall bending structure using a helical jet model.

- Lubowich, D. A., N. Kuno, H. Roberts, T. J. Millar, C. Henkel, J. M. Pasachoff, and R. Mauersberger [2004], "Deuterium Nucleosynthesis in AGN: Is D Cosmological?," American Astronomical Society Meeting 205, #118.07.

➢ Although deuterium is predicted to be primarily cosmological, D can also be produced by

cosmic-ray or gamma -ray spallation reactions - possibly between high energy jets and the surrounding gas in AGN. We used the Nobeyama mm array with a 3" resolution (220 pc) in April 2003 to search for any enhanced D from the DCN J = 2-1 line in the Seyfert galaxy NGC 1068. NGC 1068 is an optimal target because it has jets, starburst activity, a circumuclear molecular ring and disk, dense optically thick concentrations of HCN, and a low-energy X-ray flux of 1042 erg/s (the highest X-ray flux of any galaxy in which HCN has been detected and the flux required to produce high D abundances). We did not detect DCN (which is detected in all other molecular clouds with optically thick HCN in the Galaxy or LMC) and we obtained an upper limit of S<=15 mJy/beam = 48.5 mK in the circumnuclear region and a DCN/HCN ratio of 0.0046. Using our 5300 reaction chemical network we estimate D/H $leq 1.5 \times 10^{-5}$ as compared to the local Galactic ISM D/H = 1.4×10^{-5}. Thus there is no significant D production in the nuclear region of NGC 1068 and NGC 1068 has probably not had a recent period of activity with a gamma -ray or cosmic-ray luminosity > 10^{42} erg/s. If jet-cloud nucleosynthesis produces significant amounts of D, then the D is produced outside of the nuclear region where the subsequent infall may be one way to continuously supply galactic nuclei with D. However, any enhanced D produced via spallation reactions would have been destroyed via astration due to the faster star formation rate. Our results are additional evidence that D is primarily cosmological and that AGN do not produce D.

- Maezawa, H., T. Sato, and T. Noguchi [2005], "Process Simulation of Reactive DC Magnetron Sputtering for Thin Film Deposition of Niobium-Titanium Nitride," IEEE Trans, Appl. Superconductivity, vol.15, pp.3520-3523.

➢ A process simulation for depositions of Niobium-Titanium Nitride (NbTiN) films with a reactive magnetron sputtering system was demonstrated. In the modeling, VAr-dependent sputtering yields with quasi target erosion profile were newly incorporated for the precise optimization of the sputtering conditions. The numerical results were found to agree well with the experimental data. We present the dependence of the film resistivity and Tc on the chemical composition. It was also confirmed by the simulation that ΔV can be a good indicator to control the chemical compositions for the fabrications of high Tc films. In addition, the resistivity and stars were found to deeply relate to the total process pressure and residual N2 gas in the plasmas as suggested in the atomic peeing model. Preliminary results suggest that the process simulation has a potential of the useful tool to control the properties of superconducting films.

- Maksimov, V. P., D. V. Prosovetsky, V. V. Grechnev, B. B. Krissinel, and K. Shibasaki [2006], "On the Relation of Brightness Temperatures in Coronal Hoes at 5.7 and 17 GHz," Publ. Astron. Soc. Japan, vol.58, pp.1-10.

➢ From the analysis of simultaneous observations with the Siberian Solar Radio Telescope and Nobeyama Radioheliograph we show that coronal holes are not uniform. In particular, in coronal holes small-scale features exist with anticorrelating brightness temperatures at 5.7 and 17GHz. The features are disposed radially, which suggests radial heat transfer in them. We propose that the favorable heating mechanism within those features is dissipation of Alfvén waves.

- Matsuda, Y., D. Iono, K. Ohta, T. Yamada, R. Kawabe, T. Hayashino, A. B. Peck, and G. R. Pettipas [2007], "High-Resolution Submillimeter Imaging of the Lyalpha Blob 1 in SSA 22," Astrophys. J., vol.667, pp.667-672.

➢ We present ~2" resolution submillimeter observations of the submillimeter luminous giant Lyalpha blob (LAB1) in the SSA 22 protocluster at redshift z=3.1 with the Submillimeter Array (SMA). Although the expected submillimeter flux density is 16 mJy at 880 mum, no emission is detected with the 2.4"Å-1.9" (18Å-14 kpc) beam at the 3 sigma level of 4.2 mJy beam-1 in the SMA field of view of 35". This is in contrast to the previous lower angular resolution (15") observations where a bright (17 mJy) unresolved submillimeter source was detected at 850 mum toward the LAB1 using the Submillimeter Common-User Bolometer Array on the James Clerk Maxwell Telescope. The SMA nondetection suggests that the spatial extent of the submillimeter emission of LAB1 should be larger than 4" (>30 kpc). The most likely interpretation of the spatially extended submillimeter emission is that starbursts occur throughout the large area in LAB1. Some part of the submillimeter emission may come from spatially extended dust expelled from starburst regions by galactic superwind. The spatial extent of the submillimeter emission of LAB1 is similar to those of high-redshift radio galaxies rather than submillimeter galaxies.

- Matsumoto, K., T. Sato, H. Fujimoto, Y. Tamura, M. Nishio, R. Hino, T. Higashi, and T. Kanazawa [2006], "Ocean Bottom Pressure Observation off Sanriku and Comparison with Ocean Tide Models, Altimetry, and Barotropic Signals from Ocean Models," Geophys. Res. Letters, vol.33, p.L16602.

  ➢ We discuss tidal and non-tidal signals which are obtained from ocean bottom pressure (OBP) measurements at two sites off Sanriku, Japan. Comparison between the observed tidal component and five ocean tide models shows that recent models have accuracy better than 1.3 cm in terms of root sum square of vector differences for eight principal constituents. The empirical estimates of non-tidal signal from TOPEX/POSEIDON (T/P) and JASON-1 deviate from barotropic signals observed by OBP recorders, which can be attributed to baroclini component in the altimeter data. We also compared the non-tidal barotropic signal derived from the observation with those from ECCO model (wind-driven) and Kyusu University model (pressure-driven). The comparison indicates that the pressure-driven model increases explained variance and it is suggested to combine the wind-drive model and the pressure-driven model in order to describe non-tidal ocean mass variability in particular at period shorter than 30 days.

- Matsumoto, T., T. Nakazato, and K. Tomisaka [2006], "Alignment of Outflows with Magnetic Fields in Cloud Cores," Astrophys. J. (Letters), vol.637, pp.L105-L108.

  ➢ We estimate the polarized thermal dust emission from MHD simulations of protostellar collapse and outflow formation in order to investigate the alignment of outflows with magnetic fields. The polarization maps indicate that the alignment of an outflow with the magnetic field depends on the field strength inside the cloud core; the direction of the outflow, projected on the plane of the sky, is aligned preferentially with the mean polarization vector for a cloud core with a magnetic field strength of 80 muG, while it does not tend to be aligned for 50 muG as long as the 1000 AU scale is considered. The direction of the magnetic field at the cloud center is probed by the direction of the outflow. In addition, the magnetic field at the cloud center can be revealed by the Atacama Large Millimeter Array (ALMA) even when the source is embedded deeply in the envelope. The Chandrasekhar-Fermi formula is examined using the polarization maps, indicating that the field strength predicted by the formula should be corrected by a factor of 0.24-0.44. The correction factor has a tendency to be lower for a cloud core with a weaker magnetic field.

- Matsunaga, N., S. Deguchi, Y. Ita, T. Tenabe, and Y. Nakada [2005[, "SiO Maser Sources toward Globular Clusters," Publ. Astron. Soc. Japan, vol.57, pp.L1-L6.

  ➢ We report on the detection of SiO masers in Asymptotic Giant Branch variables toward bulge/disk globular clusters. In five out of six cases, the radial velocities are compatible with the optically measured radial velocities of globular clusters in the assessed uncertainty. Two sources, toward Terzan 5 and Terzan 12, lie very close to the cluster centers. The objects toward Pal 6 and Terzan 12 have luminosities appropriate to the AGB tip in globular clusters, while those toward NGC 6171, Pal 10, and Terzan 5 are brighter than expected. It is suggested that the latter three may have evolved from merged binaries, offering a test for binary-evolution scenarios in globular clusters, if the membership is approved.

- Matsushita, S., R. Kawabe, K. Kohno, N. Matsumoto, T. G. Tsuru, and B. Vila-Vilaro [2004], "Starburst at the Molecular Superbubble in M82," Proc. of "The Neutral ISM in Starbust Galaxies", eds. S. Aalto, S. Huttemeiister, and A. Pedlar, ASP Conf. Ser. vol.320, pp.138-141.

  ➢ We present high spatial resolution 100 GHz continuum emission observations with the Nobeyama Millimeter Array (NMA) toward an expanding molecular superbubble in the central region of M 82. The 100 GHz continuum image, which is dominated by free-free emission, revealed that the strongest peaks are concentrated at the inner edge of the superbubble. Star formation at these peaks is an order of magnitude more active in terms of ionizing flux than from the most massive star forming regions in our Galaxy. At this region, high velocity ionized gas, masers, and diffuse hard X-ray emission are also concentrated. These observations suggest that a strong starburst produced plasma and the superbubble expansion, and induced the present starburst regions. These results provide the first clear evidence of a self-propagating starburst in external galaxies.

- Matsushita, S., R. Kawabe, K. Kohno, H. Matsumoto, T. G. Tsuru, and B. Vila-Vilaro [2005a], "Starburst at the Expanding Molecular Superbubble in M82: Self-induced Starburst at the Inner Edge of the Superbubble," Astrophys. J., vol.618, pp.712-722.

- We present high spatial resolution (2.3"x1.9" or 43pcx36pc at D=3.9 Mpc) 100 GHz millimeter-wave continuum emission observations with the Nobeyama Millimeter Array toward an expanding molecular superbubble in the central region of M82. The 100 GHz continuum image, which is dominated by free-free emission, revealed that the four strongest peaks are concentrated at the inner edge of the superbubble along the galactic disk. The production rates of Lyman continuum photons calculated from 100 GHz continuum flux at these peaks are an order of magnitude higher than those from the most massive star-forming regions in our Galaxy. At these regions, high-velocity ionized gas (traced by H41α and [Ne II]) can be seen, and H_2O and OH masers are also concentrated. The center of the superbubble, on the other hand, is weak in molecular and free-free emissions and strong in diffuse hard X-ray emission. These observations suggest that a strong starburst produced energetic explosions and the resulting plasma and superbubble expansions and induced the present starburst regions traced by our 100 GHz continuum observations at the inner edge of the molecular superbubble. These results, therefore, provide the first clear evidence of self-induced starburst in external galaxies. The starburst at the center of the superbubble, on the other hand, is beginning to cease because of a lack of molecular gas. This kind of intense starburst seems to have occurred several times within 10^6-10^7 yr in the central region of M82.

- Matsushita, S., and J. Lim [2005b], "SMA CO(3-2) Observation of the Seyfert 2 Galaxy M51," Proc. of the "The Cool Universe: Observing Cosmic Dawn", eds. C. Lidman and D. Alloin, ASP Conf. Ser. vol.344, pp.90-95.

- We have obtained the first interferometric CO(3-2) image (3.9 arcsec 1.6 arcsec or 160 pcx65 pc) of the central ~36" region of the Seyfert 2 galaxy M51 with the Submillimeter Array (SMA). The CO(3-2) emission is strongly peaked at the nucleus and is weakly distributed along the spiral arm to the northwest. The CO(3-2) integrated intensity of the central peak is almost twice as high as that in CO(1-0), indicating that the circumnuclear molecular gas is warm and dense. Similar intensity ratios are seen in shocked regions in our Galaxy, suggesting that the properties of the gas in M51 may be related to AGN or starburst activity. The circumnuclear molecular gas shows a linear velocity gradient along the radio continuum jet, in addition to the gradient perpendicular to it. The velocity gradient along the jet can also be explained by AGN or starburst activity, which is consistent with the high intensity ratio.

- Matsushita, S., M. Saito, K. Sakamoto, T. R. Hunter, N. A. Patel, T. K. Sridharan, and R. W. Wilson [2006], "Elevation Angle Dependence of the SMA Antenna Focus Position," Proc. of the SPIE, vol.6275, p.62751W.

- We report the measurement results and compensation of the antenna elevation angle dependences of the Submillimeter Array (SMA) antenna characteristics. Without optimizing the subreflector (focus) positions as a function of the antenna elevation angle, antenna beam patterns show lopsided sidelobes, and antenna efficiencies show degradations. The sidelobe level increases and the antenna efficiencies decrease about 1% and a few %, respectively, for every 10° change in the elevation angle at the measured frequency of 237 GHz. We therefore obtained the optimized subreflector positions for X (azimuth), Y (elevation), and Z (radio optics) focus axes at various elevation angles for all the eight SMA antennas. The X axis position does not depend on the elevation angle. The Y and Z axes positions depend on the elevation angles, and are well fitted with a simple function for each axis with including a gravity term (cosine and sine of elevation, respectively). In the optimized subreflector positions, the antenna beam patterns show low level symmetric sidelobe of at most a few %, and the antenna efficiencies stay constant at any antenna elevation angles. Using one set of fitted functions for all antennas, the SMA is now operating with real-time focusing, and showing constant antenna characteristics at any given elevation angle.

- Matsuzaki, K., M. Shimojo, T. D. Tarbell, L. K. Harra, and E. E. Delica [2007], "Data Archive of the Hinode Mission, Solar Phys., vol.243, pp.87-95.

- All of the Hinode telemetry data are to be reformatted and archived in the DARTS system at ISAS and mirrored to data centers around the word. The archived data are distributed to users through the Internet. This paper gives an overview of the files in the archive, including the file formats. All formats are portable and have heritage from the previous missions. From the reformatted files, index information is created for faster data search. Users can perform queries

based on information contained in the index. This allows for searches to return observations that conform to particular observing conditions.

- Meech, K. J., N. Ageorges, M. F. A'Hearn, C. Arpigny, A. Ates, J. Ayccock, S. Bagnulo, J. Bailey, R. Barber, L. Barrera, R. Barrena, J. M. Bauer, M. J. S. Belton, F. Bensch, B. Bhattacharya, N. Biver, G. Blake, D. Bockelee-Morvan, H. Boehnhardt, B. P. Bonev, T. Bonev, M. W. Buie, M. G. Burton, H. M. Butner, R. Cabanac, R. Campbell, H. Campins, M. T. Capria, T. Carroll, F. Chaffee, S. B. Charnley, R. Cleis, A. Coates, A. Cochran, P. Colom, A. Conrad, I. M. Coulson, J. Crovisier, J. deBuizer, R. Dekany, J. de Leon, N. Dello Russo, M. Delsanti, J. Drummond, L. Dundon, P. B. Etzel, T. L. Farnham, P. Feldman, Y. R. Fernandez, M. D. Filipovic, S. Fisher, A. Titzsimmons, D. Fong, R. Fugate, H. Fujiwra, T. Fujiyoshi, R. Furusho, T. Fuse, E. Gibb, O. Groussin, S. Gulkis, M. Gurwell, M. Hadamick, O. Hainaut, D. Harker, D. Harrington, M. Harwit, S. Hasegawa, C. W. Hergenrother, P. Hirst, K. Hodapp, M. Honda, E. S. Howell, D. Hutsemekers, D. Iono, W.-H. Ip, W. Jackson, E. Jehin, Z. J. Jiang, G. H. Jones, P. A. Jones, T. Kadono, U. W. Kamath, H. U. Kaufl, T. Kasuga, H. Kawakita, M. S. Kelley, F. Kerber, M. Kidger, D. Kinoshita, M. Knight, L. Lara, S. M. Larson, S. Lederer, C.-F. Lee, A. C. Levasseur-Regourd, J. Y. Li, Q.-S. Li, J. Licandro, Z.-Y. Lin, C. M. Lisse, G. LoCurto, A. J. Lovell, S. C. Lowry, J. Lyke, D. Lynch, J. Ma, K. Magee-Sauer, G. Maheswar, J. Manfroid, O. Marco, P. Martin, G. Melnick, S. Miller, T. Miyata, G. H. Moriarty-Schieven, N. Moskovitz, B. E. A. Mueller, M. J. Numma, S. Nuneer, D. A. Neufeld, T. Ootsubo, D. Osip, S. K. Pandea, E. Pantin, R. Paterno-Mahler, B. Patten, B. E. Penprase, A. Peck, G. Petitas, N. Pinippa-Alonso, J. Pittichova, E. Pompei, T. P. Prabhu, C. Qi, R. Rao, H. Rauer, H. Reitsema, S. D. Rodgers, P. Rodriguez, R. Ruane, G. Ruch, W. Rujopakarn, D. K. Sahu, S. Sako, I. Sakon, N. Samarashinha, J. M. Sarkissian, L. Saviane, M. Schirmer, P. Schultz, R. Schulz, P. Seitzer, T. Sekiguchi, N. Selman, M. Serra-Ricart, R. Sharp, R. L. Snell, C. Snodgrass, T. Stallard, G. Stecklein, C. Sterken, J. A. Stuwe, S. Sugita, M. Sumner, N. Suntzeff, R. Swaters, S. Takakuwa, N. Takato, J. Thomas-Osip, E. Thompson, A. T. Tokunaga, G. P. Tozzi, H. Tran, M. Troy, C. Trujillo, J. van Cleve, R. Vasundhara, R. Vazquez, F. Vilas, G. Villanueva, K. von Braun, P. Vora, R. J. Wainscoat, K. Walsh, J. Watanabe, H. A. Weaver, W. Weaver, M. Weiler, P. R. Weissman, W. F. Welsh, D. Wilner, S. Wolk, M. Womack, D. Wooden, L. M. Woodney, Z.-Y. Wu, J.-H. Wu, T. Yamashita, B. Yang, Y.-B. Yang, S. Yokogawa, A. C. Zook, A. Zauderer, X. Zhao, X. Zhou, and J.-M. Zucconi [2005], "Deep Impact: Observations from a Worldwide Earth-Based Campaign," Science, vol.310, pp.265-269.

- ➤ On 4 July 2005, many observatories around the world and in space observed the collision of Deep Impact with comet 9P/Tempel 1 or its aftermath. This was an unprecedented coordinated observational campaign. These data show that (i) there was new material after impact that was compositionally different from that seen before impact; (ii) the ratio of dust mass to gas mass in the ejecta was much larger than before impact; (iii) the new activity did not last more than a few days, and by 9 July the comet's behavior was indistinguishable from its pre-impact behavior; and (iv) there were interesting transient phenomena that may be correlated with cratering physics.

- Melnikov, V. F., V. E. Reznikova, K. Shibasaki, and V. M. Nakariakov [2004], "Observations of Sausage Mode Oscillations in a Flaring Loop," Proc. of the IAU Symp. 223, "Multi-Wavelength Investigations of Solar Activity", ed. A. V. Stepanov, E. E. Benevolenskaya, and A. G. Kosovivhev, pp.647-648.

- ➤ We provide an observational proof of the existence of the global sausage mode oscillations in a flaring loop studying a microwave burst with quasi-periodical pulsations observed with the Nobeyama Radioheliograph (NoRH).

- Melnikov, V. F., V. E. Rexnikova, K. Shibasaki, and V. M. Nakariakov [2005a], "Spatially Resolved Microwave PUlsations of a Flare Loop," Astron. Astrophys., vol.439, pp.727-736.

- ➤ A microwave burst with quasi-periodic pulsations was high spatial resolution using observations with the Nobeyama Radioheliograph (NoRH). We found that the time profiles of the microwave emission at 17 and 34 GHz exhibit quasi-periodic (with two well defined periods $P_1 = 14\text{-}17$ s and $P_2 = 8\text{-}11$ s) variations of the intensity at different parts of an observed flaring loop. Detailed Fourier analysis shows the P_1 spectral component to be dominant at the top, while the P_2 one near the feet of the loop. The 14-17 s pulsations are synchronous at the top and in both legs of the loop. The 8-11 s pulsations at the legs are well correlated with each other but the correlation

is not so obvious with the pulsations at the loop top. For this P_2 spectral component, a definite phase shift, $P_{2/4} \approx 2.2$ s, between pulsations in the northern leg and loop top parts of the loop have been found. The length of the flaring loop is estimated as L = 25 Mm ($\approx 34"$) and its average width at half intensity at 34 GHz as about 6 Mm ($\approx 8"$). Microwave diagnostics shows the loop to be filled with a dense plasma with the number density $n_0 \approx 10^{11}$ cm^{-3}, penetrated by the magnetic filed changing from $B_0 \approx 100$G near the loop top up to $B_0 \approx 200$ G near the north footpoint. A comparative analysis of different MHD modes of the loop demonstrates the possibility of the simultaneous existence of two modes of oscillations in the loop: the global sausage mode, with the period P_1 = 14-17 s and the modes at the footpoint, and a higher harmonics mode (possibly with the radial wave number l > 1), with P_2 = 8-11 s.

- Melnikov, V. F., S. P. Gorbikov, V. E. Reznikova, and K. Shibasaki [2005b], "Dynamics of Electron Spatial Distribution in Microwave Flaring Loops," Proc. of the 11th European Solar Physics meeting "The dynamic sun: challenges for theory and observations", eds. D. Danesy, S. Poedts, A. De Groof, and J. Andries, ESA SP-600, 132.1. (CD-ROM)

➢ The microwave brightness distribution and its observed temporal evolution along several well resolved flaring loops are analyzed. Spatial attention is paid to the redistribution of microwave brightness and formation of the brightness peak near the loop top on the late phase of a burst. To understand the origin of this redistribution we do modeling of the evolution of electron spatial distribution along a magnetic loop by solving the non-stationary Foller-Plank equation for different positions of the injection site (loop top and foot).

- Melnikov, V. F., V. E. Reznikova, S. P. Gorbikov, and K. Shibasaki [2006], "Electron Spatial Distribution in Microwave Flaring Loops," Recent Advances in Astronomy and Astrophysics: 7th International Conference of the Hellenic Astronomical Society, AIP Conf. Proc., vol.848, pp.123-132.

➢ In this paper we review recent studies of Nobeyama Radioheliograph observations concerning 1) spatial distribution of microwave brightness along flaring loops; 2) peculiarities ofits temporal dynamics in different parts of a loop; 3) consequences of the obtained findings on spatial and pitchangle distributions of high energy electrons.

- Migenes, V., L. Cruz-Vazquez, V. I. Slysh, I. E. Val'Tts, S. Horiuchi, and M. Inoue [2005], "The VLBA Survey of OH Masers towards SFR: Preliminary Results," Proc. of the "Future Directions in High Resolution Astronomy: A Celebration of the 10th Anniversary of the VLBA", eds. J. D. Romney, and M. J. Reid, ASP Conf. Ser. vol.340, pp.361-363.

➢ In 2001 the VLBA was used as part of a continuing program to observe OH MASERs towards Star Forming Regions, to study their structure with the highest angular resolution possible. One goal is to classify the sources by their structure and prepare a database composed of those that show highly compact structure and promise interesting and exciting results when observed with higher resolution arrays (i.e. Space-VLBI). We present preliminary results from the first 45 sources observed. These are the first high resolution observations for over 50% of the sources. Approximately 20% exhibit highly compact structure and moderately strong emission.

- Miyazaki, A., T. Tsutsumi, M. Miyoshi, M. Tsuboi, and Z.-Q. Shen [2005], "Flares of Sagittarius A* at Millimeter Wavelengths," Proc. at the XXVIIIth General Assembly of the URSI, October 2005, India. (CD-ROM : JB-P.11)

➢ We have performed monitoring observations of the flux density toward the Galactic center compact radio sources, Sagittarius A* (Sgr A*), which is a supermassive black hole, from 1996 to 2005 using the Nobeyama Millimeter Array of the Nobeyama Radio Observatory, Japan. The monitoring observations of Sgr A* were carried out in the 3- and 2-mm (100 and 140 GHz) bands, and we have detected several flares of Sgr A*. We found intraday variation of Sgr A* in the 2000 March flare. The twofold increase timescale is estimated to be about 1.5 hr at 140 GHz. This intraday variability suggests that the physical size of the flare-emitting region is compact on a scale at or below about 12 AU ($\dagger$ 150 Rs; Schwarzschild radius). On the other hand, clear evidence of long-term periodic variability was not found from a periodicity analysis of our current millimeter data set.

- Miyazaki, A., Z.-Q. Shen, M. Miyoshi, M. Tsuboi, and T. Tsutsumi [2006], "Flux Monitoring of Sagittarius A* at MM-Wavelengths," J. Physics: Conference Series, vol.54, pp.363-369.

- ➢ We performed the monitoring observations of the fbx density toward the Galactic center compact radio source, Sagittarius A* (Sgr A*), which is associated with a supermassive black hole, since 1996 using the Nobeyama Millimeter Array (NMA). The monitoring observations of Sgr A* were carried out in the 3- and 2-mm (100 and 140 GHz) bands over one to several months on each NMA observable season. We have detected several fares of Sgr A* with duration of, roughly, one month. The fbx density at the fare peak increases 100%-200% at 100 GHz band and 200%-400% at 140 GHz band, respectively, while the averaged quiescent fbx density was about 1 Jy. We also found some intraday variations (IDVs) of Sgr A* at both 2- and 3-mm bands. The shortest twofold increase timescale of the IDV is estimated to be about 1.5 hr at 140 GHz. This short timescale variability suggests that the physical size of emitting region is compact on a scale at or below about 12 AU (~150 RS). The IDV at mm-wavelengths has a similar increase timescale as those in the X-ray and infrared fares but has a smaller amplitude.
- ● Miyoshi, M., J. K. Ishitsuka, S. Kameno, Z.-Q. Shen, and S. Horiuchi [2004a], "Direct Imaging of the Massive Black Hole, Sgr A*," Proc. of the "Stellar-Mass, Intermediate-Mass, and Supermassive Black Holes", eds. S. Mineshige and K. Makishima, Porg. Theore. Phys. Supple., No.155, pp.186-189.
- ➢ Imaging the vicinity of black hole is one of the ultimate goals of VLBI astronomy. The closest massive black hole, SgrA*, located at Galactic center is the leading candidate for such observations. Combined with recent VLBI recording technique and sub-mm radio engineering, we now have the sufficient sensitivity for the observations. We here show performance simulations of sub-mm VLBI arrays for imaging SgrA*. An excellent image is obtained from a sub-mm VLBI array in southern hemisphere like the configuration of VLBA. We also note that even with a small array, we can estimate the shadow size and then the mass of black hole from visibility analysis. Now, if only constructing a sub-mm VLBI array in southern hemisphere, we can unveil the black hole environments of SgrA*.
- ● Miyoshi, M. [2004b], "An Approach Detecting the Event Horizon of SgrA*," Proc. of the 7th symposium of the European VLBI Network on New Developments in VLBI Sciences and Technology, eds. R. Bachiller, F. Colomer, J.-F. Desmurs, and P. de Vicente, pp.11-14.
- ➢ Imaging the vicinity of black hole is one of the ultimate goals of VLBI astronomy. The closest massive black hole, SgrA*, located at Galactic center is the leading candidate for such observations. Combined with recent VLBI recording technique and sub-mm radio engineering, we now have the sufficient sensitivity for the observations. We here show performance simulations of sub-mm VLBI arrays for imaging SgrA*. An excellent image is obtained from a sub-mm VLBI array in the Southern hemisphere like the configuration of VLBA. We also note that even with a small array, we can estimate the shadow size and then the mass of black hole from visibility analysis. Now, if only constructing a sub-mm VLBI array in Southern hemisphere, we can unveil the black hole environments of SgrA*.
- ● Miyoshi, M., H. Imai, J. Nakashima, S. Deguchi, and Z.-Q. Shen [2005], "VLBA Observations of an Intraday Flare of Sagittarius A*," Proc. of the "Future Directions in High Resolution Astronomy: A Celebration of the 10th Anniversary of the VLBA", eds. J. D. Romney, and M. J. Reid, ASP Conf. Ser. vol.340, pp.258-262.
- ➢ We report here the results of VLBA observations of Sagittarius A* (Sgr A*) at 43GHz, when Sgr A* showed an intraday variation. The flux density increased from 1Jy to 3Jy, and the duration is about 104 seconds which is quite similar to its X-ray flaring that Chandra detected. VLBA snapshot mappings show that Sgr A* flared and erupted jets in two opposite directions (north-south) with nearly half the speed of light. The lengths of jets reached about 15AU at most.
- ● Mori, Y., T. Sekiguchi, S. Sugita, N. Matsunaga, H. Fukushi, N. Kaneyasu, T. Kawadu, R. Kandori, Y. Nakajima, and M. Tamura [2006], "Near-IR Monitoring Observation of Comet 9P/Temple 1," 37nd Ann. Lunar & Planetary Sci. Conf., abstract no. 2458.
- ➢ We performed a long-term observation of comet 9P/Tempel 1, the target of NASA's Deep Impact mission using the near-IR camera on a 1.4 m telescope. We present the observed change of the comet activity and the motion of the dust ejected by the impact.
- ● Morisawa, Y., H. Hoshina, Y. Kato, Z. Simizu, S. Kuma, N. Sogoshi, M. Fushitani, S. Watanabe, Y. Miyamoto, T. Momose, Y. Kasai, and K. Kawaguchi [2005], "Search for CCH⁻, NCO⁻, and NCS⁻ Negative Ions in Molecular Clouds," Publ. Astron. Soc. Japan, vol.57, pp.325-334.

- Despite several suggestions concerning the existence of negatively charged molecules and negative atomic ions in molecular clouds, few attempts have been made to search for negative ions in molecular clouds. In the present study, we extensively searched for three negative molecular ions (CCH⁻, NCO⁻, and NCS⁻) in a dark cloud, L134N, using the Nobeyama 45-m radio telescope. The three negative ions are molecules whose rotational constants have been reported based on laboratory experiments. After a long accumulation, a trace amount of an unidentified emission line was detected at a frequency close to the theoretical prediction of the J = 1-0 transition of CCH⁻. If this unidentified line is attributable to CCH⁻, the observed emission intensity would provide an estimation of the column density of CCH⁻ in L134N to be 1.0×10^{11} cm^{-2}, which corresponds to a fractional abundance of 5×10^{-12} relative to hydrogen. However, our recent observation using the IRAM 30-m telescope did not reproduce the J = 1-0 signal, nor detect any trace of the J = 2-1 transition. Thus, the identification of CCH⁻ in L134N is not yet confirmed. As for other ions, signals of neither NCO⁻ nor NCS⁻ were detected in L134N. Although we also searched for the three negative ions in a translucent cloud, CB228, and a star-forming region, SgrB2, no signals were detected. The upper limit abundances of the ions in these clouds are discussed.
- Motohara, K., T. Takata, F. Iwamuro, S. Eto, T. Shima, D. Mochida, T. Maihara, K. Nakanishi, and N. Kashikawa [2005], "Nature of the Strongly Lensed Submillimeter Galaxy SMM J14011+0252," Astron. J., vol.129, pp.53-60.
- We have carried out near-infrared JHK spectroscopy of the gravitationally lensed submillimeter galaxy SMM J14011+0252 at z=2.565, using the OH-airglow suppressor and the Cooled Infrared Camera and Spectrograph for OHS on the Subaru Telescope. This object consists of two optical components, J1 and J2, which are lensed by the cluster Abell 1835. J1 suffers additional strong lensing by a foreground galaxy at z=0.25 in the cluster. The rest-frame optical Hα, Hβ, and [O II] λ3727 lines are detected in both J1 and J2, and [N II] λ6548, 6583 lines are also detected in J1. A diagnosis of emission-line ratios shows that the excitation source of J1 is stellar in origin, consistent with previous X-ray observations. The continua of J1 and J2 show breaks at rest-frame 4000Å indicating a relatively young age. Combined with optical photometry, we have carried out model-spectrum fitting of J2 and find that it is a very young (~50 Myr) galaxy of rather small mass (~10^8 M$_{solar}$) that suffers some amount of dust extinction. A new gravitational lensing model is constructed to assess both the magnification factor and contamination from the lensing galaxy of the component J1, using a Hubble Space Telescope F702W image. We have found that J1 suffers strong lensing with magnification of ~30, and its stellar mass is estimated to be <~10^9 M$_{solar}$. These results suggest that SMM J14011+0252 is a major merger system at high redshift that undergoes intense star formation but is not a formation site of a giant elliptical galaxy. Still having plenty of gas, it will transform most of the gas into stars and will evolve into a galaxy of <~10^{10} M$_{solar}$. Therefore, this system is possibly an ancestor of a present-day, less massive galaxy such as a midsized elliptical galaxy or a spiral galaxy.
- Motoyama, K., T. Umemoto, and H. Shang [2007a], "Radiation Driven Implosion Model for Star Formation Near an H II Region," Proc. of the IAU Symp, 237, "Triggered Star Formation in a Turbulent Interstellar Medium", eds. B. G. Elmegreen & J. Palous, p.450.
- We performed numerical simulation including UV radiation transfer, and investigated effects of radiation driven implosion on star formation processes. We also observed two bright-rimmed clouds with $C^{12}O$(J=1-0) and $C^{13}O$(J=1-0) in order to compare density distributions between numerical results and observational results. Density profiles of bright-rimmed clouds are consistent with those of numerical simulations. These facts insist that star formation in bright-rimmed clouds are triggered by radiation driven implosion.
- Motoyama, K., T. Umemoto, and H. Shang, [2007b], "A Radiation Driven Implosion Model for the Enhanced Luminosity of Protostars Near HII Regions," Astronomy & Astrophysics, vol.467, pp.657-664.
- Context: Molecular clouds near H II regions tend to harbor more luminous protostars. Aims: We investigate whether a radiation-driven implosion mechanism enhances the luminosity of protostars near regions of high ionizing fluxes. Methods: We performed numerical simulations to model collapse of cores exposed to UV radiation from O stars. We investigated the dependence of mass loss rates on the initial density profiles of cores and variation of UV fluxes. We derived

simple analytic estimates of accretion rates and final masses of protostars. Results: The radiation-driven implosion mechanism can increase accretion rates of protostars by 1-2 orders of magnitude. On the other hand, mass loss due to photo-evaporation is not high enough to have a significant impact on the luminosity. The increase in accretion rate results in luminosity 1-2 orders of magnitude higher than those of protostars that form without external triggering. Conclusions: Radiation-driven implosion can help explain the observed higher luminosity of protostars in molecular clouds near H II regions.

- Muders, D., F. Boone, F. Wyrowski, J. Lightfoot, G. Kosugi, C. Wilson, L. Davis, and D. Shepherd [2007], "ALMA Pipeline Heuristics," Proc. of the "Astronomical Data Analysis Software and Systems XVI", eds. Richard A. Shaw, Frank Hill and David J. Bell, ASP Conf. Ser. vol.376, p.241.

➢ The Atacama Large Millimeter Array / Atacama Compact Array (ALMA / ACA) Pipeline Heuristics system is being developed to automatically reduce data taken with the standard observing modes such as single fields, mosaics or on-the-fly maps. The goal is to make ALMA user-friendly to astronomers who are not experts in radio interferometry. The Pipeline Heuristics must capture the expert knowledge required to provide data products that can be used without further processing. The Pipeline Heuristics system is being developed as a set of Python scripts using as the data processing engines the Common Astronomy Software Applications (CASA[PY]) libraries and the ATNF Spectral Analysis Package (ASAP). The interferometry heuristics scripts currently provide an end-to-end process for the single field mode comprising flagging, initial calibration, re-flagging, recalibration, and imaging of the target data. A Java browser provides userfriendly access to the heuristics results. The initial single-dish heuristics scripts implement automatic spectral line detection, baseline fitting and image gridding. The resulting data cubes are analyzed to detect source emission spectrally and spatially in order to calculate signal-to-noise ratios for comparison against the science goals specified by the observer.

- Müller, T. G., T. Sekiguchi, M. Kaasalainen, M. Abe, and S. Hasegawa [2005], "Thermal Infrared Observations of the Hayabusa Spacecraft Target Asteroid 25143 Itokawa," Astron. Astrophys., vol.443, pp.347-355.

➢ We obtained N- and Q-band observations of the Apollo-type asteroid 25143 Itokawa during its close Earth approach in July 2004 with TIMMI2 at the ESO 3.6 m telescope. Our photometric measurement, in combination with already published data, allowed us to derive a radiometric effective diameter of 0.32 ± 0.03 km and an albedo of $0.19^{+0.11}_{-0.03}$ through a thermophysical model. This effective diameter corresponds to a slightly asymmetrical and flattened ellipsoid of the approximate size of 520($\pm$50)x270($\pm$30)x230($\pm$20) m, based on the Kaasalainen et al. (2005, Proceedings of the 1st Hayabusa Symposium, ASP Conf. Ser., submitted) shape model. Our studies show that the thermal observations lead to size estimates which are about 15% smaller than the radar results (Ostro et al. 2005, Met. Plan. Sci., submitted), slightly outside the stated radar uncertainties of $\pm$10%. We determined a rather high thermal inertia of 750 J m^{-2} s$^{-0.5}$ K^{-1}. This is an indication for a bare rock dominated surface, a thick dust regolith can be excluded as well as a metallic surface. From our data we constructed a 10.0 mum thermal lightcurve which is nicely matched in amplitude and phase by the shape and spin vector solution in combination with our TPM description. The assumed S-type bulk density in combination with radiometric size lead to a total mass estimate of $4.5^{+2.0}_{-1.8}$ x10^{10} kg.

- Müller, T. G., T. Sekiguchi, M. Kaasalainen, S. Abe, and S. Hasegawa [2006], "Itokawa: The Power of Ground-Based Mid-Infrared Observations," International Astronomical Union XXVIth General Assembly, Pragua, 14-25 August, 2006, abstract book, p.116 (S236-85).

➢ Pre-encounter ground-based N- and Q-band thermal observations of NEA Itokawa led to a size prediction of 520($\pm$50) x 270($\pm$30) x 230($\pm$20)m, corresponding to an effective diameter of 318m (Muller et al. 2005, A&A 443). This is in almost perfect agreement with the final-in-situ results (Deff=535x294x209)$^{?}$ = 320 m; Demurae et al. 2006, Science 312). The corresponding radar value (Ostro et al. 2005, DPS 37, #15.19), based on the same shape model (Kaasalainen et al. 2005, ASP Conf. Series), was about 20% too high (Deff = (594x320x288)$^{?}$ = 379 m). The very simple mid-infrared observations revealed a surface which is dominated by bare rocks rather than a thick regolith layer. This prediction was nicely confirmed by the Hayabusa mission (e.g.,

Fujiwara et al. 2006; Saito et al. 2006, Science 312). The ground-based measurements covered three different phase angles which enabled us to determal properties with unprecedented accuracy and in excellent agreement with the results from the touch-down measurements (Okada et al., 2006, LPS XXXVII; Yano et al. 2006, Science 312). These thermal values are also key ingredients for Yarkovsky and YORP calculations (e.g., Vokrouhlicky et al. 2004, A&A 414; Vokrouhlicky et al. 2005, Icarus 173). We present a direct comparison between the predictions of our thermophysical model work and the corresponding Hayabusa results. In addition to the above mentioned properties, our data allowed us to derive the surface albedo and to estimate the total mass. We believe that with our well-tested and calibrated techniques (Lagerros 1996/97/98, A&A; Muller & Lagerros 1998/2002, A&A) we have tools at hand to distinguish between monolithic, regolith-covered and rubble pile near-Earth objects by only using remote thermal observations. This project also emphasizes the high and so far not yet fully exploited potential of thermophysical modeling techniques for the NEA/NEO exploration.

- Murakawa, K., J. Nakashima, K. Ohnaka, and S. Deguchi [2007], "Near-Infrared Polarimetric Study of the Bipolar IRAS 19312+1950," Astron. Astrophys., vol.470, pp.957-963.

➢ Aims.We have investigated the properties of the central star and dust in the bipolar nebula IRAS 19312+1950, which is an unusual object showing the characteristics of a supergiant, a young stellar object, and an asymptotic giant branch (AGB) star. Methods: We obtained H-band polarimetric data of IRAS 19312+1950 using the near-infrared camera (CIAO) on the 8 m Subaru telescope. In order to investigate the physical properties of the central star and the nebula, we performed radiative transfer modeling and compared the model results with the observed spectral energy distributions (SEDs), the radial profiles of the total intensity image, and the fraction of linear polarization map.   Results: The total intensity image shows a nearly spherical core with ~3 arcsec radius, an <sf>S</sf>-shaped arm extending ~10 arcsec in the northwest to southeast direction, and an extended lobe towards the southwest. The polarization map shows a centro-symmetric vector alignment in almost the entire nebula and low polarizations along the <sf>S</sf>-shaped arm. These results suggest that the nebula is accompanied by a central star, and the <sf>S</sf>-shaped arm has a physically ring-like structure. From our radiative transfer modeling, we estimated the stellar temperature, the bolometric luminosity, and the current mass-loss rate to be 2800 K, 7000 Lo, and 5.3×10^{-6} M yr^{-1}, respectively. Conclusions: Taking into account previous observational results, such as the detection of SiO maser emissions and silicate absorption feature in the 10 mum spectrum, our dust radiative transfer analysis based on our near-infrared imaging polarimetry suggests that (1) the central star of IRAS 19312+1950 is likely to be an oxygen-rich, dust-enshrouded AGB star and (2) most of the circumstellar material originates from other sources (e.g. ambient dark clouds) rather than being a result of mass loss from the central star. H-band polarization data is only available in electronic form at the CDS via anonymous   ftp   to   cdsarc.u-strasbg.fr   (130.79.128.5)   or   via http://cdsweb.u-strasbg.fr/cgi-bin/qcat?J/A+A/470/957

- Muraoka, K., K. Kohno, T. Tosaki, N. Kuno, K. Nakanishi, K. Sorai, T. Okuda, S. Sakamoto, A. Endo, B. Hatsukade, K. Kamegai, K. Tanaka, J. Cortes, H. Ezawa, N. Yamaguchi, T. Sakai, and R. Kawabe [2007a], "ASTE CO(3-2) Observations of the Barred Spiral Galaxy M 83: I. Correlation between CO(3-2)/CO(1-0) Ratios ad Star Formation Efficiencies," Publ. Astron. Soc. Japan, vol.59, pp.43-54.

➢ We present CO(J=3-2) emission observations with the Atacama Submillimeter Telescope Experiment (ASTE) toward the 5' x 5' (or 6.6 x 6.6 kpc at the distance D = 4.5 Mpc) region of the nearby barred spiral galaxy M 83. We successfully resolved the major structures, i.e., the nuclear starburst region, bar, and inner spiral arms in CO(J=3-2) emission at a resolution of 22" (or 480 pc), showing a good spatial coincidence between CO(J=3-2) and 6 cm continuum emissions. We found a global CO(J=3-2) luminosity L'CO(3-2) of 5.1 x 108 K km s-1 pc2 within the observed region. We also found $L'_{CO(3-2)}$ in the disk region (0.5 < r < 3.5 kpc) of 4.2 x 10^8 K km s^{-1} pc^2, indicating that CO(J=3-2) emission in the disk region significantly contributes to the global $L'_{CO(3-2)}$. From a comparison of a CO(J=3-2) data with CO(J=1-0) intensities measured with Nobeyama 45-m telescope, we found that the radial profile of CO(J=3-2)/CO(J=1-0) integrated intensity ratio $R_{3-2/1-0}$ is almost unity in the central region (r < 0.25 kpc), whereas it drops to a constant value, 0.6--0.7, in the disk region. The radial profile of star formation

efficiencies (SFEs), determined from 6 cm radio continuum and CO(J=1-0) emission, shows the same trend as that of $R_{3-2/1-0}$. At the bar-end (r ~ 2.4 kpc), the amounts of molecular gas and the massive stars are enhanced when compared with other disk regions, whereas there is no excess of $R_{3-2/1-0}$ and SFE in that region. This means that a simple summation of the star forming regions at the bar-end and the disk cannot reproduce the nuclear starburst of M 83, implying that the spatial variation of the dense gas fraction traced by $R_{3-2/1-0}$ governs the spatial variation of SFE in M 83.

- Muraoka, K., K. Kohno, T. Tosaki, N. Kuno, K. Nakanishi, K. Sorai, and S. Sakamoto [2007b], "ASTE CO(3-2) Observations of M83: Correlation between CO(3-2)/(1-0) Ratios and Star Formation Efficiencies," Proc. of the IAU Symp, 237, "Triggered Star Formation in a Turbulent Interstellar Medium", eds. B. G. Elmegreen & J. Palous, p.451.

➤ We have performed CO(J=3 2) emission observations with the Atacama Submillimeter Telescope Experiment (ASTE) toward the 5x5 (or 6.6x6.6 kpc at the distance D = 4.5 Mpc) region of the nearby barred spiral galaxy M 83. We successfully resolved the major structures, i.e., the nuclear starburst region, bar, and inner spiral arms in CO(J=3 2) emission at a resolution of 22" (or 480 pc), showing a good spatial coincidence between CO(J=3 2) and 6 cm continuum emissions. From a comparison of CO(J=3 2) data with CO(J=1 0) intensities measured with Nobeyama 45-m telescope, we found that the radial profile of CO(J=3 2)/CO(J=1 0) integrated intensity ratio $R_{3-2/1-0}$ is almost unity in the central region (r<0.25 kpc), whereas it drops to a constant value, 0.6-0.7, in the disk region. The radial profile of star formation efficiencies (SFEs), determined from 6 cm radio continuum and CO(J=1 0) emission, shows the same trend as that of $R_{3-2/1-0}$. At the bar-end (r ~ 2.4 kpc), the amounts of molecular gas and the massive stars are enhanced when compared with other disk regions, whereas there is no excess of R3 2/1 0 and SFE in that region. This means that a simple summation of the star forming regions at the bar-end and the disk cannot reproduce the nuclear starburst of M 83, implying that the spatial variation of the dense gas fraction traced by $R_{3-2/1-0}$ governs the spatial variation of SFE in M 83.

- Murata, Y., H. Hirabayashi, M. C. Natori, T. Umemoto, K. Asada, S. Iikura, and The next generation Space VLBI working group [2005], "Development of the Large High Accuracy Deployable Antenna for the VSOP-2 Mission," Proc. at the XXVIIIth General Assembly of the URSI, October 2005, India. (CD-ROM : BP.11)

➤ We are developing the satellite for the space VLBI mission for radio astronomy, called VSOP-2[1, 2]. Details of this mission will be presented in the papers in Commission J in this meeting. We need to make the satellite small enough to fit the nose fairing of the launcher, the M-V rocked developed by JAXA, and to make a large antenna to get sensitivity for radio astronomy. The on-board large deployable antenna, which will be used at a shortest wavelength of 7-mm, is one of the key parts of the spacecraft. We should make this large antenna light and small enough to fit the launcher and sufficiently reliable to use in space. The VSOP-2 satellite has a 9-m antenna modules to help to shape a surface accuracy as high as 0.4 mm-rms. We developed a new full scale test module for checking the concept of the radial rib surface module. We tested how to adjust the surface of the module, how to measure the surface, how the deployment mechanism works, and the mechanical interface while the module is folded for the launch. The surface of the module is formed of the mesh knitted by the gold-coated molybdenum wire. We confirmed we can use this mesh up to 43 GHz by making measurements of the reflection loss. We show the overall antenna system in this paper.

- Musha, M., Y. Sato, K. Nakagawa, K. Ueda, A. Ueda, and M. Ishiguro [2006], "Robust and Precise Length Stabilization of a 25-km Long Optical Fiber Using an Optical Interfermetric Method with a Digital Phase-Frequency Discriminator," Appl. Phys. B, vol.82, pp.555-559.

➤ We have developed an optical fiber length stabilization system for the distribution of reference millimeter wave signals in a long-baseline phased-array radio telescope. The fiber length was compared with an absolute wavelength reference laser using a Michelson interferometer. We used a digital servo system including a digital phase-frequency discriminator with a wide phase dynamic range and a digital signal processor (DSP) for the digital servo system. All-digital servo system made it possible to realize a robust and precise length stabilization of a 25-km long optical fiber.

- Nagai, H., M. Inoue, K. Asada, and Y. Uchida [2004], "Magnetic Field and Faraday Rotation

Measure Structure in the Jet of 3C120," Proc. of the 7th symposium of the European VLBI Network on New Developments in VLBI Sciences and Technology, eds. R. Bachiller, F. Colomer, J.-F. Desmurs, and P. de Vicente, pp.89-90.

➢ We present multi-frequency polarimetric VLBI observation of 3C 120. We investigated RM distribution of central parsecs of the host of the jet. Our analysis revealed the RM feature closely associated with the change of magnetic field (B-field) orientation of the jet. The change of B-field is brought by the some physical mechanism of the synchrotron emitting plasma of the jet. On the other hand the change of RM distribution is brought by the change of electron density and/or B-field strength of the low energy plasma (γ<20), since such plasma is responsible for the Faraday rotation. This result leads us to expect the idea that the low energy plasma is surrounding the synchrotron emitting plasma, and both of them are physically associated.

● Nagai, H., T. Kasuga, M. Tsuboi, Y. Murata, and VSOP-2 working group [2005], "Development of the Receiving System for VSOP-2 Mission," Proc. at the XXVIIIth General Assembly of the URSI, October 2005, India. (CD-ROM :C07.7)

➢ Not Available

● Nagai, H., M. Inoue, K. Asada, S. Kameno, and A. Doi [2006], "The Kinematic and Spectra Ages of the Compact Radio Source CTD 93," Astrophys. J., vol.648, pp.148-157.

➢ We present a study of the kinematic and spectral ages of the gigahertz-peaked spectrum (GPS) source CTD 93. Measurements of the hot-spot separation over 8.5 yr show evidence of an increase. The separation rate along the source axis is $(0.34\pm0.11)c(H_0$=72 km s^{-1} Mpc^{-1}), which results in a kinematic age of 2200±700 yr. Assuming that two hot spots are moving apart at equal speeds, we derive an advance speed of (0.17±0.06)c. The Radio-lobe spectra show a high-frequency steeping, as expected if energetic electrons lose energy by synchrotron radiation. The spectral break decreases with the distance from the hot spot in the northern component of CTD 93. This tendency is expected from the basic scenario of radio-lobe evolution involving particle acceleration at the hot spots, with the radio lobes populated by high-energy electrons that have leaked from the hot spots. Although a core-jet morphology for CTD 93 has previously been proposed these results indicate that the morphology is similar to that of compact symmetric object (CSO). From the spectral fits in the northern component we found a break frequency of 3.7 GHz at the edge of the lobe. The resultant spectral age is ~300 yr, assuming the equipartition magnetic field. This requires the advances speed of 0.26c, which shows a good agreement of the hot-spot motion of (0.17 ∓ 0.06)c. Our results strongly support the hypothesis that CSO are young radio sources.

● Nagai, M., K. Tanaka, K. Kamegai, and T. Oka [2007], "Physical Conditions of Molecular Gas in the Galactic Center," Publ. Astron. Soc. Japan, vol.59, pp.25-31.

➢ We estimated physical conditions of molecular gas in the central molecular zone (CMZ) of the Galaxy, using our CO J=3-2 data obtained with the Atacama Submillimeter Telescope Experiment (ASTE) in conjunction with J=1-0 ^{12}CO and ^{13}CO data previously observed with the NRO 45m telescope. The large velocity gradient (LVG) approximation was employed. Distributions of gas density, kinetic temperature, and CO column density are derived as functions of position and velocity for the entire coverage of the CO J=3-2 data. We fairly determined physical conditions for 69 % of data points in the CMZ with ≥ 1 σ CO detections. Kinetic temperature was found to be roughly uniform in the CMZ, while gas density is higher in the 120-pc star forming ring than in the outer dust lanes. Physical conditions of high J=3-2/J=1-0 features are also discussed.

● Nagayama, T., T. Omodaka, T. Handa, H. B. H. Iahal, T. Sawada, T. Miyaji, and Y. Yokoyama [2007], "A Complete Survey of the Central Molecular Zone in NH3," Publ. Astron. Soc. Japan, vol.59, pp.869-887.

➢ We present a map of the major part of the central molecular zone (CMZ) of simultaneous observations in the NH$_3$ (J,K) = (1,1) and (2,2) lines using the Kagoshima 6m telescope. The mapped area is -1D.000 ≤ l ≤ 1D.625 and -0D.375 ≤ b ≤ 0D.250. The kinetic temperatures derived from the (2,2) to (1,1) intensity ratios are 20-80 K, or exceed 80 K. The gases corresponding to temperatures of 20-80 K and ≥80 K contain 75% and 25% of the total NH$_3$ flux, respectively. These temperatures indicate that the dense molecular gas in the CMZ is dominated

by gas that is warmer than the majority of the dust present there. A comparison of our observations with a CO survey by Sawada et al. (2001, ApJs, 136, 189) shows that the NH_3 emitting region is surrounded by a high-pressure region on the longitude-velocity (l - v) plane. Although NH3 emission traces dense gas, it does not extend over a high-pressure region. Therefore, the high-pressure region is less dense and has to be hotter. This indicates that the molecular-cloud complex in the Galactic center region has a "core" of dense and warm clouds that are traced by the NH3 emission, and an "envelope" of less-dense and hotter gas clouds. Besides heating by ambipolar diffusion, the hot plasma gas emitting the X-ray emission may heat the hot "envelope".

- Nakanishi, H., N. Kuno, Y. Sofue, N. Sato, N. Nakai, Y. Shioya,T. Tosaki, S. Onodera, K. Sorai, F. Egusa, and A. Hirota [2005a], "Environmental Effects on Gaseous Disks of Virgo Spiral Galaxies," Proc. of the "The Dusty and Molecular Universe: A Prelude to Herschel and ALMA", ed. A. Wilson, ESA SP-577, pp.301-302.

➢ We present the results of ^{12}CO (J=1-0) observations of five Virgo spiral galaxies obtained with the Nobeyama 45-m telescope equipped with a multi-beam receiver, BEARS. We combined these CO data with the H I data to address the environmental effect on the gaseous disks. We investigated a relationship between the molecular fraction (f_{mol}) and the total gaseous density (H I plus H_2 density, Σ_{HI+H2}). We found that three of our samples displays unusually larger fmol than that expected for the field galaxies, while the rest two galaxies show the normal fmol. It implies that the ram-pressure stripping occurs at the inner disks to result in unusually large fmol as one possibility.

- Nakanishi, H., Y. Sofue, and J. Koda [2005b], "Virgo High-Resolution CO Survey: V. Circumnuclear Elliptical Ring in NGC 4569," Publ. Astron. Soc. Japan, vol.57, pp.905-916.

➢ We present high-resolution (1".8 - 4".5) CO data of the Virgo spiral galaxy NGC 4569, obtained using the Nobeyama Millimeter Array. We found that the molecular gas is highly concentrated in the circumnuclear region with two off-center peaks. A CO image with the highest angular resolution of 2".0x1".8 shows that six blobs likely form a circumnuclear elliptical ring (CER) with a semimajor axis of 720pc. The CER shows a strongly twisted velocity field, and the position-velocity diagram shows significant forbidden velocity components. These kinetic features are understood as being non-circular motion due to a bar-potential. We found that the CER coincides with the Halpha bright central core and that the mass ratio of the molecular gas to the dynamical mass is about 18%. These results support a gaseous inflow scenario induced by a weak bar potential and self-gravity of the gas.

- Nakanishi, H., and Y. Sofue [2006a], "Three-Dimensional Distribution of the ISM in the Milky Way Galaxy: II. The Molecular Gas Disk," Publ. Astron. Soc. Japan, vol.58, pp.847-860.

➢ We created a three-dimensional distribution map of molecular gas throughout the Milky Way galaxy using the latest ^{12}CO (J=1-0) survey data cube and the rotation curve based on the kinematic distance. The radial distribution of the molecular gas shows a central peal and a second peak around 0.5 R_0 (R_0: the solar Galactocentric distance). The thickness of the molecular disk slightly increases from 48 pc to 160 pc with the Galactocentric distance within a radius range of 0-11 kpc. We were able to trace the Outer, the Perseus, the Sagittarius-Carina, The Scutum-Crix, and the Norma arms as logarithmic spiral arms with pitch angles of 11°-15°. Considering that the pitch angles of the spiral arms are within this range, the Norma and the Outer arms seem to be identified as the same spiral arm. We could also trance a midplane displacement, whose amplitude is nearly constant inside a 10 kpc radius increases beyond this radius. The ridges of the midplane displacement form the leading spiral arms.

- Nakanishi, H., N. Kuno, Y. Sofue, N. Sato, N. Nakai, Y. Shioya, T. Tosaki, S. Onodera, K. Sorai, F. Egusa, and A. Hirota [2006b], "Environmental Effects on Gaseous Disks of the Virgo Spiral Galaxies," Astrophys. J., vol.651, pp.804-810.

➢ We found high molecular fractions (fmol; ratio of the molecular to total gas surface densities) in three of five Virgo spiral galaxies in spite of their low total gas column density, based on ^{12}CO J=1-0 observations with the Nobeyama 45 m telescope equipped with a multibeam receiver, BEARS. We interpret this as a result of environmental effects. Combining the CO data with H I data, the relationship between the surface density of the total gas (H I plus H_2) and fmol indicates that the three galaxies near the cluster center have larger f_{mol} values than expected for field

galaxies, while the others show normal f_{mol}. The large f_{mol} is interpreted as being due either to effective H I gas stripping, even in the inner disks, or to large ISM pressure induced by the high ICM pressure and/or ram pressure, although the possibility of an unusually high metallicity cannot be ruled out.

- Nakanishi, H., T. Tosaki, K. Kohno, Y. Sofue, and N. Kuno [2007], "ASTE 12CO(J=3-2) Survey of Elliptical Galaxies," Publ. Astron. Soc. Japan, vol.59, pp.61-65.

➤ We report $^{12}CO(J=3-2)$ observations of 15 nearby elliptical galaxies, carried out with the ASTE telescope. Thirteen were selected without regard to the presence of other tracers of cold interstellar matter. CO emission was detected from three of the galaxies, two of which are undetected by IRAS at 100 μm. The molecular gas masses range from 2.2 x 10^6 to 4.3 x 10^8 M . The ratio of the CO(3-2) and (1--0) lines, R_{31}, has a lower value for elliptical galaxies than for spiral galaxies except for NGC 855, for which the value is close to the mean for spirals. The molecular gas in NGC 855 has a mean density in the range 300 - 1000 cm^{-3} adopting a temperature range of 15 - 100 K.

- Nakanishi, K., S. K. Okumura, K. Kohno, R. Kawabe, and T. Nakagawa [2004], "Dense and Warm Molecular Gas in the Luminous IR Galaxy NGC 6240," Proc. of "The Neutral ISM in Starbust Galaxies", eds. S. Aalto, S. Huttemeiister, and A. Pedlar, ASP Conf. Ser. vol.320, pp.31-34.

➤ Interferometric multi-line observations of molecular emission toward a luminous infrared galaxy NGC 6240 have been performed. HCN(1-0) and HCO^+(1-0) emissions have spatially compact distributions which are peaked between the double nuclei of this galaxy. ^{13}CO(1-0) emission is also detected, but it is much weaker than ^{12}CO(1-0) and HCN emissions. These results suggest that the molecular gas concentrated between the double nuclei is dense and warm, and such conditions may be the product of the interaction of gas and an intense outflow from the nuclear region.

- Nakanishi, K., S. K. Okumura, K. Kohno, R. Kawabe, and T. Nakagawa [2005], "Dense and Warm Molecular Gas between Double Nuclei of the Luminous Galaxy NGC 6240," Publ. Astron. Soc. Japan, vol.57, pp.575-586.

➤ High spatial resolution observations of the ^{12}CO (1-0), HCN(1-0), HCO^+(1-0), and ^{13}CO(1-0) molecular lines toward the luminous infrared merger NGC 6240 have been performed using the Nobeyama Millimeter Array and the RAINBOW Interferometer. All of the observed molecular emission lines are concentrated in the region between the double nuclei of the galaxy. However, the distributions of both HCN and HCO^+ emissions are more compact compared with that of ^{12}CO, and they are not coincident with the star-forming regions. The HCN/^{12}CO line intensity ratio is 0.25; this suggests that most of the molecular gas between the double nuclei is dense. A comparison of the observed high HCN/^{13}CO intensity ratio, 5.9, with large velocity gradient calculations suggests that the molecular gas is dense [$n(H_2) = 10^{4-6}$ cm^{-3}] and warm (Tkin > 50 K). The observed structure in NGC 6240 may be explained by time evolution of the molecular gas and star formation, which was induced by an almost head-on collision or very close encounter of the two galactic nuclei accompanied with the dense gas and star-forming regions.

- Nakashima, J., and S. Deguchi [2005], "BIMA Array Observations of the Highly Unusual SiO Maser Source with a Bipolar Nebulosity IRAS 19312+1950," Astrophys. J., vol.633, pp.282-294.

➤ We report the results of mapping observations of the bipolar nebula with SiO maser emission, IRAS 19312+1950, in the CO (J=1-0 and 2-1), ^{13}CO (J=1-0 and 2-1), $C^{18}O$ (J=1-0), CS (J=2-1), SO ($J_K=3_2-2_1$), and HCO^+ (J=3-2) lines with the Berkeley-Illinois-Maryland Association array. The evolutional status of this source has been evoking a controversy since its discovery, although SiO maser sources are usually identified as late-type stars with active mass loss. In line profiles, two kinematical components are found, as reported in previous single-dish observations: a broad pedestal component and a narrow component. Spatiokinetic properties of a broad-component region traced by ^{12}CO lines are roughly explained by a simple spherical outflow model with an expanding velocity typical of an AGB star, although some properties of the broad-component region still conflict with properties of a typical AGB spherical outflow. A narrow-component region apparently exhibits a bipolar flow. The angular size of the narrow-component region is spatially larger than that of the broad-component region. The intensity distribution of the CS

emission avoids the central region of the source, and that of the SO broad-component emission exhibits a small feature peaked exactly at the mapping center. According to the present results, if the broad component really originates in a spherical outflow, an oxygen-rich evolved stellar object seems to be a natural interpretation for the central star of IRAS 19312+1950.

- Nakashima, J., and S. Deguchi [2006], "SiO Masers in a Scutum Massive Star Cluster of Red Supergiants," Astrophys. J. (Letters), vol.647, pp.L139-L142.

➢ We have detected five objects toward a Scutum massive star cluster of red supergiants in the SiO J=1-0, v=1 or v=2 transitions. The radial velocity data indicate that four of the detections are cluster members and that the other, which is located close to the X-ray source AX 1838-0655, is a foreground object. The high velocity resolution of the maser lines provides a more accurate determination of the radial velocity (120 km s^{-1}) and velocity dispersion (~2 km s^{-1}) of the cluster and, hence, of the distance (6.5 kpc) and luminosities of the stars. We discuss the implications of those measurements in constraining the relationships between SiO masers and mass-loss rate and modeling the cluster age and mass.

- Nishio, M., Q. Lui, T. Miyazaki, M. Hirata, Y. Kuroki, M. Kusuhata, N. Iwashita, C. Minamitake, S. Yasuda, N. Iino, T. Omodaka, O. Kameya, N. Kawano, T. Suzuyama. Y. Shibuya, and N. Kurihara [2007], "Observation Site Atmospheric Phase Fluctuations Observed by Three-Element VLBI," IEEE Trans., Antenna & Propagation, vol.55, pp.2056-2063.

➢ The beacon signals from a geostationary satellite were observed using three-element very long baseline interferometry (VLBI), and the phase fluctuations along the baselines between three sites were obtained. The atmospheric phase fluctuations at each observation site were derived from the baseline phase fluctuation data. The fluctuations were classified into three time-interval regions based on the dependence of the Allan standard deviation of the fluctuations on the one where it was greater than one hundred seconds, the curve of the Allan standard deviation was steep and showed the property of white phase noise. In the region between these two regions, the dependence of the Allan standard deviation on the time interval was weak. The magnitude of the Allan standard deviations for the three observation sites showed time variations in the region where the time interval was longer than a few seconds. Comparison with the weather conditions suggested than the time variation of the Allan standard deviation reflected atmospheric instability above the sites.

- Niwa, T., Y. Itoh, K. Tachihara, Y. Oasa, K. Sunada, and K. Sugitani [2007], "Radio Observation of Molecular Clouds around the W5-East Triggered Star-Forming Region," Proc. of the IAU Symp, 237, "Triggered Star Formation in a Turbulent Interstellar Medium", eds. B. G. Elmegreen & J. Palous, p.454.

➢ It is known that most of stars are formed as clusters (Lada & Lada 2003, ARAA 41, L57) and clusters are formed by triggering. However, the relationships of molecular clouds' conditions and properties of formed stars by triggering is not well studied. To clarify differences between triggered and spontaneous star formation through physical properties of molecular clouds (e.g. mass, density, morphology), we observed the W5-East HII region. The W5-East HII region is located at 2 kpc and has a 10 pc extent of HII region. This region has 3 Bright Rimmed Clouds (BRCs; Sugitani et al. 1991, ApJS 77, S59), which are interface between HII regions and molecular clouds, and known as sites of triggered star formation. The molecular clouds surround the W5-East (Karr et al. 2003, ApJ, 595, 900), thus we expect molecular clouds morphology is affected by the HII region and the cloud evolution is supposed to be dominated by the expanding HII region.

- Ohta, K., G. Kiuchi, K. Nakanishi, K. Aoki, I. Iwata, M. Akiyama, N. Tamura, and M. Ando [2007], "CO Observations of a FeLoBAL Quasar with an Hα Absorption Line at z=2.3," Publ. Astron. Soc. Japan, vol.59, pp.527-530.

➢ SDSS J083942.11+380526.3 is an Iron Low-ionization Broad Absorption Line (FeLoBAL) quasar at z = 2.3, and Aoki et al (2006) recently found the presence of an Hα absorption line in the broad Hα emission line. Motivated by an idea that this quasar may be a huge molecular gas reservoir in the early phase of quasar evolution, we made CO(J=3-2) observations of it using Nobeyama Millimeter Array. No significant CO emission was detected; although an emission-like feature (2.5σ) was seen close (~2") to the quasar, we regard it as noise. The obtained 3σ upper limit on the CO luminosity is L'$_{CO(J=3-2)}$ = 4.5x10^{10} K km s^{-1} pc^2, which

corresponds to $M(H_2) = 3.6 \times 10^{10} M_{Solar}$ if we adopt CO-to-H_2 conversion factor of 0.8 M_{Solar} (K km s^{-1} pc^2)$^{-1}$. This upper limit is comparable to $L'_{CO(J=3-2)}$ (and thus the molecular gas mass) detected in quasars and BAL quasars at $Z = 1-3$, and no sign of the presence of the huge amount of molecular gas in this FeLoBAL quasar was obtained.

- Ohtsuka, K., T. Sekiguchi, D. Kinoshita, Jung-Li, and J. Watanabe [2005], "2005 UD and the Daytime Sextantids," IAU Circ., Electronic Telegram No. 283.

➢ Suggest that the Apollo-type minor planet 2005 UD (MPEC 2005-U22, 2005-U68, 2005-V49) is a possible candidate for the parent object of the daytime Sextantids meteor stream (Sekanina 1976, Icarus 27, 265). Furthermore, it may be a member of the Geminid stream complex (e.g., Cook 1973, in NASA SP-319, p. 183) -- i.e., perhaps a larger fragment of (3200) Phaethon. The phase of orbital evolution of 2005 UD shifts by about 4000 yr or more from the present orbit of Phaethon (Ohtsuka et al. 1999, Earth, Moon and Planets 77, 83). Kinoshita obtained multi-color images of 2005 UD at Lulin observatory (1.0-m f/8 reflector + CCD) on Oct. 31-Nov. 5, but no cometary features were detected.

- Ohtsuka, K., T. Sekiguchi, D. Kinoshita, J.-I. Watanabe, T. Ito, H. Arakida, and T. Kasuga [2006], "Apollo Asteroid 2005 UD: Split Nucleus of (3200) Phaethon?," Astron. Astrophys., vol.450, pp.L25-L28.

➢ context: The recently discovered Apollo asteroid 2005 UD is the most likely candidate for being a large member of the Phaethon-Geminid stream Complex (PGC). Aims: Detecting more complex members like this should clarify the formation and evolution of the PGC. Methods: Our backward and forward (±10 000-yr) integration of the Kustaanheimo-Stiefel regularized equation of motion revealed that the orbital evolutions of Apollo asteroids (3200) Phaethon and 2005 UD show a similar profile, time-shifting by ~4600 yr. Results: Within the PGC, this time shift is rather large against the time-lag of 220 yr for Phaethon-Geminids and =3900 yr between Phaethon-Sextantids, although much smaller than that of ~19 000 yr between Phaethon-Canis Minorids. Conclusions: This is a km-order object, hence may be a split nucleus of Phaethon. Besides, the orbital parameters of 2005 UD and the Sextantids are in good agreement along with the time-lag of 100 yr. Therefore, the Sextantid meteor shower seems to be associated more closely with 2005 UD than Phaethon.

- Ohtsuka, K., H. Arakida, T. Ito, T. Kasuga, J. Watanabe, D. Kinoshita, T. Sekiguchi, D. J. Asher, and S. Nakano [2007], "Apollo Asteroids 1566 Icarus and 2007 MK6: Icarus family Members?" Astrophys. J. (Letters), vol.668, pp.L71-L74.

➢ Although it is more complicated to search for near-Earth object (NEO) families than main belt asteroid families, since differential orbital evolution within a NEO family can cause current orbital elements to drastically differ from each other, we have found that Apollo asteroids 1566 Icarus and the newly discovered 2007 MK6 are almost certainly related. Specifically, their orbital evolutions show a similar profile, time shifted by only ~1000 yr, based on our time-lag theory. The dynamical relationship between Icarus and 2007 MK6 along with a possible dust band, the Taurid-Perseid meteor swarm, implies the first detection of an asteroidal NEO family, namely, the "Icarus asteroid family."

- Oka, T., K. Kamegai, M. Hayashida, M. Nagai, M. Ikeda, N. Kuboi, K. Tanaka, L. Bronfman, and S. Yamamoto [2005], "Atomic Carbon in the Southern Milky Way," Astrophys. J., vol.623, pp.889-896.

➢ We present a coarsely sampled longitude-velocity (l-V) map of the region l=300°-354°, b=0° in the 492 GHz fine-structure transition of neutral atomic carbon (C^0 $^3P_1$-$^3P_0$ [C I]), observed with the Portable 18 cm Submillimeter-wave Telescope (POST18). The l-V distribution of the [C I] emission resembles closely that of the CO J=1-0 emission, showing a widespread distribution of atomic carbon on the Galactic scale. The ratio of the antenna temperatures, $R_{CI/CO}$, concentrates on the narrow range from 0.05 to 0.3. A large velocity gradient (LVG) analysis shows that the [C I] emission from the Galactic disk is dominated by a population of neutral gas with high C^0/CO abundance ratios and moderate column densities, which can be categorized as diffuse translucent clouds. The ratio of bulk emissivity, J_{CI}/J_{CO}, shows a systematic trend, suggesting the bulk C^0/CO abundance ratio increasing with the Galactic radius. A mechanism related to kiloparsec-scale structure of the Galaxy may control the bulk C^0/CO abundance ratio in the Galactic disk. Two groups of high-ratio ($R_{CI/CO}>0.3$) areas reside in the l-V loci several degrees inside of tangential

points of the Galactic spiral arms. These could be gas condensations just accumulated in the potential well of spiral arms and be in the early stages of molecular cloud formation.

- Oka, T., M. Nagai, K. Kamegai, and K. Tanaka [2006], "A Large-Scale CO J=3-2 Survey of the Galactic Center," J. Physics: Conference Series, vol.54, pp.67-71.

➢ We have surveyed the central molecular zone (CMZ) of our Galaxy in the CO J=3-2 line with the Atacama Submillimeter-wave Telescope Experiment (ASTE). Molecular gas in the Galactic center shows high J=3-2/J=1-0 intensity ratio (~ 0.9) while gas in the Galactic disk shows the lower ratio (~ 0.5). The high-velocity compact cloud CO 0.02-0.02 and the hyperenergetic shell CO 1.27+0.01, as well as number of small spots of high ratio gas. Some of these high ratio spots have large velocity widths and some seem to associate with nonthermal 'threads' or filaments. These could be spots of hot molecular gas shocked by unidentified supernova which may be abundant in the CMZ.

- Oka, T., M. Nagai, K. Kamegai, K. Tanaka, and N. Kuboi [2007], "A CO J = 3-2 Survey of the Galactic Center," Publ. Astron. Soc. Japan, vol.59, pp.15-23.

➢ We have surveyed the central molecular zone (CMZ) of our Galaxy in the CO J=3-2 line with the Atacama Submillimeter-wave Telescope Experiment (ASTE). Molecular gas in the Galactic center shows high J=3-2/J=1-0 intensity ratio (~ 0.9) while gas in the spiral arms in the Galactic disk shows the lower ratio (~ 0.5). The high-velocity compact cloud CO 0.02-0.02 and the hyperenergetic shell CO 1.27+0.01, as well as gas in the Sgr A region exhibit high J=3-2/J=1-0 intensity ratio exceeding 1.5. We also found a number of small spots of high ratio gas. Some of these high ratio spots have large velocity widths and some seem to associate with nonthermal threads or filaments. These could be spots of hot molecular gas shocked by unidentified supernovae which may be abundant in the CMZ.

- Okuda, T., K. Kohno, S. Iguchi, and K. Nakanishi [2004], "Rotating Molecular Gas Associated with a Silhouette Disk in the Center of the Radio Galaxy 3C 31," Proc. of the IAU Symp. 222, "The Interplay among Black Holes, Stars and ISM in Galactic Nuclei", eds. T. Storchi-Bergmann, L. C. Ho, & H. R. Schmitt, pp.349-350.

➢ We have carried out aperture synthesis CO(J=1-0) observations of the FRI radio galaxy 3C 31 (NGC 383), using the Nobeyama Millimeter Array (NMA) and the RAINBOW interferometer, which achieves a large collecting area by adding the NRO 45m telescope. Our high-resolution (1.9" x 1.4") CO 3D observations reveal a very massive (~ 10^9 M), circularly-rotating molecular gas ring, which coincides nicely with the silhouette disk seen in the Hubble Space Telescope (HST) optical images. This is the first map depicting the molecular gas distribution and kinematics associated with a silhouette disk in the heart of a radio galaxy.

- Okuda, T., K. Kohno, S. Iguchi, and K. Nakanishi [2005], "Rotating Molecular Gas Associated with a Silhouette Disk at the Center of the Radio Galaxy 3C 31," Astrophys. J., vol.620, pp.673-679.

➢ Aperture synthesis observations of ^{12}CO(J=1-0) emissions of the radio galaxy 3C 31 (NGC 383) have been made using the Nobeyama Millimeter Array (NMA) and the RAINBOW interferometer (NMA plus the Nobeyama 45 m radio telescope). Our high-resolution (1.9"x1.4", or 640pcx470pc, at D=70 Mpc) ^{12}CO image shows a circularly rotating molecular gas disk that closely coincides with a silhouette disk observed in the Hubble Space Telescope (HST) optical images. The molecular gas mass (M_{gas}) of the disk is estimated to be $9.7 \times 10^8 M_{solar}$ within a radius of 1 kpc, and the peak gas surface density Σ_{gas} is $4.0 \times 10^2 M_{solar}$ pc^{-2} at 440 pc from the center, if a Galactic I(CO)-to-N(H$_2$) conversion factor (1.8×10^{20} cm^{-2} [K km s^{-1}]$^{-1}$) is applied. The rotation velocity of the disk is 460 km s^{-1} at a radius of 1 kpc, giving an enclosed mass (dynamical mass) of $M_{dyn} = 5.0 \times 10^{10} M_{solar}$ within this radius. The ratio of gas mass to dynamical mass, M_{gas}/M_{dyn}, is less than 0.02, indicating that the gas disk at the center of 3C 31 is stable against gravitational instabilities, although the total gas mass of the nuclear disk in 3C 31 is fairly large compared with the nuclear gas concentration observed in late-type spirals.

- Onishi, T. [2005], "From Dense Cores to Protostars in Low-Mass Star Forming Regions," Proc. of "The Initial Mass Function 50 Years Later", eds. Corbello, E., Palla, F., and Zinnecker, H., ASSL vol.237, pp.321-322.

➢ We present the results of a survey for dense molecular condensations in nearby low-mass star forming regions and the succeeding detection of a high-density condensation that is very close to

the moment of the formation of a protostellar core within a time scale of $\sim 10^4$ yr.

- Onodera, S., J. Koda, Y. Sofue, and K. Kohno [2004], "Gas Dynamics in the Non-Barred Seyfert Galaxy NGC 4501," Proc. of "The Neutral ISM in Starbust Galaxies", eds. S. Aalto, S. Huttemeiister, and A. Pedlar, ASP Conf. Ser. vol.320, pp.271-272.

➢ We report high resolution interferometer observations of the central 5 kpc region of NGC 4501. The observations were carried out with the CO line using the Nobeyama Millimeter Array (NMA). It is known that NGC 4501 has high degree of central gas concentration for a non-barred galaxy. The CO major features (1) a nuclear concentration which is resolved into double peaks, (2) spiral arms. The feature (1) has a low star-forming efficiency, which might be due to low Mgas/Mdyn ratio. Double peaks are located on the root of optical spiral arms in a HST image. To understand gas motions in NGC 4501, we did model calculations of gas cloud orbits governed by a stellar spiral potential, which is a modification of the model with a bar potential. The observed CO spirals and non-circular motions were explained with this spiral model. We estimated the loss of angular momentum due to galactic spiral shocks in orbit-crowding regions and gravitational torques exerted by the stellar spirals. We found that the galactic shock is dominant. These mechanisms lead to gas inflow and possibly explain the central-condensed double peaks in NGC 4501.

- Peck, A. B., D. Iono, G. R. Petitpas, A. Pope, C. Borys, J. S. Dunlop, M. Krips, and D. J. Wilner [2007], "Astrometric Imaging of High-Redshift Galaxies at 345 GHz," Proceedings in "From Z-Machines to ALMA:(Sub)Millimeter Spectroscopy of Galaxies", eds. Andrew J. Baker, Jason Glenn, Andrew I. Harris, Jeffrey G. Mangum and Min S. Yun, ASP Conf. Ser. vol.375, pp.263-266.

➢ Recent single-dish submillimeter wavelength surveys have revolutionized observational cosmology by uncovering a substantial new population of dust-enshrouded starburst galaxies at high redshift. A tremendous amount can be learned about the star formation history of the universe by comparing the characteristics of these early sources at a range of wavelengths, from radio to X-ray. Unfortunately, the positions of these sources are not well enough determined in the parent surveys to justify devoting large amounts of time using higher-resolution instruments without first performing high-precision astrometry. The Submillimeter Array on Mauna Kea is now the ideal instrument for this, as it can observe at the same frequency as the original survey but with substantially better angular resolution, yielding astrometric accuracies of ~ 100 mas. We present images of the distant galaxies detected to date using the Submillimeter Array at 345 GHz.

- Petitpas, G. R., C. D. Wilson, A. J. Baker, D. Iono, A. B. Peck, K. Sakamoto, M. Krips, P. T. P. Ho, and S. Matsushita [2006], "SCONES: Determining the Warm Gas Properties of Nearby Galaxies," American Astronomical Society Meeting 209, #15.12.

➢ We present preliminary results from our SMA CO Nearby Extragalactic Survey (SCONES) which will determine the warm gas properties of a sample of nearby galaxies at high angular resolution. Thus far we have mapped seven galaxies in ^{12}CO J=2-1, ^{13}CO J=2-1, C^{18}O J=2-1 and ^{12}CO J=3-2. Using these SMA data combined with archival data we will answer the following questions: 1) Do the temperature and density of molecular gas correlate with the CO morphology? 2) Do the morphologies and dynamics of the warm gas match those of the cool gas? 3) How does the CO-to-H$_2$ conversion factor vary with galaxy type?

- Petitpas, G., D. Iono, A. Peck, C. Wilson, S. Matsushita, K. Sakamoto, J. Wang, P. Ho, Q. Zhang, A. Rots, Z. Wang, M. Yun, and J. Surace [2007], "SMA CO J = 3 - 2 Observations of the Antennae (NGC 4038/39)," Proceedings in "From Z-Machines to ALMA:(Sub)Millimeter Spectroscopy of Galaxies", eds. Andrew J. Baker, Jason Glenn, Andrew I. Harris, Jeffrey G. Mangum and Min S. Yun, ASP Conf. Ser. vol.375, p.267.

➢ The Submillimeter Array (SMA) is currently the only interferometer capable of studying molecular gas warmer than ~30K in nearby and high-redshift sources. We present high angular resolution ^{12}CO J = 3 - 2 observations of the Antennae merging galaxy system made with the SMA. We find that the peaks in the warm molecular gas emission do not necessarily correspond to the peaks seen in the cooler CO J = 1 - 0 gas. This suggests the existence of temperature and/or density gradients in the molecular gas in this interacting system. To study this effect in more detail, we have created a data cube comprising the CO J = 3 - 2/J = 1 - 0 line ratio for every

20 km s^{-1} channel in this galaxy. With this cube, we can trace the temperature gradients across the spatial and dynamical range of this system. We find excellent spatial agreement between elevated CO J = 3 - 2/J = 1 - 0 ratio and bright spots in the Spitzer 8 μm map, suggesting that the star formation that is heating the dust is also actively heating the molecular gas. With this correlation, it is possible to trace the dynamics of the warm and cold dust in this system using the CO line ratio, whereas it is not possible to do this with dust measurements alone. The techniques used in this study of a nearby interacting system have strong implications for and analogies to future studies of higher-redshift galaxies that will be studied when ALMA comes online.

- Petrov, L., T. Hirota, M. Honma, K. M. Shibata, T. Jike, and H. Kobayashi [2007], "VERA 22 GHz Fringe Search Survey," Astron. J., vol.133, pp.2487-2494.

➢ This paper presents results of a survey search for bright compact radio sources at 22 GHz with the VERA radio interferometer. Each source from a list of 2494 objects was observed in one scan for 2 minutes. The purpose of this survey was to find compact extragalactic sources bright enough at 22 GHz to be useful as phase calibrators. Observed sources were either (1) within 6° of the Galactic plane, or (2) within 11° of the Galactic center, or (3) within 2° of known water masers. Among the observed sources, 549 were detected, including 180 extragalactic objects that were not previously observed with the very long baseline interferometry technique. Estimates of the correlated flux densities of the detected sources are presented. It was found that the probability of detecting a 200 mJy source with 120 s of integration time is 60%.

- Qi, C., P. T. P. Ho, D. J. Wilner, S. Takakuwa, N. Hirano, N. Ohashi, T. L. Burke, Q. Zhang, G. A. Blake, M. Hogerheijde, M. Saito, M. Choi, and J. Yang [2004], "Imaging the Disk Around TW Hydrae with the Submillimeter Array, A" strophys. J. (Letters), vol.616, pp.L11-L14.

➢ We present ~2"-4" aperture synthesis observations of the circumstellar disk surrounding the nearby young star TW Hya in the CO J=2-1 and J=3-2 lines and associated dust continuum obtained with the partially completed Submillimeter Array. The extent and peak flux of the 230 and 345 GHz dust emission follow closely the predictions of the irradiated accretion disk model of Calvet et al. The resolved molecular line emission extends to a radius of at least 200 AU, the full extent of the disk visible in scattered light, and shows a clear pattern of Keplerian rotation. Comparison of the images with two-dimensional Monte Carlo models constrains the disk inclination angle to 7°±1°. The CO emission is optically thick in both lines, and the kinetic temperature in the line formation region is ~20 K. Substantial CO depletion, by an order of magnitude or more from canonical dark cloud values, is required to explain the characteristics of the line emission.

- Reznikova, V. E., V. M. Nakariakov, V. F. Melnikov, and K. Shibasaki [2005], "Diagnostics of Mhd-Oscillation Modes of a Flaring Loop Using Microwave Observations with High Spatial Resolution," Proc. of the 11th European Solar Physics meeting "The dynamic sun: challenges for theory and observations", eds. D. Danesy, S. Poedts, A. De Groof, and J. Andries, ESA SP-600, 140.1. (CD-ROM)

➢ A detailed study of an oscillating loop observed with high spatial resolution (NoRH) shows the presence of two Fourier spectral peaks: P_1 = 16 s, which is more pronounced at the loop apex and P_2 = 9s, that is stronger at the loop legs. The further analysis reveals the phase shift, $P_2/4$, between the pulsations at the northern leg and at the loop top for the P_2 spectral component and a lack of the phase shift between different parts of the flare loop for the P1 component. The computed phase speeds and periods of MHD modes of a coronal loop confirm the previous identification of the first periodicity P_1 as the global (aka fundamental) sausage mode. The observed distribution of the oscillation phase along the loop suggests that the mode responsible for the P_2 component is likely to have a complicated radial structure, with the radial mode number l > 1.

- Reznikova, V. E., V. F. Melnikov, V. M. Nakariakov, and K. Shibasaki [2006], "MHD-Oscillation Modes of a Flaring Loop Using Microwave Observations with High Spatial Resolution," Recent Advances in Astronomy and Astrophysics: 7th International Conference of the Hellenic Astronomical Society, AIP Conf. Proc., vol.848, pp.133-142.

➢ Study of an oscillating loop observed with high spatial resolution (NoRH) shows the presence of two Fourier spectral peaks: P1 = 14-17 s, which is more pronounced at the loop apex and P2 = 8-11 s, that is stronger at the loop legs. We found the phase shift, P2/4, between the pulsations at

the northern leg and at the loop top for the P2 spectral component and a lack of the phase shift between different parts of the flare loop for the P1 component. The computed phase speeds and periods of MHD modes of a coronal loop confirm identification of the first periodicity P1 as the global (fundamental) sausage mode. The second periodicity can be associated with several modes: the second and the third longitudinal harmonics of the kink mode, the third harmonics of the sausage mode and the second harmonics of ballooning mode.

- Rocha-Pinto, H. J., S. R. Majewski, M. F. Skrutskie, R. J. Patterson, H. Nakanishi, R. P. Munoz, and Y. Sofue [2006] "The Dog on the Ship: The Canis Major Dwarf Galaxy as an Outlying Part of the Argo Star System," Astrophys. J. (Letters), vol.640, pp.L147-L150.

➢ Overdensities in the distribution of low-latitude, 2MASS giant stars are revealed by systematically peeling away from sky maps the bulk of the giant stars conforming to "isotropic" density laws generally accounting for known Milky Way components. This procedure, combined with a higher resolution treatment of the sky density of both giants and dust, allows us to probe to lower Galactic latitudes than previous 2MASS giant star studies. While the results show the swath of excess giants previously associated with the Monoceros ring system in the second and third Galactic quadrants at distances of 6-20 kpc, we also find a several times larger overdensity of giants in the same distance range concentrated in the direction of the ancient constellation Argo. Isodensity contours of the large structure suggest that it is highly elongated and inclined by about 3° to the disk, although details of the structure-including the actual location of highest, overall extent, true shape-and its origin remain unknown because only a fraction of it lies outside highly dust-obscured, low-latitude regions. Nevertheless, our results suggest that the 2MASS M giant overdensity previously claimed to represent the core of a dwarf galaxy in Canis Major ($l\sim240°$) is an artifact of a dust extinction window opening to the overall density rise to the more significant Argo structure centered at larger longitude ($l\sim290° \pm 10°$, $b \sim -4° \pm 2°$).

- Rodriguez, L. F., R.-D. Nan, P. J. Diamond, G. Dubner, M. Garrett, A. Green, M. Ishiguro, W. M. Goss, R. Taylor, L. Padrielli, A. P. Rao, J. M. Torrelles, and   J. L. Turner [2007], "Division X: Radio Astronomy," IAU Transactions, Vol. 26A, Reports on Astronomy 2002-2005, ed. by O. Engvold, pp.313-318.

➢ There have been important advances in radio astronomy in the last three years. New discoveries both at the galactic and extragalactic scale have been reported over this period and we highlight here several of them. The outstanding results of the Wilkinson Microwave Anisotropy Probe satellite, allowing an accurate determination of the main cosmological constants, are certainly among the most important. At the international level, the consolidation of the Atacama Large Millimeter Array project, with participation of the USA, Europe, and Japan and an estimated cost of around one billion US dollars, takes the construction of radio telescopes to a new level of complexity and potential. We also include the activities of this recently created working group.

- Rosat, S., T. Sato, Y. Imanishi, J. Hinderer, Y. Tamura, H. McQueen, and M. Ohashi [2005a], "High-Resolution Analysis of the Gravest Seismic normal Modes After the 2004 Mw = 9 Sumatra Earthquake Using Superconducting," Geophys. Res. Letters, vol.32, p.L13304.

➢ The Mw > 9 Sumatra-Andaman earthquake on December 26, 2004 has strongly excited the low-frequency seismic modes and is a unique opportunity to improve the frequency and damping measurements of the gravest seismic modes. The precise estimation of the frequency splitting of the seismic modes below 1 mHz is needed to improve 1D-density models of the Earth. From this event, $_2S_1$ is observed for the first time without any stacking on both SG (Superconducting Gravimeter) and seismic records. We report here analyses of SG data obtained from 11 sites. The spectra of SG records clearly show the splitting of $_0S_2$ into 5 completely resolved singlets and the splitting of $_0S_3$ into 7 singlets at individual stations. The present results demonstrate that SGs provide high quality data for a precise analysis of the low-frequency seismic modes.

- Rosat, S., S. Watada, T. Sato, and Y. Tamura [2005b], "Information on the Earth's Deep Interior Conveyed by the 2004 Sumatra-Andaman Earthquake Using Superconducting Gravimeter Data," American geophysical Union, Fall Meeting, abstract #G33A-0025.

➢ The recent Sumatra-Andaman earthquake of magnitude Mw > 9 on 2004 December 26th has strongly excited the low-frequency seismic modes and, in particular, the degree one 2S1 mode is observed for the first time without any stacking. This mode corresponds to the first overtone of the sub-seismic mode 1S1, the so-called Slichter triplet (Slichter, Proc. Nat. Acad. Sci., 1961).

On the one hand, theoretical computations suggest that the Slichter modes could not have been excited with sufficient amplitude to be detected by superconducting gravimeters (SGs) on the Earth's surface. The maximum surface gravity effect of 1S1 after Sumatra event is 0.3 nGal, that is to say 0.3 10-12 g, where g is the mean absolute gravity value on the Earth's surface, corresponding to a free air displacement of 10-3 mm (1 nm). On the other hand, the core-sensitive mode 3S2 and the fundamental radial mode 0S0 were strongly excited, meaning that the earthquake radiated much energy toward the core. 0S0 is a radial fundamental spheroidal mode called "breathing mode" of the Earth and corresponds to changes in the Earth's circumference. The high stability of SG records has enabled us to follow the time decay of 0S0 amplitude till the second Sumatra event on March 28th 2005 and to estimate 0S0 quality factor at a value of 5513 +- 8 from the weighted mean of 12 SG record estimates. Amplitude measurements of 0S0 at most SG sites in the world reveal a latitude dependency that we try to explain by theory. The amplitude deviation of 0S0 reaches +- 2% while the calibration errors of SGs are usually less than 0.2%.

- Ryabov, B. I., V. P. Maksimov, S. V. Lesovoi, K. Shibasaki, A. Nindos, and A. Pevtsov [2005], "Coronal Magnetography of Solar Active Region 8365 with the SSRT and NoRH Radio Heliographs," Solar Phys., vol.226, pp.223-237.

➢ Microwave maps of solar active region NOAA 8365 are used to derive the coronal magnetograms of this region. The technique is based on the fact that the circular polarization of a radio source is modified when microwaves pass through the coronal magnetic field transverse to the line of sight. The observations were taken with the Siberian Solar Radio Telescope (SSRT) on October 21-23 and with the Nobeyama Radio Heliograph (NoRH) on October 22-24, 1998. The known theory of wave mode coupling in quasi-transverse (QT) region is employed to evaluate the coronal magnetograms in the range of 10-30 G at the wavelength 5.2 cm and 50-110 G at 1.76 cm, taking the product of electron density and the scale of coronal field divergence to be constant of 10^{18} cm^{-2}. The height of the QT-region is estimated from the force-free field extrapolations as 6.2×10^9 cm for the 20 G and 2.3×10^9 cm for 85 G levels. We find that on large spatial scale, the coronal magnetograms derived from the radio observations show similarity with the magnetic fields extrapolated from the photosphere.

- Saito, H., M. Saito, Y. Moriguchi, and Y. Fukui [2006], "High-Resolution Studies of the Dense Molecular Cores toward Massive Star-Forming Regions," Publ. Astron. Soc. Japan, vol.58, pp.343-359.

➢ We present the results of the imaging of dense molecular cores in three massive star-forming regions (IRAS 02461+6147, IRAS 03035+5819, and IRAS 06058+2138), which are associated with luminous infrared sources with $1-5 \times 10^4$ L . The $C^{18}O$ (J = 1-0) molecular emission from the dense cores and the thermal dust and/or free-free emission at 98GHz and 110GHz in the hot core candidates have been imaged with a resolution of ~ 4" using the Nobeyama Millimeter Array. We identified 28 $C^{18}O$ dense cores, whose mass, effective radius, and line-width range from 2.1 to 29M , from 0.013 to 0.108pc, and from 0.7 to 2.7km s^{-1}, respectively, and identified four thermal dust millimeter continuum sources (MCSs). We divided the $C^{18}O$ cores into two types, a turbulent core and a non-turbulent core. The non-turbulent cores are similar to the typical cores in the low-mass star-forming regions. The turbulent cores have a higher average H_2 density than those of the non-turbulent cores, and the external pressure of these cores is 100-1000 times higher than that of low-mass star-forming regions. Three of the turbulent cores are associated with massive protostar candidates and the intensity peak of MCS. Massive stars are formed from the turbulent cores which are gravitationally bound. In order to form such a turbulent core a molecular cloud has a large kinetic motion and a large mass.

- Saito, H., M. Saito, K. Sunada, and Y. Yonekura [2007a], "Dense Molecular Clumps Associated with Young Cluster in Massive Star-forming Regions," Astrophys. J., vol.659, pp.459-478.

➢ We present the results of $C^{18}O$ observations by the 45 m Nobeyama radio telescope toward dense clumps with young clusters in nine massive star-forming regions.

- Saito, H., M. Saito, and K. Sunada [2007b], "Detected Core Clusters in the Massive Star-Forming Region, S247 Cloud," Proceedings in "Protostars and Planets V", LPI contribution no. 1286, p.8315.

➢ Not Available

- Saitoh, T. R., J. Koda, T. Okamoto, K. Wada, and A. Habe [2006], "Tidal Disruption of Dark Matter Halos around Proto-Globular Clusters," Astrophys. J., vol.640, pp.22-30.
  - ➤ Tidal disruption of dark matter halos around proto-globular clusters in the halo of a small galaxy is studied in the context of the hierarchical clustering scenario by using semicosmological N-body/SPH simulations assuming the standard cold dark matter model (Ω_0=1). Our analysis on the formation and evolution of the galaxy and its substructures continues until z=2.0. In such a high-redshift universe, the Einstein-de Sitter universe is still a good approximation for the recently favored Lambda-dominated universe, and thus our results do not depend on the choice of cosmology. In order to resolve small gravitationally bound clumps around galaxies and consider radiative cooling below T=10^4 K, we adopt a fine mass resolution (m_{SPH}=1.12x10^3 M). Because of the cooling, each clump immediately forms a "core-halo" structure that consists of a baryonic core and a dark matter halo. The tidal force from the host galaxy mainly strips the dark matter halo from clumps, and as a result, these clumps get dominated by baryons. Once a clump is captured by the host halo, its mass drastically decreases with each pericenter passage. At z=2, more than half of the clumps become baryon-dominated systems (baryon mass/total mass>0.5). Our results support the tidal evolution scenario of the formation of globular clusters and baryon-dominated dwarf galaxies in the context of the cold dark matter universe.
- Sakai, N., T. Sakai, and S. Yamamoto [2006], "Detection of $HCOOCH_3$ toward a Low-Mass Protostar, NGC 1333 IRAS 4B," Publ. Astron. Soc. Japan, vol.58, pp.L15-L18.
  - ➤ The rotational spectral lines of methyformate ($HCOOCH_3$) have been detected toward a low-mass protostar, NGC 1333 IRAS 4B, with the Nobeyama 45m radio telescope. The column density is derived to be (7-37) x 10^{15} cm^{-2}, assuming a source size of 1" and the range of the excitation temperature to be from 50K to 200K. The column density is almost comparable to those found in other low-mass star-forming regions, NGC 1333 IRAS 4A and IRAS 16293-2422. The line width of $HCOOCH_3$ is (1.0-1.2) km s^{-1}, which is narrower than that of the high-excitation line of CH_3OH (8-4-9-3). Since NGC 1333 IRAS 4B is likely to be a very young protostar, $HCOOCH_3$ appears even in the early stage protostellar evolution. The spectral lines of $HCOOCH_3$ cloud be used as a novel tracer for detecting an onset of star formation.
- Sakai, N., T. Sakai, and S. Yamamoto [2007a], "Methyl Formate in the NGC 2264 IRS 1 Region," Astrophys. J., vol.660, pp.363-369.
  - ➤ Millimeter-wave spectral lines of $HCOOCH_3$ are observed toward a massive star-forming region, NGC 2264 IRS 1, with the Nobeyama 45 m radio telescope and Nobeyama Millimeter Array. The $HCOOCH_3$ emission is not detected toward the dense core around IRS 1, which is the brightest IR source. However, it is definitively detected toward MMS 3, which is thought to contain a high-mass equivalent of a Class 0 protostar. The column density and the fractional abundance of $HCOOCH_3$ in MMS 3 are found to be (4-30)x10^{15} cm^{-2} and (0.7-5.3)x10^{-8}, respectively, assuming that the range of the excitation temperature is from 50 to 250 K. The fractional abundance is lower by an order of magnitude than that in the compact ridge of Orion KL. On the other hand, the upper limit to the fractional abundance toward IRS 1 is significantly lower than the abundance toward MMS 3. Since MMS 3 is less evolved than IRS 1, this result would indicate that $HCOOCH_3$ preferentially exists in the younger stage of protostellar evolution, as in the case of low-mass star forming regions. The distribution of $HCOOCH_3$ is found to be slightly offset from the dust continuum peak of MMS 3 by 13". This situation is similar to that found in the compact ridge of Orion KL, which would provide us with an important clue in exploring its peculiar chemistry.
- Sakai, N., M. Ikeda, M. Morita, T. Sakai, S. Takano, Y. Osamura, and S. Yamamoto [2007b], "Production Pathways of CCS and CCCS Inferred from Their [13]C Isotopic Species," Astrophys. J., vol.663, pp.1174-1179.
  - ➤ The rotational spectral lines (J_N=3_2-2_1 and J_N=2_1-1_0) of [13]CCS and C[13]CS have been observed toward a cold dark cloud, TMC-1. The strongest hyperfine component lines of [13]CCS and C[13]CS (J_N=2_1-1_0, F=5/2-3/2) have successfully been detected. The [C[13]CS/[[13]CCS abundance ratio is determined to be 4.2±2.3 (3σ). The [CCS/[[13]CCS ratio is evaluated to be 230±130 (3σ), and hence, [13]CCS is found to be significantly diluted. Such a difference between the [13]CCS and C[13]CS abundances is also found in L1521E, which is a very young core with rich carbon-chain molecules. Therefore, the anomaly is not specific to TMC-1, but seems to be common for the

CCS-rich clouds. Furthermore, we have also observed the J=4-3 transition of ^{13}CCCS and CCC^{34}S in TMC-1 and L1521E and have found that the [CCC^{34}S/[^{13}CCCS ratio is larger than 8.4 (3σ). This lower limit is considerably larger than the interstellar [^{12}C[^{34}S/[^{13}C[^{32}S ratio of 3, indicating that ^{13}CCCS is diluted as in the case of ^{13}CCS. These results give us strong constraints on the main pathways to produce CCS and CCCS.

- Sakai, N., T. Sakai, Y. Osamura, and S. Yamamoto [2007c], "Detection of H$_6$H$^-$ toward the Low-Mass Protostar IRAS 04368+2557 in L1527," Astrophys. J., (Letters), vol.667, pp.L65-L68.

➢ We have detected the J=7-6, 8-7, and 15-14 lines of C$_6$H$^-$ toward a low-mass star-forming region of L1527. We have also detected the J=15/2-13/2 and 33/2-31/2 lines of the corresponding neutral species, C$_6$H, and the 8$_{1,8}$-7$_{1,7}$ line of C$_6$H$_2$ in L1527. This is the first detection of these three species in star forming regions. The column density of C$_6$H$^-$ is (5.8±1.8) x 10^{10} cm^{-2}, which is comparable to that in TMC-1, although the column density of C$_6$H in L1527 is about 1/5 of that in TMC-1. Hence, the N(C$_6$H$^-$)/N(C$_6$H) ratio is 0.0093±0.029, which is higher than that in TMC-1 by a factor of 4. This high anion-to-neutral ratio is discussed in terms of a simplified chemical model.

- Sakai, T., T. Oka, and S. Yamamoto [2005a], "Atomic Carbon in the W3 Giant Molecular Cloud," J. of the Korean Astron. Soc., vol.38, pp.257-260.

➢ We have mapped the W 3 giant molecular cloud in the C0 ^{3}P$_1$ ^{3}P$_0$ ([CI]) line with the Mount Fuji Submillimeter-wave Telescope. The [CI] emission is extended over the molecular cloud, having peaks at three star forming clouds; W 3(Main), W 3(OH), and AFGL 333. The [CI] emission is found to be strong in the AFGL 333 cloud. We have also observed the C^{18}O, CCS, N$_2$H$^+$, and H^{13}CO$^+$ lines by using the Nobeyama Radio Observatory 45 m telescope. In the AFGL 333 cloud, we find two massive cores, which are highly gravitationally bound and have no sign of active star formation. The high [C0]/[CO] and [CCS]/[N$_2$H$^+$] abundance ratios suggest that the AFGL 333 cloud is younger than the W 3(Main) and W 3(OH) clouds.

- Sakai, T., and S. Yamamoto [2005b], "Mount Fuji [CI] Line Survey," J. of the Korean Astron. Soc., vol.38, pp.253-256.

➢ We have constructed the Mount Fuji submillimeter-wave telescope at Nishiyasugawara (alt. 3725 m) near the summit of Mt. Fuji (alt. 3774 m). Thanks to the excellent condition of Mt. Fuji, we have successfully carried out the [CI] survey toward more than 40 square degrees of sky, including Orion MC, Taurus MC, Rosetta MC, DR 15, DR 21, NGC 1333, NGC 2264, W 3, W 44, W 51, L 134, ρ-Oph. Our [CI] survey have revealed that the [CI] 492 GHz emission widely extends to the molecular clouds. The spatial and velocity structures of the [CI] 492 GHz emission resemble those of ^{13}CO J=1- 0 in many molecular clouds, implying that [CI] 492 GHz and ^{13}CO J=1- 0 are emitted from the same gas. The column density of C^0 linearly correlates with that of CO up to high AV, suggesting that C^0 exist in the deep interior of molecular clouds. In several regions, we have found that the distributions of C^0 and CO are different from each other. The C^0-rich area is found in the Hieles' cloud 2. The C$^+$/CO/C^0 configuration is found in DR 15, ρ-Oph, M 17, Orion KL, and NGC 1333. These results indicate that an origin of C^0 is unrelated with the photodissociation process. We discuss the observed C^0 distributions in relation to the non-equilibrium chemistry.

- Sakai, T., T. Oka, and S. Yamamoto [2006], "Atomic Carbon in the AFGL 333 Cloud," Astrophys. J., vol.649, pp.268-279.

➢ We have mapped W3 giant molecular cloud in the C^0 ^{3}P$_1$ - ^{3}P$_0$ ([CI] 492 GHz) and ^{12}CO J=3-2 emission lines with the Mount Fuji Submillimeter-wave Telescope. The [CI] distribution is extended over the molecular cloud, having peaks at three star forming clouds, W3 Main, W3(OH), and AFGL 333. The [CI] emission is found to be strong in the AFGL 333 cloud, where the ^{12}CO J=3-2 emission is relatively weak. In order to characterize the physical and chemical states of the AFGL 333 cloud, we have also observed the CO J=1-0 isotopomer lines and the CCS and N$_2$H$^+$ lines with the Nobeyama Radio Observatory 45 m Telescope. The [C^0]/[CO] and [CCS]/[N$_2$H$^+$] abundance ratios are found to be higher in the AFGL 333 cloud than in the W3(OH) cloud, suggesting that the AFGL 333 cloud is younger than the W3(OH) cloud. In the AFGL 333 cloud we have found two massive cores without any sign of active star formation. They are highly gravitationally bound and are regarded as good candidates for a massive

prestellar core.

- Sakai, T., T. Oka, and S. Yamamoto [2007a], "Physical and Chemical Properties of the AFGL 333 Cloud," Proc. of the IAU Symp, 237, "Triggered Star Formation in a Turbulent Interstellar Medium", eds. B. G. Elmegreen & J. Palous, p. 471.

➢ We have found massive clumps without any sign of active star formation in the AFGL 333 cloud. We present a study of the physical and chemical properties of the AFGL 333 cloud.

- Sakai, T., T. Oka, and S. Yamamoto [2007b], "Physical and Chemical Properties of Massive Clumps in the AFGL 333 Cloud," Astrophys. J., vol.662, pp.1043-1054.

➢ We have mapped twi masssive clumps, clump A and B, of the AFGL 333 cloud in the N_2H^+ J=1-0, CCS $J_N=4_3-3_2$, HC_3N J=5-4, and MH_3 (J,K)=(1,1) lines with the Nobeyama Radio OBservatory 45 m telescope. Intense N_2H^+ emission comes from the two clumps, and its overall distribution is similar to that of $C^{18}O$ J=1-0. On the other hand, the CCS and HC_3N emissions are more intense toward clumpB than toward clump A. Thus, the column density ratios of $[CCS]/[N_2H^+]$ and $[HC_3N]/N_2H^+]$ tens to be higher toward clump B than toward clump A, indicating that clump B is younger than clump A. This is supported by a fact that the 2MASS sources with H-K>2 and the Spitzer 24 mum sources are mostly associated with clump A, whereas only a few such sources exist in clump B. Clump B involves a few dense cores that are dark in the mid-infrared maps. Such cores are though to be good candidates of starless cores for high- or intermediate-mass stars.

- Sakamoto, S. [2005], "Development of Paper Models of Telescopes for Education and Public Outreach," Proc. of the 9th Asian-Pacific Regional IAU Meeting, pp.350-351.

➢ A series of paper models of telescopes for education and public outreach was developed. So far, models of nine telescopes (ALMA, VERA, NRO 45m, IGP 32m antenna, Nobeyama Radioheliograph, VST-1, Subaru, OAO 188 cm, and OAO 91 cm) have been completed. The models are accurate because they are designed based on the drawings or measurements of the original telescopes. Moreover, the models are steerable, and some of them have additional movable/exchangeable parts. With these models, learners may understand basic structures of telescopes as well as some of the key technologies to the cutting-edge telescopes. PDF files of these models are available at http://www.nro.nao.ac.jp/~lmsa/outreach/papermodel.html.

- Sako, S., T. Ymashita, H. Kataza, T. Miyata, Y. K. Okamoto, M. Honda, T. Fujiyoshi, H. Terada, T. Kamazaki, Z. Jiang, T. Hanawa, and T. Onaka [2007], "Giant Silhouette Young Stellar Object M17-SO1," Proceedings in "Protostars and Planets V", LPI contribution no. 1286, p.8405.

➢ Not Available

- Sakurai, T., K. Dobashi, M. Kaiden, S. Nishiura, S. Takano, K. Kawara, S. Oyabu, T. Kozasa, and K. Fukuhara [2007], "Molecular Cloud Core MCLD 123.5+24.9 in Polaris Cirrus," Proceedings in "Protostars and Planets V", LPI contribution no. 1286, p.8138.

➢ Not Available

- Sato, M., T. Hiraota, M. Honma, H. Kobayashi, T. Sasao, T. Bushimata, Y. K. Choi, H. Imai, K. Iwadate, T. Jike, S. Kameno, O. Kameya, R. Komohara, Y. Kan-ya, N. Kawaguchi, M. Kijima, M. K. Kim, S. Kuji, T. Kurayama, S. Manabe, K. Maruyama, M. Matsui, N. Matsumoto, T. Miyaji, T. Nagayama, A. Nakagawa, K. Nakamura, C. S. Oh, T. Omodaka, T. Oyama, S. Sakai, K. Sato, K. M. Shibata, M. Shintani, Y. Tamura, M. Tsushima, and K. Yamashita [2007], "Absolute Proper Motions of H_2O Masers Away from the Galactic Plane Measured with VERA in the "Superbubble" Region NGC 281," Publ. Astron. Soc. Japan, vol.59, pp.743-751.

➢ We report on absolute proper-motion measurements of an H_2O maser source in the NGC281 West molecular cloud, which is located ~320 pc above the Galactic plane and is associated with an H I loop extending from the Galactic plane. We conducted multi-epoch phase-referencing observations of the maser source with VERA (VLBI Exploration of Radio Astrometry) over a monitoring period of 6 months, since 2006 May. We find that the H2O maser features in NGC281 West are systematically moving toward the southwest and further away from the Galactic plane with a vertical velocity of 20-30 km s^{-1} at its estimated distance of 2.2-3.5 kpc. Our new results provide the most direct evidence that the gas in the NGC 281 region on the H I loop was blown out from the Galactic plane, most likely in a superbubble driven by multiple or sequential supernova explosions in the Galactic plane.

- Sato, N., A. Yamauchi, Y. Ishihara, K. Sorai, N. Kuno, N. Nakai, R. Balasubramanyam, and P.

Hall [2005], "Water-Vapor Maser Survey for Active Galactic Nuclei: A Megamaser in NGC 6926," Publ. Astron. Soc. Japan, vol.57, pp.587-594.

➢ We made a survey of water-vapor maser emission for 93 AGNs with the Nobeyama 45-m and Mopra 22-m telescopes from 1999 to 2002. A megamaser was detected in a Seyfert 2 galaxy, NGC 6926, at a distance of 80Mpc, in 2002 June. [Greenhill et al. (2003a) have also reported a detection of the megamaser at the close date.] The peak flux density was 110mJy, and the total isotropic luminosity was 340 L . The maser shows triply peaked spectrum, suggesting an edge-on disk. A narrow-line feature of the maser components at $V_{LSR} = 6001$ km s^{-1} was strongly variable with a time scale of a few tens of days, and the variation should be of intrinsic origin. We also showed a possibility of variability of water-vapor maser emission of a megamaser previously detected in a Seyfert/ultraluminous FIR galaxy, NGC 6240.

● Sato, T., J. Okuno, J. Hinderer, D. S. MacMillan, H.-P. Plag, O. Francis, R. Falk, R., and Y. Fukuda [2006], "A Geophysical Interpretation of the Secular Displacement and Gravity Rates Observed at Ny-Ålesund, Svalbard in the Arctic - Effects of post-Glacial Rebound Present-Day Ice Melting," Geophys. J. Intl., vol.165, pp.729-743.

➢ We have analysed the Ny-Ålesund very long baseline interferometry (VLBI) data over the period 1994 August to 200 May, and we obtain secular displacement rates relative to a NNR-NUVEL-1A reference frame of 0.2±0.5 mm yr^{-1}, -1.7±0.5 mm yr^{-1} and 4.8±1.1 mm yr^{-1} for the north, east and vertical directions, respectively. The corresponding global positioning system (GPS) station displacement rates relative to the same reference frame for the north, east, and vertical directions are 0.2±0.6 mm yr^{-1}, -2.3±0.6 mm yr^{-1}, and 6.4±1.5 mm yr^{-1} at NYA and -0.1±0.5 mm yr^{-1}, -1.6±0.5 mm yr^{-1}, and 6.9±0.9 mm yr^{-1} at NALL, where these GPS rates were derived from the ITRF2000 velocity solution of Heflin. From the comparison at 25 globally distributed collocated sites, we found that the difference in uplift rate between VLBI and GPS at Ny-Ålensund is mainly due to a GPS reference frame scale rate error corresponding to 1.6 mm yr^{-1} in the GPS vertical rates. The uplift rate was estimated at be 5.2±0.3 mm yr^{-1} from the analysis of the tide gauge data at Ny-Ålesund. Hence the uplift rates obtained from three different kinds of data are very consistent each other. The absolute gravity (AG) measurements at Ny-Ålensund, which were carried out four times (period: 1998-2002) by three different FG5 absolute gravimeters, lead to a decreasing secular rate of -2.5±0.9 muGal yr^{-1} (1 muGal=10^{-8} m s^{-2}). In this analysis, the actual data obtained from a superconducting gravimeter at Ny-Ålesund were used in the corrections for the gravity tide (including the ocean tide effect) and for the air pressure effect. We have estimated three geophysical contributions to examine the observed rates: (1) the effect of the sea-level (SL) change on a timescale of a few decades, (2) the effect of the present-day ice melting (PDIM) in Svalbard and (3) the sensitivity of the computed post-glacial rebound (PGR) effects to different choices of the models of past ice history and Earth's viscosity parameters. Our analysis indicates that the effect of SL change can be neglected as the main source of the discrepancy. On the other hand, the effect to PDIM cannot be ignored in explaining the mutual relation between the observed horizontal and vertical rates and the predicted ones. A large melting rate of the order of -75 cm yr^{11} (i.e. roughly 1.6 times larger than the mean rate derived from glaciology over Svalbard) would explain the observed uplift but only half of the gravity changes. Our comparison results clearly out the importance of both the estimation accuracy of the elastic deformations and better observation accuracy to constrain the size of PGR effects in the northwestern Svalbard more tightly.

● Sawada-Satoh, S., S. Kameno, K. M. Shibata, and M. Inoue [2005a], "Positional Coincidence Between Water Masers and a Plasma Torus in NGC 1052," J. Korean Astron. Soc., vol.38, pp.183-186.

➢ We presented results of the VLBA observation toward the radio continuum and water maser emissions in a nearby LINER galaxy NGC 1052. The jet structure observed in 2000 is similar to that in 1998, and the two jet structures in 1998 and 2000 support the sub-luminal motion with apparent velocity of 0.26c. Distribution of water maser spots are located ~0.05 pc shifted to southwest from the component which is supported to be the nucleus, and no rapid positional change of the water maser gas with respect to the central engine is seen from 1995 to 2000. The maser gas is positionally coincident with a plasma torus, and the position of the maser gas relative to the nucleus is stable from 1995 to 2000. The maser gas in NGC 1052 could be

explained to be associated with the nuclear circumnuclear torus or disk like the situation found in the nucleus of NGC 4258.

- Sawada-Satoh, S., S. Kameno, K. M. Shibata, and M. Inoue [2005b], "Positional Coincidence between Water Masers and a Plasma Torus in NGC 1052," Proc. of the "Future Directions in High Resolution Astronomy: A Celebration of the 10th Anniversary of the VLBA", eds. J. D. Romney, and M. J. Reid, ASP Conf. Ser. vol.340, pp.119-121.

➢ We present result of the VLBA observation toward a radio galaxy NGC 1052. In NGC 1052, double-sided jet structure and a dense plasma circumnuclear torus with a radius of 0.7 pc have been found around the central mass. From our observations, the jet structure in 2000 is similar to that in 1998, and the two jet structures in 1998 and 2000 support the sub-luminal motion with apparent velocity of 0.26c. The maser gas is positionally coincident with a plasma torus, and the position of the maser gas relative to the nucleus is stable from 1995 to 2000. The maser gas in NGC 1052 could be explained as a nuclear circumnuclear torus or disk like the situation found in the nucleus of NGC 4258.

- Sawada, T., K. Tatematsu, R. Kandori, K. Nakanishi, K.-I. Morita, and K. Sunada [2005], "Development of a Virtual Observatory Prototype in ALMA-Japan," Proc. of the "Astronomical data analysis software and system XIV", eds. P. Shopbell, M. Britton, and R. Ebert, ASP Conf. Ser. vol.347, pp.252-256.

➢ We report the present status of a prototype VO development in the Japanese side of the Atacama Large Millimeter/submillimeter Array. The prototype has been constructed based on our science requirements and science cases. Since we consider that pipeline data reduction and calibration from raw data will be crucial in future VOs, pipeline reduction for existing radio and near-infrared telescopes is implemented into the prototype. Interactive data reduction is also available.

- Sekido, M., R. Ichikawa, H. Takeuchi, Y. Koyama, E. Kawai, T. Kondo, M. Yoshikawa, N. Mochizuki, Y. Murata, T. Kato, T. Ichikawa, H. Hirabayashi, T. Ohnishi, F. Kikuchi, K. Takashima, K. Fujisawa, H. Takaba, K. Sorai, W. Cannon, S. Novikov, and M. Berube [2005], "VLBI Observation of Spacecraft for Navigation: Approaches with Group Delay and Phase Delay," Proc. at the XXVIIIth General Assembly of the URSI, October 2005, India. (CD-ROM : J06-P.7)

➢ Very long baseline interferometry (VLBI) has high sensitivity in coordinate measurement in the celestial sphere. Joint use of VLBI and range and range rate measurement can enhance the accuracy of the spacecraft navigation. Group delay and phase delay are observables of VLBI observation. The latter has an advantage of better delay resolution than the former, although its drawback is difficulty to get absolute delay due to phase ambiguity. We have observed spacecraft NOZOMI with Japanese and Canadian VLBI stations. As an approach to the phase ambiguity problem, we have successfully connected the phase delay over 24 hours, and celestial coordinates of NOZOMI was estimated by astrometry analysis. Group delay observable is good at absolute delay measurement even though delay resolution is limited by bandwidth of the signal from the spacecraft. For increasing the delay resolution, spectrum filtering and correlation with replica of the signal are tested in VLBI observation of spacecraft HAYABUSA.

- Shan, W., S. C. Shi, T. Matsunaga, M. Takizawa, A. Endo, T. Noguchi, and Y. Uzawa [2007], "Design and Development of SIS Mixers for ALMA Band 10," IEEE Trans. Applied Superconductivity, vol.17, pp.363-370.

➢ We present the design and preliminary experimental results of superconductor-insulator-superconductor (SIS) mixers for Atacama large millimeter array (ALMA) band 10 (780-950GHz) receivers. To achieve wide frequency coverage as well as low noise temperature, we integrated high current density (10 kA/cm^2) and small-sized (one micrometer in diameter) Nb/AlO$_x$/Nb SIS junctions with a tuning microstrip line using NbTiN ground plane and Al wiring layers. High quality NbTiN films with Tc reaching 14.5 K and Al films with residual resistivity ratio as large as 15 have been achieved. To minimize the waveguide transmission loss and facilitate the fabrication of mixer block, a full height waveguide was adopted. The waveguide probe was optimized to achieve low input impedance in the frequency range of 780-950 GHz while adopting a backshort cavity of zero depth. Preliminary RF testing with a Nb/Al microstrip tuning circuit demonstrated a DSB receiver noise

temperature about 400 K at 832.5 GHz, which promises the accommodation of receiver performance in ALMA specification with low loss NbTiN/Al microstrip lines.

- Shen, Z.-Q., L.-L. Shang, H.-B. Cai, X. Chen, D. R. Jiang, Y.-J. Chen, X. Liu, R. Yang, S. Kameno, and H. Hirabayashi [2005], "The Center of Activity in the Compact Steep-Spectrum Superluminal Source 3C 138," Astrophys. J., vol.622, pp.811-815.

➢ We present the results from the first quasi-simultaneous multifrequency (2.3, 5.0, 8.4, and 15 GHz) very long baseline interferometry (VLBI) observations of the compact steep-spectrum (CSS) superluminal source 3C 138. For the first time, the spectral distribution of the components within its central 10 milliarcsecond (mas) region was obtained. This enables us to identify the component at the western end as the location of the nuclear activity, assuming that the central engine is associated with one of the detected components. The possibility that none of these visible components is the true core is also discussed. The new measurements further clarify the superluminal motions of its inner jet components. The multifrequency data reveal a convex spectrum in one jet component, implying the existence of free-free absorption by the ambient dense plasma.

- Shibasaki, K. [2004], "A New Solar Flare Scenario: - High-Beta Plasma Disruption -," Proc. of the IAU Symp. 223, "Multi-Wavelength Investigations of Solar Activity", ed. A. V. Stepanov, E. E. Benevolenskaya, and A. G. Kosovivhev, pp.485-486.

➢ The solar corona is believed to be generally low beta. In a low-beta plasma, energy is mainly stored as magnetic energy or current. To dissipate the stored magnetic energy in the highly conductive corona, anomalous resistivity is needed. Activities of outer layers of X-ray loops in solar flares have been interpreted as the result of reconnection of magnetic field due to anomalous resistivity in a current sheet located above the flaring loop.

- Shibasaki, K. [2005], "Nobeyama Radioheliograph and its Recent Results," Proc. at the XXVIIIth General Assembly of the URSI, October 2005, India. (CD-ROM : J05.1)

➢ Nobeyama Radioheligraph (NoRH) is a dedicated radio interferometer for solar observation. It was constructed in FY 1990 and 1991 and started observations late June 1992. Routine observation continues more than cycle.

- Shibasaki, K. [2006a], "Microwave Measurements of Coronal Magnetic Field," International Astronomical Union XXVIth General Assembly, Pragua, 14-25 August, 2006, abstract book, p.283 (JD03-48 Invited Paper).

➢ Magnetic field measurements of the solar corona using microwave observation are reviewed. The solar corona is filled with highly ionised plasma and magnetic field. Moving charged particles interact with magnetic field due to Lorentz force. This results in gyration motion perpendicular to the magnetic field and free motion along the magnetic field. Circularly polarized electro-magnetic waves interact with gyrating electrons efficiently and the interaction depends on the sense of circular polarization (right-handed or left-handed). This is the reason why we can measure magnetic field strength through microwave observations. This process does not require complicated quantum physics but the classical treatment is enough. Hence the inversion of measured values to magnetic field strength is simpler than in the case of optical and infrared measurements. There are several methods to measure magnetic field strength through microwave observations. We can divide them into two categories: one is based on emission mechanisms and the other is based on wave propagation. In this case of emission mechanisms, thermal f-f emission, thermal gyro-resonance emission and non-thermal gyro-synchrotron emission can be used to measure magnetic field strength. In the case of wave propagation, polarization reversal due to propagation through quasi-transverse magnetic field region can be used. Examples of distribution of magnetic field strength in the solar corona measured by Nobeyama Radioheliograph will be presented.

- Shibasaki, K. [2006b], "Solar Physics with the Nobeyama Radioheliograph - Nobeyama Symposium 2004-," Proc. of Nobeyama Symposium 2004, "Solar Physics with the Nobeyama Radioheliograph", pp.1-2.

➢ The Nobeyama Radioheliograph (NoRH) has been in operation since 1992 and well covered one solar cycle. Many user groups of NoRH have been formed in the world and we have organized three symposiums related to NoRH in the past. 1. "Symposium on Nobeyama Radioheliograph" November 26-28, 1990 at Nobeyama 2. "New Look at the Sun with Emphasis on Advanced

Observations of Coronal Dynamics and Flares" September 6-10, 1993 at Kofu (jointly with Yohkoh) 3. "Solar Physics with Radio Observations" October 27-30, 1998 at Kiyosato We are glad to know that more and more data from NoRH are used and scientific outputs are still increasing. In this symposium, we would like to summarize recent development of solar physics using NoRH and discuss future direction of NoRH.

- Shimajiri, Y., S. Takahashi, M. Saito, R. Kawabe, and S. Takakuwa [2007], "Interaction between Molecular Outflows and Dense Gas in the Cluster Forming Region OMC-2/FIR4," Proc. of the IAU Symp, 237, "Triggered Star Formation in a Turbulent Interstellar Medium", eds. B. G. Elmegreen & J. Palous, p.475.

➢ Since most stars are born as members of clusters (Lada & Lada 2003), it is important to clarified the detailed mechanism of cluster formation for comprehensive understanding of star formation. However, our current understanding of cluster formation is limited due to the followings;
(a) Cluster forming regions are located at the far distance.
(b) There are complex mixtures of outflows and dense gas in cluster forming regions. So, we focused on the Orion Molecular Cloud 2 region (OMC-2), a famous cluster-forming region (Lada & Lada 2003) and the most nearest GMC. We observed the FIR 4 region with the Nobeyama Millimeter Array (NMA), Atacama Submillimeter Telescope Experiment (ASTE). In this region, there are 3 protostars (FIR3, FIR4, FIR5) which were identified as 1.3 mm dust continuum sources (Chini et al. 1997) and driving sources of mixed outflows, and FIR 4 is the most strongest source of 1.3 mm dust continuum in OMC-2. Molecular lines we adopted are a high density $(10^5 cm^{-3})$ gas tracer of $H^{13}CO^+$ (J=1-0), a molecular outflow tracer of ^{12}CO(J=1-0) and ^{12}CO(J=3-2), and SiO(J=2-1 v=0) as a tracer of shocks associated with an interaction between outflows and dense gas. From results of the ^{12}CO(J=1-0) outflow, $H^{13}CO^+$ dense gas, and the SiO shock, the outflow from FIR 3 interacts with dense gas in the FIR 4 region. Moreover the Position-Velocity diagram along the major axis of the ^{12}CO(J=3-2) outflow shows that the ^{12}CO(J=1-0) and SiO emission exhibits a L shape (the line widths increase in the interacting region in morphology). This is an evidence of interaction between the outflows and dense gas (Takakuwa et al. 2003). From result of the 3 mm dust continuum, the interacted region by the molecular outflow of FIR 3 is an assemble of seven dense cores. The mass of each core is 0.1-0.8 M . This clumpy structure is evident only at FIR 4 in the entire OMC-2/3 region. There are possible that two cores are in the proto-stellar phase, because 3 mm dust continuum source correspond to NIR source or 3.6 cm f-f jet source. From these results, cores in the FIR 4 region may be potential source of the next-generation stars. In the other words, there is a possibility that the molecular outflow ejected from FIR 3 is triggering the cluster formation in the FIR 4 region.

- Shimoikura, T., H. Kobayashi, T. Omodaka, P. J. Diamond, L. L. Matveyenko, and K. Fujisawa [2005], "VLBA Observations of a Bursting Water Maser in Orion KL," Astrophys. J., vol.634, pp.459-467.

➢ We have performed multiepoch single-telescope and Very Long Baseline Interferometry (VLBI) observations of an anomalously strong outburst of a water vapor maser in the Orion KL region that occurred in 1998. This burst, dubbed a superburst, exhibited a flux density increase that started in 1997 December and reached a maximum of 4.6×10^6 Jy in 1998 September; it then decreased to 0.2×10^6 Jy in 1999 February. The spatial and the velocity structure revealed by our observations showed that the bursting feature consisted of at least two components having two different peak velocities. Moreover, these two components exhibited a relative motion over 287 days with the relative position of the two components changing across the period of the outburst maximum. This suggests that an overlapping of two maser clouds caused the superburst. The brightness temperature reached 10^{16} K, while the line width was as narrow as 0.48 km s^{-1} at maximum phase. This extremely high brightness and narrow line width can be understood as the radiation from the maser being highly beamed.

- Shimojo, M. [2004], "Derivation of DEM distribution Using YOHKOH/SXT," Proc. of the 5th Solar-B Science Meeting, "The Solar-B Mission and the Forefront of Solar Physics : Dedicated to the Memory of Yutaka Uchida", ASP Conf. Ser., vol.325, pp.313-318.

➢ We present preliminary results of the DEM analysis for an active region seen in X-ray images. We apply the Withbroe-Sylwester method to estimate DEM distributions from X-ray images observed with Yohkoh/SXT, and obtain the DEM distribution in the temperature range of 2 MK

to 10 MK. The DEM distribution of quiet loops in the center of the active region shows a power-law distribution with an index of 4-5.

- Shimojo, M. [2005], "The Joint Observations of Prominence Eruptions using Solar-B, STEREO and NoRH," 35th COSPAR Scientific Assembly, p.1927.

➢ Prominence/Filament eruption is one of the most spectacular solar phenomena and causes large disturbances in interplanetary space. Hence, the trigger mechanism of the eruption will be still a very important problem for space weather in Solar-B and STEREO era. We analyzed the simultaneous observation of some prominence eruptions using Nobeyama Radioheliograph (NoRH) and SOHO/EIT for understanding of the problem. As a result, we find that a part of the prominence become bright in EUV and the material of the prominence fall down to solar surface when the prominence is decelerated. The result suggests that the prominence is heated by magnetic reconnection between magnetic field of the prominence and corona. So, the simultaneous observation is very useful for the understanding of the prominence evolution. After Solar-B and STEREO are launched, we will be able to know the 3-D configuration of prominence. In the paper, we discuss the simultaneous observation of Solar-B, STEREO and NoRH based on our results and proposed the observation plan for prominence eruption.

- Shimojo, M., T. Yokoyama, A. Asai, H. Nakajima, and K. Shibasaki [2006], "One Solar-Cycle Observations of Prominence Activities Using the Nobeyama Radioheliograph 1992-2004," Publ. Astron. Soc. Japan, vol.58, pp.85-92.

➢ We newly developed a method of limb-event detection for the Nobeyama Radiograph, and show the results over one solar-cycle, 1992 July-2004 December. We detected 785 prominence activities and 31 flares on the limb by this method. We investigated the relationship between the distributions of the prominence activities and the solar cycle. As a result, we found the following facts: 1) The variation in the number of prominence activities is similar to that of sunspots during one solar cycle. 2) There are differences between the peak times of prominence activities and sunspots. 3) The frequency distribution as a function of the magnitude of the prominence activities (the size of activated prominences) at each phase shows a power-law distribution. The power-law index of the distribution does not change, except around the solar minimum. 4) The number of prominence activities has a dependence on the latitude. On the other hand, the average magnitude is independent of the latitude. 5) During the rise phase of the solar cycle, the location of the high-latitude prominence activities migrates to the pole region. 6) After a solar polarity reversal, the location of the prominence activities in the northern hemisphere migrates to the equator. On the other hand, the prominence activities in the southern hemisphere occurred in the high-latitude region until the decay phase of Cycle 23.

- Shimojo, M., and the Solar-B Mission Operation and Data A [2007a], "Archiving, Distribution and Analysis of Solar-B Data," Proc. of the "New Solar Physics with Solar-B Mission", eds. Shibata, Kazunari, Nagata, Shin'ichi, and Sakurai, T., ASP Conf. Ser., vol.369, pp.31-34.

➢ The Solar-B Mission Operation and Data Analysis (MODA) working group has been discussing the data analysis system for Solar-B data since 2001. In the paper, based on the Solar-B MODA document and the recent work in Japan, we introduce the dataflow from Solar-B to scientists, the data format and data-level of Solar-B data, and the data searching/providing system.

- Shimojo, M., S. Tsuneta, and Solar-B project/NAOJ [2007b], "The Solar-B Science Center in Japan," Proc. of the "New Solar Physics with Solar-B Mission", eds. Shibata, Kazunari, Nagata, Shin'ichi, and Sakurai, T., ASP Conf. Ser., vol.369, pp.59-62.

➢ We are proposing to establish the Solar-B Science Center (SBSC) at NAOJ. The concept of the proposal is that SBSC be a platform for joint research to maximize scientific return from Solar-B. The concept was accepted both by NAOJ and JAXA. The computer system of SBSC includes the PC-cluster for the inversion of the vector magnetogram and the local helioseismology. The mass-storage system at NAO is mainly for the higher-level data, while JAXA/ISAS maintains lower-level data. We plan to provide methodology to make DVD Movie disc etc for simultaneous browse of SOT, XRT and EIS data. We are discussing with JAXA/ISAS for the easy-to-use data search system based on the existing ISAS DARTS data archive system. We recognize that these plans are ambitious. SBSC invites both domestic and international visitors, and provide scientifically comfortable environment for joint data analysis.

- Shiratori, Y., H. Yokoo, T. Saso, O. Kameya, K. Iwadate, and K. Asari [2006], "Ten Years of

Quests for Radio Bursts from Extrasolar Plenets," Proc. of the "Status of and prospects for hot Jupiter studies", eds. L. Arnold, F., Bouchy, and C. Moutou, pp.290-292.

➢ We searched for radio bursts towards 51 Peg, τBoo, νAnd and 55 Cancri, which were found to have "hot Jupiter" companions. The star 51 Peg has a planet with 0.5 M_{Jup} (lower limit) and 4.23 day period. The star τBoo has a planet of 3.7 M_{Jup} and 3.31 day period. Such planets are called "Hot Jupiter". We made a non-thermal radio emission model of magneto-electric environment between the stars and their planets. Since a detection of signals is expected, we made observations at 8.6 GHz with Mizusawa 10-m telescope. From 1996 to 2000, we observed with a detection limit of 10 Jy using a position-swiching method. Since 2001, we changed to beam-swiching method, and achieved a detection limit of 1 Jy. No radio burst signals were detected.

● Shirley, Y. L., A. Wootten, D. Johnstone, K. Tatematsu, and C. Brogan [2004], "Probing the Physical Conditions of High-Mass Star-forming Cores with Dust Continuum and Molecular Ions," American Astronomical Society Meeting 205, #98.01.

➢ Our understanding of the earliest stages of high-mass star formation is still inchoate. Theoretically, we are limited by a lack of systematic information on the large-scale properties of the regions. While many detailed studies of individual regions have been made, the field has lacked statistical information based on larger samples analyzed with uniform methods. We present a mapping survey of submillimeter dust continuum (850 and 450 micron), N_2H^+ (J = 1-0 and 3-2), HCO^+ (J = 3-2), and HCS^+ (J = 6-5) observed with the JCMT 15-m, the NRO 45-m, and the CSO 10.4-m telescopes. Sources are selected from the Plume sample of high-mass star-forming cores with dense gas emission (CS J = 7-6) and H_2O masers. In this poster, we highlight the most important results from the survey. Results are compared to previous surveys of 350 micron dust continuum, CS, and HCN emission. Dust continuum radiative transfer models are updated to include the newly observed submillimeter wavelengths, improving constraints on the density and temperature structure of the cores. N_2H^+ is observed to have smaller linewidths than optically thin dense gas tracers ($C^{34}S$) and maps of the emission display chemical differentiation toward a few very luminous sources; N_2H^+ is a probe of colder, more "quiescent" gas and is not a reliable dense gas tracer throughout the envelope of high-mass cores. HCO^+ line profiles indicate an excess of blue asymmetric, self-absorbed profiles that correlate well with previously observed HCN blue asymmetries; this may indicate large scale collapse in a few high-mass star-forming cores.

● Shirley, Y. L., M. K. Nordhaus, J. M. Grcevich, N. J. Evans II, J. M. Rawlings, and K. Tatematsu [2005], "Modeling the Physical Structure of the Low-Density Pre-Protostellar Core Lynds 1498," Astrophys. J., vol.632, pp.982-1000.

➢ Pre-protostar cores likely represent the incipient of low-mass (~1 M_{solar}) star formation. Lynds 1498 is a pre-protostellar core (PPC) and was one of the initial objects toward which molecular depletion and differentiation was detected. Despite the considerable scrutiny of L1498, there has not been an extensive study of the density and temperature structure as derived from radiative transfer modeling of dust continuum observations. We present deep SCUBA observations of L1498 at 850 and 450 μm, high-resolution BEARS maps of the N_2H^+ 1→0 transition, Caltech Submillimeter Observatory of the N_2H^+ 3→2 transition, and Green Bank Telescope observations of the C_3S 4→3 transition. We also present a comparison of derived properties between L1498 and nearby PPCs that have been observed at far-infrared and submillimeter wavelengths. The L1498 continuum emission is modeled using a one-dimensional radiative transfer code that self-consistently calculates the temperature distribution and calculates the spectral energy distribution and intensity profiles at 850 and 450 μm. We present a more realistic treatment of PPC heating that varies the strength of the interstellar radiation field (sisrf) and includes attenuation of the ISRF due to dust grains at the outer radius of the core AV. The best-fit model consists of a Bonner-Ebert sphere with a central density of (1-3) x 10^4 cm^{-3}, R_0~ 0,29 pc, 0.5<= s_{isrf}<= 1, A_V~1 mag, and a nearly isothermal temperature profile of ~10.5 K for OH8 opacities. C_3S emission shows a central depletion hole, while N_2H^+ emission is centrally. We derived a mean N_2H^+ abundance of 4.0 x 10^{-10} relative to H_2 that is consistent with chemical models for a dynamically young yet chemically evolved source. The observed depletions of C_3S and H_2CO, the models N_2H^+ abundance, and a central density that is an order of magnitude lower than other

modeled PPCs suggests that L1498 may be a forming PPC. Our derived temperature and density profile will improve modeling of molecular line observations that will explicate the core's kinematical and chemical state.

- Sofue, Y. [2007], "The Galactic Center Molecular Tornado Driven by Magnetic Squeezing Mechanism," Publ. Astron. Soc. Japan, vol.59, pp.189-198.

➢ Based on an analysis of the CO line-survey data, we report on peculiar properties of a helical-spur object of molecular gas at a radial velocity of $V_{lsr} \sim 70$ km s^{-1} extending vertically from the galactic plane at l = 1°.2 to high latitudes of b ~ ±0°.6. We call the object the Galactic Center molecular Tornado (GCT). The tornado is 170 pc (1°.2) long and 14 pc (6') wide, and is spinning at a rotation velocity of ~ 30 km s^{-1} in the same sense as, but with much steeper velocity gradient than, the galactic rotation. The coherent collimation and helical structure suggest that the tornado id related to an ordered vertical magnetic field. We propose a magnetic flux is twisted and squeezed by a molecular cloud in galactic rotation, and the gas is pushed out along the magnetic tube. The angular momentum of the cloud is lost along the twisting magnetic tube, which promotes gravitational collapse of the cloud and enhances star formation.

- Sridharan, T. K., H. Beuther, M. Saito, F. Wyrowski, and P. Schilke [2005], "High-Mass Starless Cores," Astrophys. J. (Letters), vol.634, pp.L57-L60.

➢ We report the identification of a sample of potential high-mass starless cores (HMSCs). The cores were discovered by comparing images of fields containing candidate high-mass protostellar objects (HMPOs) at 1.2 mm and mid-infrared (MIR; 8.3 mum) wavelengths. While the HMPOs are detected at both wavelengths, several cores emitting at 1.2 mm in the same fields show absorption or no emission at the MIR wavelength. We argue that the absorption is caused by cold dust. The estimated masses of a few times 10^2-10^3 M_{solar} and the lack of IR emission suggest that they may be massive cold cores in a prestellar phase, which could form massive stars. Ammonia observations indicate smaller velocity dispersions and lower rotation temperatures compared with HMPOs and ultracompact H II regions, suggesting a quiescent prestellar stage. We propose that these newly discovered cores are good candidates for the HMSC stage in high-mass star formation. This sample of cores will allow us to study the high-mass star and cluster formation processes at the earliest evolutionary stages.

- Stepanov, A. V., K. Shibasaki, Y. G. Kopylova, and Y. T. Tsap [2006], "MHD-Oscillations of Coronal Loops and Diagnostics of Flare Plasma," Proc. of Nobeyama Symposium 2004, "Solar Physics with the Nobeyama Radioheliograph", pp.23-32.

➢ Effects of ballooning and radial oscillations of coronal magnetic loops on the modulations of microwave and X-ray emission from flare loops are considered. The damping mechanisms of loop MHD modes are analyzed. The method for diagnostics of flare plasma parameters using peculiarities of the microwave and X-ray pulsations is proposed. The diagnostic method was applied for two solar flares: on May 8, 1998 and August 28, 1999 observed with the Nobeyama Radioheliograph.

- Stepanov, A. V., T. Yokoyama, K. Shibasaki, and V. E. Melnikov [2007], "Turbulent Propagation of High-Energy in a Solar Coronal Loop," Astron. Astrophys., vol.465, pp.613-619.

➢ Aims.We study the solar flare on 28 August 1999 observed by the Nobeyama Radioheliograph at 17 and 34 GHz and analyze the unusual behavior of microwave source (a coronal loop) after injections of high-energy electrons. The observations reveal a propagation velocity of the emission front along the loop of about 104 km s^{-1}, which is 30 times less than the velocity of high-energy electrons generating gyrosynchrotron emission at 17 and 34 GHz. The main goal is to understand the physical origin of this electron propagation. Methods: We interpret this anomalous propagation in terms of the collective effects of relativistic electrons interacting with plasma turbulence. A cloud of highly energetic electrons responsible for microwave emission generates low-frequency whistler waves, and a turbulent "wall" in the loop is formed. Results: The electrons undergo strong resonant scattering due to wave-particle interaction, and the emission front propagates with the wave phase velocity, which is much lower than the particle velocity.

- Sudou, H., S. Iguchi, Y. Murata, and Y. Taniguchi [2005], "Orbital Motion of the Radio Core in the Radio Galaxy 3C 66B," Proc. of the "Future Directions in High Resolution Astronomy: A Celebration of the 10th Anniversary of the VLBA", eds. J. D. Romney, and M. J. Reid, ASP

Conf. Ser. vol.340, pp.541-543.

➢ Supermassive black hole binaries may exist in the centers of active galactic nuclei like radio galaxies. We imaged the radio galaxy 3C 66B at radio frequencies using the Very Long Baseline Interferometer and found that the unresolved radio core of 3C 66B shows well-defined elliptical motions with a period of 1.05 ± 0.03 years. This result strongly suggests the orbital motion of a supermassive black hole binary.

● Sugimoto, M., Y. Sekimoto, K. Tatematsu, T. Kamba, H. Toba, S. Yokogawa, T. Okuda, K. Kohno, T. Noguchi, N. Yamaguchi, R. Kandori, and K. Muraoka [2004], "Cartridge-Type 800 GHz Receiver for the Atacama Submillimeter Telescope Experiment (ASTE)," Publ. Astron. Soc. Japan, vol.56, pp.1115-1126.

➢ We have developed a cartridge-type 800GHz receiver for the ASTE telescope in Atacama, Chile. The receiver has been assembled with a cooled receiver optics, a Nb-based SIS mixer, a local oscillator (LO) optics, and IF components in a 170mm diameter column-type cartridge. The cooled optics is composed of a single ellipsoidal mirror to couple between the feed horn and the subreflector of the antenna, and an LO coupler with 10% efficiency. Owing to its cartridge and cryostat structure, the mechanical vibrations of the GM cryocooler are significantly reduced, and therefore the receiver is highly stable on the telescope. The receiver noise temperature, using a Nb-based SIS mixer and a 4-8GHz HEMT amplifier, was attained to 1300K in DSB at an LO frequency of 815GHz. The system noise temperature, Tsys, was typically 4000-8000K in DSB at an LO frequency of 812GHz during operations, which depended on the atmospheric opacity. The typical zenith opacity at an LO frequency of 812GHz was ~1. The half-power beam width (HPBW) of the main beam was measured by total power scanning across the Moon, and was consistent with the diffraction limit. A spectrum of the CO J = 7-6 line (806.6518GHz) toward Orion KL was successfully detected.

● Sunada, K., S. Hongo, N. Ikeda, and Y. Kitamura [2006], "A Giant Molecular Outflow Triggered the Formation of the High Mass Dense Clumps in the NGC 7538 Region," International Astronomical Union XXVIth General Assembly, Pragua, 14-25 August, 2006, abstract book, p.148 (S237-217 Poster).

➢ To reveal the formation processes of dense clumps, we have carried out the observations of various molecular emissions in the molecular cloud NGC7538 region. We used the 45m telescope of the Nobeyama Radio Observatory and mapped the whole of this region by the spectral on-the fly-mapping mode using the SIS 25-BEam Array Receiver System (BEARS). In the western region of IRS11, we have found the dense gas has a shell-like structure with a central cavity. The distribution of the $H^{13}CO^+$ (J=1-0) emissions was concentrated on this shell-like structure. The velocity structure within the cavity, which was traced by the $C^{18}O$ (J=1-0) emissions, suggests an expanding motion. The line widths of the clumps on the shell-like structure tended to be broader than ones of the others. These require the energy source to drive these motions. In addition to these results, the detection of the H_2O maser at the position on this shell-like structure had been reported. It is very strange that star formation activities were not found around this position. Since the exciting of the H_2O maser requires some shocks, this fact also requires the energy source to excite. Although this structure is very large in size, this resembles a structure of a cavity created by a molecular outflow. One of the candidates of the driving sources id IRS11. The outflow powered by IRS11 had been previously known. Our map of the CO (J=1-0) emissions suggested the existence of the giant outflow. This is not conclusive evidence, because the whole structure remains unclear due to the contaminations of the background emissions. We assumed the outflow has the same properties as the outflow from the Orion IRc. In our estimation, the momentum and the energy of the expanding motion could be supplied from a giant molecular outflow. In addition to the broader line width, the masses of the clumps on the shell-like structure tended to be larger than ones of the others. Thus, we may conclude this outflow induced the formation of the dense clumps along the expanding shell.

● Tachihara, K., M. Rengel, Y. Nakajima, N. Yamaguchi, P. Andre, R. Neuhauser, T. Onishi, Y. Fukui, and A. Mizuno [2007a], "Gas and Dust Condensations and a Peculiar Class 0 Object in the Lupus 3 Star-Forming Cloud," Astrophys. J., vol.659, pp.1382-1393.

➢ The Lupus 3 molecular cloud has been surveyed for dense gas and dust cores and embedded objects in radio [$H^{13}CO^+$ J=1-0 line and 1.2 mm continuum] and infrared [$JHK_sL'MN1$ bands

and H_2 v=1-0 S(1) line] wavelengths. These observations unveil a filamentary cloud, three dense cores, an embedded millimeter-wave source (MMS), and an associated elongated object in the K band. The properties of the three dense cores are M=3.5-5.6 M_{solar}, R=0.04-0.06 pc, and $n(H_2)$=(1.0-3.9) 10^5 cm$_{-3}$, properties similar to those in Taurus. Two of these three objects are likely to be prestellar cores, while the other one exhibits ongoing star formation. The spectral energy distribution (SED) analysis of the MMS shows that it is a remarkably cold Class 0 object with molecular outflow detected in the CO(J=3-2) line and peculiar near-IR detections. From the estimated low bolometric temperature (39.5 K), faint bolometric luminosity (0.16 L_{solar}), and sufficiently large envelope mass (0.52 M_{solar}), the MMS is expected to be in a very early phase (~10^4 yr) of mass accretion. The K-band elongated feature appears to be scattered light originating from the embedded central object of the MMS seen through the outflow cavity opening toward HH 78 on the near side as shown by the blueshifted CO wings. The MMS has also been detected by the Spitzer Space Telescope, and its near-IR images exhibit butterfly-shaped nebulosity emission as scattered light through the bipolar cavities in contrast to that in the K band. Together with the Spitzer and NTT JHK photometric data, the observed SED has a short-wavelength cutoff suggesting a low effective temperature (<1400 K) of the central object.

- Tachihara, K., A. Hayashi, T. Onishi, A. Mizuno, and Y. Fukui [2007b], "Dense Core Evolutions Induced by Shock Triggering and Turbulent Dissipation," Proc. of the IAU Symp, 237, "Triggered Star Formation in a Turbulent Interstellar Medium", eds. B. G. Elmegreen & J. Palous, p.478.

➢ External shock triggering and internal turbulence play major role for the condensation of the ISM and star formation. Some evidences of shock triggering by non-isotropic compression are seen in the cloud morphologies and associated active cluster formation such as the   Oph and Cha I clouds. Surveys for $C^{18}O$ dense cores have shown that internal turbulence dominates the core dynamics and regulates star formation activity (Tachihara et al. 2002).

- Tafoya, D., Y. Gomez, G. Anglada, L. Loinard, J. M. Torrelles, L. F. Miranda, M. Osorio, R. Franco-Hernandez, L. A. Nyman, J. Nakashima, and S. Deguchi [2007a], "Detection of HCO$^+$ Emission toward the Planetary Nebula K3-35," Astron. J., vol.133, pp.364-369.

➢ We report the detection, for the first time, of HCO$^+$ (J=1→0) emission, as well as a marginal CO(J=1→0) emission, toward the planetary nebula (PN) K3-35 as a result of a molecular survey carried out toward this source. We also report new observations of the previously detected CO(J=2→1) and water maser emission, as well as upper limits for the emission of the SiO, $H^{13}CO^+$, HNC, HCN, HC_3OH, HC_5N, CS, HC_3N, ^{13}CO, CN, and NH_3 molecules. From the ratio of CO(J=2→1) to CO(J=1→0) emission we have estimated the kinetic temperature of the molecular gas, obtaining a value of ≃20K. Using this result we have estimated a molecular mass for the envelope of ≃0.017 M and an HCO$^+$ abundance relative to H_2 of 6 x 10^{-7}, similar to the abundances found in other PNe. K3-35 is remarkable because it is one of the two PNe reported to exhibit water maser emission, which is present in the central regions, as well as at a distance of ≃5000 AU from the center. The presence of molecular emission provides some clues that could help in understanding the persistence of water molecules in the envelope of K3-35. The HCO$^+$ emission could be arising in dense molecular clumps, which may provide the shielding mechanism that protects water molecules in this source.

- Tafoya, D., Y. Gomez, L. Loinard, G. Anglada, J. M. Torrelles, L. F. Miranda, R. Franco-Hernandez, L. A. Nyman, and J. Nakashima [2007b], "Detection of HCO$^+$ Emission toward the PN K3-35," Proc. of the IAUS. 234, "Planetary nebulae in our galaxy and beyond", eds. M. J. Barlow, and R. H. Mendez, pp.521-522.

➢ Here we are reporting the detection of HCO$^+$ (J=1→0) emission as well as emission of CO (J=1→0) toward the planetary nebula (PN) K 3-35 as a result of a molecular emission survey carried out toward this source. K 3-35 is remarkable because it is one of the two PNe that are known to exhibit water maser emission. In this nebula, the emission is present in the central region as well as at a distance of ≃5000 AU away from the center. The presence of molecular emission reveals some clues that could lead to the understanding of the persistence of water molecules in its envelope. We also report new spectra of the CO ((J=2→1) transition. From the

CO emission we have obtained a value for the excitation temperature of the molecular gas of $\simeq$ 20 K. Using this result, we have estimated a molecular mass for the envelope of 0.017 M , and that the abundance for the HCO^+ is 6.1 x 10^{-7}.

- Takahashi, S., M. Saito, S. Takakuwa, and R. Kawabe [2006], "Millimeter- and Submillimeter-Wave Observations of the OMC-2/3 Region. I. Dispersing and Rotating Core around the Intermediate-Mass Protostar MMS 7," Astrophys. J., vol.651, pp.933-944.

- We report the results of $H^{13}CO^+$ (1-0), CO(1-0), and 3.3 mm dust continuum observations toward MMS 7, on e of the strongest millimeter-wave sources in OMC-3, with the Nobeyama Millimeter Array (NMA) and the Nobeyama 45 m telescope. With the NMA, we detected centrally condensed 3.3 mm dust continuum emission, which coincides with the mid-infrared (MIR) source and the free-free jet. Our $H^{13}CO^+$ observations revealed a disklike envelope around MMS 7, whose size and mass are 0.15x0.11 pc and 5.1 M_{solar}, respectively. The outer portion of the disklike envelope has a fan-shaped structure, which delineates the rim of the observed CO outflow. The position-velocity diagrams in the $H^{13}CO^+$ (1-0) emission show that the velocity field in the disklike envelope is composed of a dispersing gas motion and a possible rigid-like rotation. The mass-dispersing rate is estimated to be $3.4x10^{-5}$ M_{solar} yr^{-1}, which implies the MMS 7 has an ability to disperse ~ 10 M_{solar} during the protostellar evolutional time. The specific angular momentum in the disklike envelope is nearby 2 orders of magnitude larger than that in low-mass cores. The turnover point to the power law of the angular momentum distribution in the disklike envelope (<=0.007 pc), which is likely to be related to the outer radius of the central mass accretion, is similar in size to the 3.3 mm dust condensation. We propose that MMS 7 is in the last stage of the main accretion phase and that a substantial portion of the outer gas has already been dispersed, while mass accretion may still be ongoing at the innermost region, traced by the dusty condensation.

- Takahashi, S., R. Kawabe, and M. Saito [2007a], "NMA High-Resolution Imaging of Molecular Lines and Dust Emissions Toward the Intermediate-Mass Protostars in OMC-3," Proceedings in "Protostars and Planets V", LPI contribution no. 1286, p.8357.

- Not Available

- Takahashi, S., Y. Shimajiri, M. Saito, S. Takakuwa, and R. Kawabe [2007b], "Survey Observations of Large-Scale Molecular Outflows Associated with Intermediate-Mass Protostar Candidates in the OMC-2/3 Region," Proc. of the IAU Symp, 237, "Triggered Star Formation in a Turbulent Interstellar Medium", eds. B. G. Elmegreen & J. Palous, p.479.

- We have newly performed millimeter- and submillimeter-wave observations in the nearest GMC: the Orion Molecular Cloud -2/3 region (OMC-2/3). Here, we report results of our large-scale (22'x14') outflow survey with the Atacama Submillimeter Telescope Experiment (ASTE) in the CO(3-2) emission. The OMC-2/3 region is one of the famous intermediate-mass star-forming regions and harbors several sources diagnosed as Class0 protostars (Chini et al. 1997). With the intensive ASTE observations, we totally identified the 8 clear, 5 probable and 6 marginal outflows in OMC-2/3. 8 clear outflows from them, MMS 2, MMS 5, MMS7, MMS9, FIR-2, FIR 3, VLA 13, and FIR 6b are associated with mm and SPITZER 24 μm sources. The others are more or less complicated, and two of which, VLA 13 and FIR 6, are newly identified. We found the interaction between the molecular outflows and the dust condensations at least in four regions. In addition, we confirmed the increment of the velocity width of the dense gas toward some of these condensations (i.e. at the termination of the outflow lobes). These results suggest that (i) the interaction between the outflows and the dense condensation occurs commonly in the OMC-2/3 region, (ii) the dense condensations in this region are compressed ubiquitously by these outflows and are receiving a part of the momentum from them. Particularly, one of the strongest millimeter sources, and hence protostar candidates, FIR4, is strongly compressed by a molecular outflow driven by FIR3 located at the north-east of FIR 4. These results suggest that the molecular outflows play an important role in the formation and evolution of stars and that the outflows are a driving mechanism of turbulence in the OMC-2/3 region.

- Takakuwa, S., T. Kamazaki, M. Saito, N. Yamaguchi, and K. Kohno [2007a], "ASTE Observations of Warm Gas in Low-Mass Protostellar Envelopes: Different Kinematics between Submillimeter and Millimeter Lines," Publ. Astron. Soc. Japan, vol.59, pp.1-13.

- With the ASTE telescope, we have made observations of three low-mass protostellar envelopes

around L483, B335, and L723 in the submillimeter CS (J=7-6) and HCN (J=4-3) lines. We detected both the CS and HCN lines toward all the targets, and the typical CS intensity (~ 1.0 K in T_B) is twice higher than that of the HCN line. Mapping observations of L483 in these lines have shown that the submillimeter emissions in the low-mass protostellar envelope are resolved, exhibit a western extension from the central protostar, and that the deconvolved size is ~ 5500 AU x 3700 AU (P.A. = 78° in the HCN emission. The extent of the submillimeter emissions in L483 implies the presence of higher-temperature (>/~ 40 K) gas at 4000 AU away from the central protostar, which suggests that we need to take 2-dimensional radiative transfer models with a flattened disklike envelope and bipolar cavity into account to explain the temperature structure inside the low-mass protostellar envelope. The position-velocity diagrams of these submillimeter lines in L483 and B335 exhibit different velocity gradients from those found in the previous millimeter observations. In particular, along the axis of the associated molecular outflow the sense of the velocity gradient traced by the submillimeter lines is opposite to that of the millimeter observations or the associated molecular outflow, both in L483 and B335. We suggest that expanding gas motions at the surface of the flattened disklike envelope around the protostar, which is irradiated from the central star directly, are the origin of the observed submillimeter velocity structure.

- Takakuwa, S., N. Ohashi, T. Bourke, N. Hirano, P. T. P. Ho, J. Jorgensen, Y.-J. Kuan, D. Wilner, and S. C. C. Yeh [2007b], "Arcsecond-Resolution Submillimeter HCN Imaging of the Binary Protostar IRAS 16293-2422," Astrophys. J., vol.662, pp.431-422.

➢ With Submillimeter Array (SMA) we have made high angular resolution (~1" = 160 AU) observations of the protobinary system IRAS 16293-2422 in the HCN (4-3), HC^{15}N (4-3), and 354.5 GHz continuum emission. The HCN (4-3) line was also observed using the JCMT to supply missing short-spacing information. The submillimeter continuum emission is detected from the individual binary components of source A in the southeast and source B in the northwest, with a separation of ~5". The optically thin HC^{15}N (4-3) emission taken with the SMA has revealed a compact (~500 AU) flattened structure (P.A.=-16°) at source A. This compact structure shows a velocity gradient along the projected minor axis, which can be interpreted as an infalling gas motion. Our HCN imaging including the short-spacing information shows an extended (~3000 AU) circumbinary envelope, as well as the compact structure at source A. A toy model consisting of a flattened structure with radial infall toward a 1 M_{solar} central star reproduces the HCN/HC^{15}N position-velocity diagram along the minor axis of the HC^{15}N emission. In the extended envelope there is also a northeast (blue) to southwest (red) velocity gradient across the binary alignment, which is likely to reflect gas motion in the swept-up dense gas associated with the molecular outflow from source A. Only a weak and narrow (~2 km s^{-1}) compact HC^{15}N emission is associated with source B, where no clear molecular outflow is identified, suggesting the different evolutionary starges between sources A and B. Our study demonstrates the importance of adding short-spacing data to interferometer data in order to probe the detailed structure and kinematics of low-mass protostellar envelopes.

- Takami, M., S. Takakuwa, M. Momose, M. Hayashi, C. J. Davis, T.-S. Pyo, T. Nishikawa, and K. Kohno [2006], "Kinematics of SiO J = 8-7 Emission towards the HH 212 Jet," Publ. Astron. Soc. Japan, vol.58, pp.563-568.

➢ We present SiO J = 8-7 (347.3GHz) observations towards HH 212 (Herbig-Haro object 212) using the ASTE (Atacama Submillimeter Telescope Experiment) telescope. Our observations with a 22"-diameter beam show that the SiO emission is highly concentrated within 1' of the driving source. We carefully compare the SiO observations with archival H$_2$ 1-0 S(1) images and published H$_2$ echelle spectra. We find that, although the SiO velocities closely match the radial velocities seen in H$_2$, the distributions of H$_2$ and SiO emission differ markedly. We attribute the latter to the different excitation conditions required for H$_2$ and SiO emission, particularly the higher critical density (n$_{H2}$~10^8 cm^{-3}) of the SiO J = 8-7 emission. The kinematic similarities imply that the H$_2$ and SiO are associated with the same internal working surfaces. We conclude that the SiO J = 8-7 emission has a potential for probing the jet/wind launching region through interferometric observations in the future, particularly for the youngest, most deeply embedded protostars where IR observations are not possible.

- Takano, S., P. Hofner, G. Winnewisser, N. Nakai, and K. Kawaguchi [2005a], "High Angular

Resolution Observations of the (J,K) = (1,1), (2,2), and (3,3) Transitions of Ammonia in NGC 253," Publ. Astron. Soc. Japan, vol.57, pp.549-561.

- ➢ The nearby starburst galaxy NGC 253 was mapped in the ammonia (J, K) = (1, 1), (2, 2), and (3, 3) lines in the 23GHz region with the Very Large Array. The angular resolutions were about 4" x3". The distributions of the three lines were different from one another. The (1, 1) and (3, 3) lines were distributed along the bar mainly at the northeastern and southwestern regions from the center, but the (2, 2) line is distributed mainly at two clumps in the southwestern region from the center. In addition, the (1, 1) line showed absorption at the central region. The obtained rotational temperatures were < 15-28 K (lower limit), depending on the clumps. The ammonia distributions are generally consistent with estimates from our single-dish results already published. The distributions of ammonia were compared with those of continuum and several other molecular lines.

- ● Takano, S., K. Nakanishi, N. Nakai, and T. Takano [2005b], "Extremely High-Velocity Gas in the Galaxy Arp 220, Revealed with Ammonia Absorption Lines," Publ. Astron. Soc. Japan, 57, L29-L32, 2005.

- ➢ We observed ammonia (J, K) = (1, 1), (2, 2), (3, 3), and (4, 4) transitions at a wavelength of 1.3cm toward a prototypical ultraluminous infrared galaxy, Arp 220, with the Nobeyama 45-m radio telescope. We detected extremely wide absorption lines at the (1, 1) and (3, 3) transitions. The maximum total velocity width was ~ 1800 km s-1. Such wide molecular absorption lines were detected for the first time in galaxies. The absorption lines are formed by ammonia only in front of the central compact continuum emission (~ 1"=370pc). The present results clearly indicate the existence of extremely high-velocity motion in the central compact region of Arp 220. A possible origin of such motion is rapidly rotating gas, suggesting the existence of an active galactic nucleus, or outflowing or inflowing gas.

- ● Takano, S., N. Nakai, K. Kawaguchi, T. Takano, P. Schilke, and G. Winnewisser [2006a], "Systematically Peculiar Molecular Composition in M 82: Regarding the Formation Mechanisms," Highlights of Astronomy, vol. 13 : As Presented at the XXVth General Assembly of the IAU, JD21, pp.875-878.

- ➢ More than 20 molecules have been detected in galaxies. Studies of the relation between their abundances and the physical conditions are important to understand physical and chemical processes. Two starburst galaxies NGC253 and M82 are known to be suitable for such study; the H2 column densities are high and nearly the same and their distances are nearly the same (about 3 Mpc). Several abundant molecules have been detected in both of the galaxies with similar abundances. However it is known that SO SiO NH3 HNCO CH3OH and CH3CN have been clearly detected in NGC253 nut barely detected with comparable sensitivity in M82. We found a common characteristic of above six molecules; they are efficiently produced under high-temperature conditions and/or they are originated from grain by evaporation process. We also compares abundances of above six molecules based on our observations including NH3 and on literatures in other nearby galaxies with rich molecular gas. As a result at least NH3 HNCO and/or CH3OH are abundant enough to be detected in NGC6946 IC342 Maffei2 M51 CenA and NGC4945 with comparable sensitivity. We concluded that the molecular composition in M82 is systematically peculiar regarding the formation mechanisms of molecules. Possible reasons are discussed.

- ● Takano, S. [2006b], "Molecular Abundances in Galaxies," ASTROCHEMISTRY: From Laboratory Studies to Astronomical Observations, AIP Conf. Proc., vol.855, pp.170-175.

- ➢ Two topics are discussed here. The first is an observational study on molecular abundance in nearby (< 10 Mpc) gas-rich galaxies based on our ammonia survey and on data in literature. As a result, a systematically peculiar molecular abundance was found in a famous starburst galaxy M 82 regarding the formation mechanisms of molecules. We discussed possible reasons for this peculiarity. We think that formation of molecules on dust grain is not effective, and/or that evaporation of molecules from dust to gas-phase is not effective in M 82. The second topics is our recent trial to detect ammonia toward a more distant galaxy. We observed ammonia toward a prototypical ultraluminous infrared galaxy, Arp 220 (~77 Mpc), with the Nobeyama 45-m radio telescope. Extremely wide absorption lines were detected at the (1,1) and (3,3) transitions. The maximum total velocity width was ~ 1800 km s^{-1}. Sun wide molecular absorption lines were

detected for the first time in galaxies. The absorption lines are formed only by foreground ammonia of the central compact continuum emission (~1"=370 pc). The present results clearly indicate the existence of extremely high-velocity gas in the central compact region. A possible origin of such motion is rapidly rotating gas, suggesting the existence of an active galactic nucleus, or outflowing or inflowing gas. The obtained column density 1.8×10^{17} cm^{-2} is the largest among galaxies where ammonia is already detected.

- Takasaki, H., J. Kiyohara, A. Asai, H. Nakajima, T. Yokoyama, S. Masuda, J. Sato, and T. Kosugi [2007], "Imaging Spectroscopy of a Gradual Hardening Flare on 2000 November 25," Astrophys. J., vol.661, pp.1234-1241.

➢ We present an examination of multiwavelength observations of an M8.2 long-duration flare which occurred on 2000 November 25. During the flare, we can see a hard X-ray (HXR) source on one Halpha flare ribbon in the HXR images obtained with the Hard X-ray Telescope aboard Yohkoh, and a compact microwave emission source on the other flare ribbon in the data taken with the Nobeyama Radioheliograph, while we can also see an extended microwave emission source that connects both of these emission sources. The compact microwave and HXR sources clearly showed gradual hardening tendencies in their spectra. In addition, we found energy-dependent delays of the peak times in the HXR bursts and concluded that almost all of the accelerated electrons are trapped in magnetic loops to generate the extended microwave source and are dripping into the chromosphere at the compact microwave and the HXR emission sites. We then performed imaging spectroscopic analyses to the microwave emission sources. The temporal evolutions of the flux and the spectral index of the compact microwave footpoint source are quite similar to those of the HXR source, which is mainly emitted at the other footpoint, while those at the loop-top extended source do not show this similarity. Moreover, there is a constant gap between the electron spectral index derived from the microwave footpoint source and that from the HXR source. We also discuss the constant gap, based on the trapped and dripping model.

- Takeda, M., Y. Uzawa, and Z. Wang [2007], "SIS Mixers Based on NbN Techniques for ALMA Band 10," IEEE Trans. Applied Superconductivity, vol.17, pp.359-362.

➢ We designed, fabricated, and tested SIS mixers based on NbN techniques and estimated the specific capacitance of NbN/AlN/NbN tunnel junctions, which were fabricated by DC-magnetron sputtering, by measuring DC-SQUID resonance steps. In the mixers, NbN/AlN/NbN junctions and NbN/SiO$_2$/Al tuning circuits were used for investigating receiver performance at frequencies greater than 900 GHz. The specific capacitance of the junction was estimated at 120 fF/ mum^2 with a critical current density of 12 kA/cm^2. The resonance frequencies generated in the tuning circuits linearly changed with respect to the tuning lengths up to at least 1.1 THz. We found that an input-circuit structure, which we used, is a factor that degrades receiver noise at frequencies greater than 900 GHz.

- Tamura, Y., K. Nakanishi, K. Kohno, R. Kawabe, and T. Okuda [2007], "A New Submillimeter Diagnostics of Physical Conditions of ISM in High Redshift Galaxies," Proc. of the IAU Symp. 235, "Galaxy evolution across the Hubble Time", eds. F. Combes & J. Palous, p.430.

➢ We present a new diagnosis method for determining physical properties of star-forming gas in high-z galaxies. In this method, we employed three key observational quantities, [CI], CO, and FIR luminosities, including our new detections of CO J = 4-3 emission from the pure-starburst (non-AGN) submm galaxy SMM J14011+0252 (z = 2.6) and the type-2 AGN IRAS FSC 10214+4724 (z = 2.3) obtained with the Nobeyama Millimeter Array (NMA) at the Nobeyama Radio Observatory. These two sources have extremely high star formation rate, and exhibit strong emission of CO and [CI] 609 μm lines. We determined ISM physical conditions for the two objects and another three high-z quasars in order to investigate the relationship between their ISM and power sources (i.e., massive star formation or AGN). A new PDR analysis (Wolfire et al. 2005, private communication) using CO, [CI], and FIR on five high-z sources provides new evidence that AGN host galaxies harbor denser (log n_H ~ 5-6) ISM exposed to stronger far-UV fluxes of log G_0 ~ 3.5-4 than the non-AGN submm galaxy. Volume filling factors of the star-forming dense gas in the AGN hosts are an order of magnitude smaller than that of the pure-starburst submm galaxy. This suggests that, in these AGN hosts, dense molecular clouds are dominating the central kpc around AGN, triggering extensive circumnuclear

starbursts, and possibly feeding their central supermassive black hole simultaneously.

● Tanaka, K., K. Kamegai, M. Nagai, and T. Oka [2007], "High-Resolution Mapping of the l = 1°.3 Complex in Molecular Lines: Discovery of a Proto-Superbubble," Publ. Astron. Soc. Japan, vol.59, pp.323-333.

➢ We report on the results of molecular line observations toward the J=1°.3 complex, an anomalous cloud complex in the central molecular zone of the Galaxy. The CO J =3-2 survey recently performed with the Atacama Submillimeter Telescope Experiment (ASTE) 10 m telescope has found that the complex has an enhanced CO J=3-2/J=1-0 intensity ratio. We have made high-resolution maps of the CO J=1-0, HCN J=1-0, J=1-0, HCO$^+$ J=1-0, SiO J=1-0, and J=2-1 lines with the Nobeyama 45 m telescope. The complex is found to be rich in shells and arcs of dense molecular gas. We identified 9 expanding shells in HCN maps and compact SiO features associated with the shells. The intensity ratios of HCN/CO, HCO$^+$/CO, and CO J=3-2/J=1-0 are coherently enhanced by a factor of a few in gas with an LSR velocity higher than 110 km s^{-1}. The high-velocity gas has a high density ($n_H \sim 10^{4.5}$ cm^{-3}) and high SiO/^{13}CO intensity ratio, indicating that the gas was shocked. The typical HCN/HCO$^+$ intensity ratio is found to be 2.3, being higher by a factor of a few than those in the Galactic disk clouds. The typical kinetic energy and expansion time of the shells are estimated to be $10^{50.9-52.5}$ erg and$10^{4.6-5.3}$ yr, respectively. The kinetic energy could be furnished by multiple supernova and/or hypernova explosions at a rate of 10^{-3-4}yr^{-1}. These estimates suggest that the expanding shells as a whole may be in the early stage of superbubble formation. This proto-superbubble may have originated in a massive cluster formation that took place $10^{6.8-7.6}$ yr ago.

● Tatematsu, K. [2005], "N$_2$H$^+$ Observations of Molecular Cloud Cores in Taurus," J. Korean Astron. Soc., vol.38, pp.279-282.

➢ We report the millimeter-wave radio observations of molecular cores in Taurus. The observed line is the N$_2$H$^+$ emission at 93 GHz, which is known to be less affected by molecular depletion. We have compared starless (IRAS-less) cores with star-forming cores. We found that there is no large difference between starless and star-forming cores, in core radius, linewidth, core mass, and radio intensity profile. Our result is in contrast with the result obtained by using a popular molecular line, in which starless cores are larger and less condensed. We suggest that different results mainly core from whether the employed molecular line is effected by depletion or not. We made a variable analysis, and found that both starless and star-forming cores are not far from the critical equilibrium state, in Taurus. Together with the fact that Taurus cores are almost thermally supported, we conclude that starless Taurus cores evolve to star formation without dissipating turbulence. The critical equilibrium state in the virial analysis corresponds to the critical Bonnor-Ebert sphere in the Bonnor-Ebert analysis (Nakano 1998). It is suggested that the initial condition of the molecular cloud cores/globules for star formation is close to the critical equilibrium state/critical Bonnor-Ebert sphere, in the low-mass star forming region.

● Tosaki, T., K. Nakanishi, M. Tsuboi, S. Trushkin, O. Kameya, K. Fujisawa, T. Kotani, and N. Kawai [2006], "Cyg X-3 is in the Active State," The Astronomer's Telegram, #952.

➢ We report that the microquasar Cyg X-3 (RA=20:32:25.78, Dec=40:57:27.9 J2000) has entered the flaring state and would request for followup observations at all frequencies. In the monitoring program of microquasars with the RATAN-600 radio telescope (Trushkin et al., astro-ph/0611550), the flux density at 4.8 GHz of Cyg X-3 was found to drop from 191±5 mJy at Nov 7.57 (UT) to 21±3 mJy on Nov 8.57 (UT), that is a quenched state followed by a flaring event with fluxes reaching 1-10 Jy (Waltman et al., 1994, AJ, 108, 189; ATel #727, #828).

● Tosaki, T., Y. Shioya, N. Kuno, T. Hasegawa, K. Nakanishi, S. Matsushita, and K. Kohno [2007a], "Giant Molecular Association in Spiral Arms of M 31: I. Evidence for Dense Gas Formation via Spiral Shock Associated with Density Waves?," Publ. Astron. Soc. Japan, vol.59, pp.33-42.

➢ We present observations of ^{12}CO (J=1-0), ^{13}CO (J=1-0), and ^{12}CO (J=3-2) emissions toward a Giant Molecular Association (GMA) in the southern spiral arm of M 31 using the NRO 45m and the ASTE 10m telescopes. Observed regions are 3' x 4' (0.6 kpc x 0.8 kpc) with an angular resolution of 16" - 17" for ^{12}CO (J=1-0) and ^{13}CO (1-0), and 1'.2 x 1'.4 with 23" for ^{12}CO (3-2). The GMA has a size of a few 100 pc and a mass of 5.6 x 10^6 M . The ^{12}CO (1-0) to ^{13}CO (1-0) integrated intensity ratio ($R_{12/13}$) and the ^{12}CO (3-2) to ^{12}CO (1-0) ratio ($R_{2-3/1-0}$), averaged over

the entire region of the GMA, are $\sim$ 10 and 0.3, respectively. These line ratios suggest gas densities of $(3-6) \times 10^2$ cm^{-3} at a temperature of 15-25 K, which are similar to, or slightly larger than, those of GMCs in the Galactic disk. We found a radial gradient of $R_{12/13}$ within the GMA, ranging from 6 at the center to 14 at the edges. The distribution of $R_{12/13}$ shows a smooth structure with an overall density gradient. The GMA consists of two velocity components, blue ($\sim$ -505 km s^{-1}) and red ($\geq$ -490 km s-1). In both the ^{12}CO (1-0) and ^{13}CO (1-0) profiles, the blue component shows a strong peak intensity and a narrow velocity width, while the red is weaker and wider. The $R_{12/13}$ value of the red component is 5 and that of the blue is 16, indicating that the red component is "post-shock" dense gas decelerated by shock due to the density wave.

- Tosaki, T., Y. Shioya, N. Kuno, K. Nakanishi, T. Hasegawa, S. Matsushita, K. Kohno, R. Miura, Y. Tamura, S. K. Okumura, and R. Kawabe [2007b], "Dense Molecular Gas Formation Triggered by Spiral Density Wave in M31," Proc. of the IAU Symp, 237, "Triggered Star Formation in a Turbulent Interstellar Medium", eds. B. G. Elmegreen & J. Palous, pp.368-372.

➢ We present the high-resolution ^{12}CO(J=1-0), ^{13}CO(J=1-0) and ^{12}CO(J=3-2) maps toward a GMA located on the southern arm region of M 31 using Nobeyama 45 m and ASTE 10 telescopes. The GMA consists of two velocity-components, i.e., red and blue. The blue component shows a strong and narrow peak, whereas the red one shows a weak and broad profile. The red component has a lower ^{12}CO(J-1-0)/^{13}CO(J=1-0) ratio ($\sim$5) than that of the blue one ($\sim$ 16), indicating that the red component is denser than the blue one. The red component could be the decelerated gas if we consider the galactic rotational velocity in this region, We suggest that the red component is "post shock" dense gas decelerated due to a spiral density wave. This could be observational evidence of dense molecular gas formation due to galactic shock by spiral density waves. We also present results from on-going observations toward NGC 604, which is the supergiant HII region of M33, using Nobeyama 45 m and ASTE 10 m telescopes. The ratio of ^{12}CO(J=3-2) to ^{12}CO(J=1-0) ranges from 0.3 to 1.2 in NGC 604. The ^{12}CO(J=1-0) map shows the clumpy structure while ^{12}CO(J=3-2) shows a strong peak near to the central star cluster of NGC 604. The high ratio gas is distributed on the arc-like or shell-like structure along with Hα emission and HII region detected by radio continuum, These suggest that the dense gas formation and second generation star formation occur in the surrounding gas compressed by the stellar wind and/or supernova in central star cluster.

- Tosaki, T., R. Miura, T. Sawada, N. Kuno, K. Nakanishi, K. Kohno, S. K. Okumura, and R. Kawabe [2007c], "Arclike Distribution oh High CO (J=3-2)/CO (J=1-0) Ratio Gas Surrounding the Central Star Cluster of the Supergiant HII Region NGC 604," Astrophys. J. (Letters), vol.664, pp.L27-L30.

➢ We report the discovery of a high CO (J=3-2)/CO (J=1-0) ratio gas with an arclike distribution("high-ratio gas arc") surrounding the central star cluster of the supergiant HII region NGC 604 in the nearby spiral galaxy M33, based on multi-J CO observations of a 5'x5' region of NGC 604 conducted using the ASTE 10 m and NRO 45 m telescopes. The discovered "high-ratio gas arc" extends to the southeast-northwest direction with a size of $\sim$200 pc. The western part of the high-ratio gas arc closely coincides with the shells of the HII regions traced by Hα and ratio continuum peaks. The CO (J=3-2)/CO (J=1-0) ratio, $R_{3-2/1-0}$, ranges between 0.3 and 1.2 in the observed region, and the $R_{3-2/1-0}$ values of the high-ratio gas arc around or higher than unity, indicating very warm ($T_{kin}>=60K$) and dense ($n_{H2}>=10^3$-10^4 cm^{-3}) conditions of the high-ratio gas arc. We suggest that the dense gas formation and second-generation star formation occur in the surrounding gas compressed by the stellar wind and/or supernova of the first-generation stars of NGC 604, i.e., the central star cluster of NGC 604.

- Tsuboi, M., H. Ezawa, H. Matsuo, N. Ota, T. Kuwabara, T. Kasuga, and Nobeyama SZ effect observation team [2005a], "High-Resolution Observations of Sunyaev-Zel'dovich Effect with the Nobeyama Radio Observatory 45-m Telescope," Proc. of the 9th Asian-Pacific Regional IAU Meeting, pp.243-244.

➢ We have three focal plane array receivers at 40, 100, and 150 GHz for the Nobeyama 45-m telescope. From the pilot ON-OFF observations toward eight X-ray bright galaxy clusters at 40 GHz, the Hubble constant was estimated to be H_0 = 64±17 km s^{-1} Mpc^{-1} for a flat A-CDM cosmology, which shows good agreement with the values by other SZ effect observations. Mapping observations toward six galaxy clusters have been performed. The overall distribution

of the hot plasma observed by SZ effect roughly follow the spherical isothermal β-model.

- Tsuboi, M., H. Ezawa, H. Matsuo, N. Ota, T. Kuwabara, T. Kasuga, and Nobeyama S-Z effect observation team [2005b], "Observations of Sunyaev-Zel'dovich Effect with Nobeyama 45-m Telescope," Proc. at the XXVIIIth General Assembly of the URSI, October 2005, India. (CD-ROM : JB-P.3)

➢ We have three focal plane systems at 40, 100, and 150 GHz for the Nobeyama 45-m telescope. These array receivers cover the wide frequency range of Rayleigh-Jeans region of the Sunyaev-Zel'dovich (S-Z) effect. We have performed systematic observations the S-Z effect since 1997. From the pilot ON-OFF observations toward 8 X-ray bright galaxy clusters at 40 GHz, the Hubble constant was estimated to be $H_0 = 64\pm17$ km/s/Mpc for a flat -CDM cosmology, which shows good agreement with the values by other SZ effect observations. Mapping observations toward 6 galaxy clusters have been performed. The overall distribution of the plasma observed by S-Z effect roughly follow the spherical isothermal β-model, while there are some possible deviations from the model especially in the central core region.

- Tsuboi, M., T. Ohno, Y. Tanabe, T. Kasuga, N. Kuno, A. Sakamoto, A. Miyazaki, and H. Matsuo [2005c], "Observation of the Sunyaev-Zel'dvich Effect toward CL0016+16 at 43 GHz," Proc. of the IAU Symp. 201, "New Cosmological Data and the Values of the Fundamental Parameters", eds. Anthony Lasenby and Althea Wilkinson, pp.521-522.

➢ We performed a mapping observation of the Sunyaev-Zel'dovich effect toward a distant cluster of galaxies, CL0016+16, at 43 GHz using a newly developed 6-beam SIS receiver installed in the Nobeyama 45-m telescope. The temperature decrement of the cosmic microwave background radiation was measured to be $\Delta T_A{}^* = -0.49 \pm 0.05$ mK at the central position of the cluster. The temperature decrement decreases, as it goes outside from the central position, and it becomes the noise level in leaving 130". Using the isothermal, spherical-symmetrical beta -model and the observed parameters, the S-Z effect is inferred to be $\Delta T_{RJ}0 = -1.0 \pm 0.1$ mK at the Rayleigh-Jeans limit. A combination of this S-Z effect and X-ray surface brightness suggests that the Hubble constant is $H_0 \{q_0 = 0.5\} = 67^{+16}{}_{-11}$ km s^{-1} Mpc^{-1}.

- Tsuboi, M., N. Kuno, T. Umemoto, T. Sawada, K. Nakanishi, T. Tosaki, Y. Kurono, K. Fujisawa, Japanese VLBI Network Team, S. Trushkin, T. Kotani, and N. Kawai [2006a], "A Radio Flare from Cyg X-3," The Astronomer's Telegram, #727.

➢ We report that the microquasar Cyg X-3 is undergoing a significant radio flare ad would request for followup observations at all frequencies. In the current milti-frequency monitoring observations with RATAN-600 radio telescope, the flux density at 4.8 GHz of the source was found to drop from 103 mJy on Jan 14.4 (UT) to 43 mJy on Jan 15.4 (UT), and to 22 mJy on Jan 17.4 (UT). The source is known to exhibit the radio flares typically with a few peaks exceeding 5 Jy following such quenched state (Waltman et al., 1994, AJ, 108, 179).

- Tsuboi, M., S. K. Okumura, and A. Miyazaki [2006b], "Interaction between the SNR Sagittarius A East and the 50-km S^{-1} Molecular Cloud," J. Physics: Conference Series, vol.54, pp.16-21.

➢ We performed high-resolution observations of the Galactic Center 50-km s^{-1} molecular cloud in the CS J=1-0 line using the Nobeyama Millimeter Array. The 50-km s^{-1} molecular cloud corresponds to a break in the Sagittarius (Sgr) A east shell. A very broad and negative velocity wing feature is detected at an apparent contact spot between the molecular cloud and the Sgr A east shell. The velocity width of the wing feature is over 50-km s^{-1}. The width is three times wider than those of typical Galactic Center clouds. This strongly suggests that the shell is interacting physically with the molecular cloud. The asymmetric velocity profile of the wing feature indicates that the Sgr A east shell expands and crashes into the far side of the molecular cloud. About 50 clumps are identified in the cloud using CLUMPFIND. The velocity width-size relation and the mass spectrum of clumps in the cloud are similar to those in Central Molecular Zone (CMZ).

- Tsukagoshi, T., Y. Kitamura, R. Kawabe, M. Saito, S. Yokogawa, and Y. Kurono [2005], "Millimeter Continuum Observations of McNeil's Nebula Object," Publ. Astron. Soc. Japan, vol.57, pp.L21-L24.

➢ We performed 98 and 110GHz continuum monitoring observations of the FU Orionis candidate, McNeil's Nebula Object (MNO), from 2004 February to May, with the Nobeyama Millimeter Array. In this study, we succeeded in detecting compact (~ 3000 AU) dust emission towards the

position of LMZ 12, the millimeter counterpart of MNO. From monitoring observations, however, we could not find any distinct time variation of the total flux densities for the period from 2004 February to May. The Spectral Energy Distribution (SED) of MNO in λ= 0.45-3 mm, which shows no increase in brightness after the outburst, is found to have a power-law form with an index of 2.5; the index corresponds to a β index of 0.5 for the dust mass opacity coefficient. If we consider the continuum emission from MNO as an optically thin thermal one from the dust in the envelope or the outer cold region of the accretion disk around MNO, the total flux densities of the emission give a mass of the circumstellar material of 0.04 ± 0.01 M , which is slightly larger than the disk mass of T Tauri stars (~ 0.01 M). It is very likely, based on these results, that MNO experiences an FU Orionis outburst in the transient stage from a protostar to a T Tauri star. Furthermore, considering the non-detection of an millimeter outburst together with the outburst at optical and IR wavelengths, we suggest that the eruptive phenomenon occurs in the innermost hot region of the disk.

- Tsukagoshi, T., Y. Kitamura, R. Kawabe, M. Saito, S. Yokogawa, and Y. Kurono [2007], "The Circumstellar Environments around FU Orions Star, PP 13S," Proceedings in "Protostars and Planets V", LPI contribution no. 1286, p.8475.
- Not Available
- Tsuru, T. G., H. Matsumoto, T. Inui, S. Matsushita, R. Kawabe, T. Harashima, T. Maihara, and F. Iwamuro [2004], "M82 X-1 - The Hyper Luminous X-Ray Source -," Proc. of the "Stellar-Mass, Intermediate-Mass, and Supermassive Black Holes", eds. S. Mineshige and K. Makishima, Porg. Theore. Phys. Supple., No.155, pp.59-66.
- By using ASCA and Chandra, we discovered a bright X-ray source M82 X-1 in the starburst galaxy M82. The peak luminosity of $\sim 1\times10^{41}$ ergs sec^{-1} and the location of off-center position of M82 in the starburst galaxy M82 suggest that M82 X-1 is a new type of black hole, intermediate massive black hole (IMBH). We also found an expanding molecular super bubble (EMSB) surrounding the IMBH. We propose a hypothesis that the IMBH was formed in the starburst activity $10^{6}\sim 10^{7}$ yrs ago. We review the course of the discovery and show recent progress on studies of the X-ray spectrum and the position of M82 X-1.
- Tzatzakis, V., A. Nindos, C. E. Alissandrakis, and K. Shibasaki [2006], "A Statistical Study of Microwave Flare Morphologies," Recent Advances in Astronomy and Astrophysics: 7th International Conference of the Hellenic Astronomical Society, AIP Conf. Proc., vol.848, pp.248-252.
- Using Nobeyama Radioheliograph (NoRH) high spatial resolution images at 17 and 34 GHz, we study the morphology of several flare events that occured relatively close to the limb. Our study has been motivated by the recent detection of a small number of optically thin flares whose maximum emission peaks close to the loop top. These events may show significant anisotropy of the density and pitch angle distribution of the nonthermal electrons, However, we do not know how often they occur. Our sample consists of 104 flare events. Using data from the Nobeyama Polarimeter we were able to determine whether the 17 and 34 GHz emissions are optically thin or thick. Almost half of our events appear unresolved in the NoRH images. Among the resolved events, special attention is paid to those with circular polarization (V) showing two distinct sources. Such V sources are considered proxies to the flaring loop footpoints if the total intensity (I) morphology is consistent with a single flaring loop configuration. A small number of events, as expected at such high frequencies, are optically thick with I maximum between the loop footpoints. The number of optically thin events showing maxima co-spatial with the V sources is approximately the same as the number of those optically thin resolved events showing emission peak between the V sources. Our future plans concerning the study of our database are also outlined.
- Ujihara, H., and Y. Chikada [2005], "Development of Film Lens Antennas for Large Aperture Radio Telescopes," Proc. at the XXVIIIth General Assembly of the URSI, October 2005, India. (CD-ROM : J04-P.1)
- Film Lens Antennas are novel lens antenna development by the authors for radio telescope with very large aperture. Conventional radio telescopes use reflector antennas which collect the radiation from radio source in the universe to make focus. These radiations are very weak when they are received at the earth because of long distance propagation. Therefore astronomers need

radio telescopes with large collecting area. Surface accuracy must be under operational wavelength over four not to degrade aperture efficiency. While operational frequency becomes higher, or this aperture becomes larger, the distortion which is normalized by operational wavelength becomes larger. These distortions are caused by the gravitation, which, or thermal distribution. In orbit around the earth, wind gravitational distortion is zero, however, thermal distortion is larger than on the earth. We need deployable antennas to launch the radio telescope to the orbit, thus deployment of the antenna causes surface error. Lens antennas are not sensitive to these error, however, no studies have ever done to apply lens to radio telescopes, because thick lens has loss and is heavy. Conventional dielectric lens is shaped to make focus by the condition of same path-length over the surface. Fresnel lens has different path-length by wavelength to be thin as several times wavelength. Instead of using delay of the wave by its path-length, thus we can directly shift the phase of the wave through the lens surface if suitable phase shifters. Efficient Fresnel lens needs large shift from 180 degree to - 180 degree with high transparency of the wave, while usual phase shifter surface has phase shift under 90 degree. Thus the Author UJIHARA developed large shifters by using mutual coupling of only two or three layers of shifters and achieved efficient Film Lens Antenna (FLA). FLA with two layers has aperture efficiency of 40 percent, which is estimated by the simulation, and measured by 90-cm FLA designed for 22GHz. Thickness of the FLA is only 2mm for the wavelength of 13mm, and is deployable. FLA is able to be designed for receiving harmonic frequencies such as 11GHz, 22GHz, 43GHz, 86GHz with phase shifters which has suitable resource characteristics. We made the first step for future large radio telescope with several Square Kilometers Apertures.

- Ukita, N., M. Saito, B. Ikenoue, J. G. Mangum, N. J. Emerson, A. C. Otarola, and S. Stangellini [2006], "Vortex Shedding from a 12-m Antenna," Proc. of the SPIE, vol.6267, p.62673P.

➢ Periodic vortex shedding from a 12-m parabola antenna has been found in the wind of 9 m s^{-1} and an attack angle of 26 degrees. The measurements have been made at the NRAO VLA site. The periodic yaw motion of an elevation axis has been detected with linear gauges mounted on a reference structure that was built in each side of the yoke. It has also been observed in the angle difference of two encoders installed at both ends of the elevation axis. The frequency of yaw motion was 0.15 Hz. The same periodicities have been found in both the wind direction and wind velocity measured with an ultrasonic anemometer in the wake downstream of the antenna. Such periodicities have been in neither common displacement of the bearing housings nor rotation of the elevation axis. The Reynolds number o f the flow was 6 x 106 (hypercritical), suggesting the vortex shedding be periodic, which is consistent with our observations. The Strouhal number of parabola has been found to be 0.19 that is comparable to those of cylinder, inverse triangle, and other similar geometric shapes. The coefficient for oscillatory lateral force exerted on the antenna by shedding vortices has been estimated to be about 1.

- Uzawa, Y., M. Tacked, A. Kawakami, Z. Wang, and T. Noguchi [2005], "Design Consideration for a Two-Distribution Tuning Circuit," Int. J. of IR. and MM Waves, vol.26, pp. 41-54.

➢ We describe a novel method of designing a tuning with two half-wave distributed junctions separated by a half-wavelength microstripline, which analytically determines the circuit parameters such as the minimum current density if the junctions and the characteristic impedances of the distributed junctions and the microstripline. The tuning circuit was approximated by simple transmission theory and then simplified with ideal circuit components for analysis. We applied Chebyshev's band-pass filter theory, in part, to optimize the circuit design. The analytical results revealed that a high characteristic-impedance ratio between the distributed junctions and the microstripline is necessary to obtain broadband matching using low-current-density junctions. The experimental results for all-NbN SIS mixers we designed with this method demonstrated double-sideband (DSB) receiver-noise temperatures of 6-10 quanta from 710 to 810 GHz for a mixer with a current density of only 4 kA/cm^2 (estimated $\omega C_J R_N$ product of 37 at 750 GHz). The RF bandwidth was broader than that of a conventional full-wave distributed SIS mixer with the same current density.

- Vourlidas, A., D. E. Gary, and K. Shibasaki [2006], "Sunspot Gyroresonance Emission at 17 GHz: A Statistical Study," Publ. Astron. Soc. Japan, vol.58, pp.11-20.

➢ We investigate the sunspot gyroresonance emission at 17GHz using the synoptic database of the Nobeyama Radioheliograph. Our statistical study is based on full disk observations obtained

during the maximum of Cycle 22 (1992-94). We study the center-to-limb variation of the brightness and polarization of the sunspot radio emission and present some cases of polarization reversal. We find that the radio emission is most likely 3rd-harmonic gyroresonance emission arising from 2000 G fields in transition region, or low corona temperatures.

- Wajima, K., H. E. Bignall, H. Kobayashi, H. HIrabayashi, Y. Murata, P. G. Edwards, M. Tsuboi, and K. Fujisawa [2006], "Milliarcsecond-Scale Structure in the Gamma-Ray Loud Quasar PKS 1622-297," Publ. Astron. Soc. Japan, vol.58, pp.223-232.

➢ We made a high-resolution VLBI observation of the gamma-ray loud quasar PKS 1622-297 with the HALCA spacecraft and ground radio telescopes at 5GHz in 1998 February, almost 3yr after the source exhibited a spectacular GeV gamma-ray flare. The source shows an elongated structure toward the west on the parsec scale. The visibility data are well modeled by three distinct components: a bright core and two weaker jet components. Comparison with previous observations confirms that the jet components have an apparent superluminal motion up to 12.1 $h^{-1}c$, with the inner jet components having lower superluminal speeds. We applied the inverse Compton catastrophe model and derived a Doppler factor, delta, of 2.45, which is rather lower than those of other gamma-ray loud active galactic nuclei (AGNs), suggesting that the source was in a more quiescent phase at the epoch of our observation. As an alternative probe of the subparsec-scale structure, we also present the results from multiepoch ATCA total flux monitoring, which indicate the presence of persistent intraday variability consistent with refractive interstellar scintillation. We examined the gamma-ray emission mechanism in light of these observations.

- Watanabe, K., M. Gros, P. H. Stoker, K. Kudela, C. Lopate, J. F. Valdes-Galicia, A. Hurtado, O. Musalem, R. Ogasawara, Y. Mizumoto, M. Nakagiri, A. Miyashita, Y. Matsubara, T. Sako, Y. Muraki, T. Sakai, and S. Shibata [2006], "Solar Neutron Events of 2003 October-November," Astrophys. J., vol.636, pp.1135-1144.

➢ During the period when the Sun was intensely active in 2003 October-November, two remarkable solar neutron events were observed by the ground-based neutron monitors. On 2003 October 28, in association with an X17.2 large flare, solar neutrons were high statistical significance (6.4 sigma) by the neutron monitor at Tsumeb, Namibia. On 2003 November 4, in association with an X28-class flare, relativistic solar neutrons were observed by the neutron monitors at Haleakala in Hawaii and Mexico City and by the solar neutron telescope at Mauna Kea in Hawaii simultaneously. Clear excesses were observed at the same time by these detectors, with the significance calculated as 7.5 sigma for Haleakala and 5.2 sigma for Mexico City. The detector on board the INTEGRAL satellite observed a high flux of hard X-rays and gamma-rays at the same time in these events. By using the time profiles of the gamma-ray lines, we can explain the time profile of the neutron monitor. It appears that neutrons were produced at the same time as the gamma-ray emission.

- Watson, D., J. P. U. Eynbo, C. Ledoux, P. Vreeswijk, J. Hjorth, A. Smette, A. C. Andersen, K. Aoki, T. Augusteijn, A. P. Beardmore, D. Bersier, J. M. C. Ceron, P. D'Avanzo, D. Diar-Fraile, J. Gorosabel, P. Hirst, P. Jakobsson, B. L. Jensen, N. Kawai, G. Kosugi, P. Laursen, A. Levan, J. Masegosa, J. Naranen, K. L. Page, K. Pedersen, A. Pozanenko, J. N. Reeves, V. Rumyantsev, T. Shahbaz, D. Sharapov, J. Sollerman, R. C. L. Starling, N. Tanvir, K. Torstensson, and K. Wiersema [2006], "A logNHI = 22.6 Damped Lyalpha Absorber in a Dark Gamma-Ray Burst: The Environment of GBR 050401," Astrophys. J., vol.652, pp.1011-1019.

➢ The optical afterglow spectrum of GRB 050401 (at z=2.8992 7̄ 0.0004) shows the presence of a damped Lyα absorber (DLA), with $logN_{HI}$=22.6±0.3. This is the highest column density ever observed in a DLA and is about 5 times larger than the strongest DLA detected so far in any QSO spectrum. From the optical spectrum, we also find a very large Zn column density, implying an abundance of [Zn/H]=-1.0±0.4. These large columns are supported by the early X-ray spectrum from Swift XRT, which shows a column density (in excess of Galactic) of $logNH=22.21^{+0.06}_{-0.08}$ assuming solar abundances (at z=2.9). The comparison of this X-ray column density, which is dominated by absorption due to alpha-chain elements, and the H I column density derived from the Lyα absorption line allows us to derive a metallicity for the absorbing matter of [α/H]=-0.4±0.3. The optical spectrum is reddened and can be well

reproduced with a power law with SMC extinction, where $A_V = 0.62 \pm 0.06$. But the total optical extinction can also be constrained independent of the shape of the extinction curve: from the optical to X-ray spectral energy distribution, we find $0.5 <\sim A_V <\sim 4.5$. However, even this upper limit, independent of the shape of the extinction curve, is still well below the dust column that is inferred from the X-ray column density, i.e., $A_V = 9.1^{+1.4}_{-1.5}$. This discrepancy might be explained by a small dust content with high metallicity (low dust-to-metals ratio). "Gray" extinction cannot explain the discrepancy, since we are comparing the metallicity to a measurement of the total extinction (without reference to the reddening). Little dust with high metallicity may be produced by sublimation of dust grains or may naturally exist in systems younger than a few hundred megayears. Based in part on observations made at the European Southern Observatory, Paranal, Chile under program 075.D-0270, with the Nordic Optical Telescope, operated on the island of La Palma jointly by Denmark, Finland, Iceland, Norway, and Sweden, in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofisica de Canarias, with the Wide Field Camera (WFCAM) on the United Kingdom Infrared Telescope, which is operated by the Joint Astronomy Centre on behalf of the UK Particle Physics and Astronomy Research Council, and on data collected at the Subaru Telescope, which is operated by the National Astronomical Observatory of Japan.

- Wilson, C., D. Muders, F. Wyrowski, J. Lightfoot, F. Boone, G. Kosugi, L. Davis, and D. Shepherd [2006], "ALMA Pipeline Heuristics," American Astron. Soc. Meeting 208, #51.01.

➢ The ALMA (Atacama Large Millimeter Array) Pipeline Heuristics system is being developed to automatically reduce data taken with the standard observing modes. The goal is to make ALMA user-friendly to astronomers who are not experts in radio interferometry. The Pipeline Heuristics must capture the expert knowledge required to provide data products that can be used without further processing. Observing modes to be processed by the system include single field interferometry, mosaics, and single dish 'on-the-fly' maps, and combinations of these modes. The data will be produced by the main ALMA array, the ALMA Compact Array (ACA), and single dish antennas. The Pipeline Heuristics system is being developed as a set of Python scripts using as the data processing engines the CASA/AIPS++ libraries and the ATNF Spectral Analysis Package (ASAP). The interferometry Heuristics scripts currently provide a five stage process comprising flagging, initial calibration, re-flagging, re-calibration, and imaging of the gain calibrator. A Java browser provides user-friendly access to the Heuristics results. Several techniques are used to search for bad data. In the spectral domain edge detection algorithms are applied, while in the time domain running mean methods are used. We have begun to develop methods to detect gain jumps. Amplitude and phase gain statistics are used for re-flagging. Basic imaging parameters are determined automatically. The initial single-dish Heuristics scripts implement automatic line detection and spectral baseline fitting using Gaussian and Lorentzian fits and major component analysis in Fourier space. This poster describes the reduction datapath and the algorithms used at each stage, recent test results, and the path future development.

- Winnberg, A., S. Deguchi, H. J. Habing, J. Nakashima, H. Olofsson, and M. J. Reid [2006], "Circumstellar CO in OH/IR Stars Close to the Galactic Centre," J. Physics: Conference Series, vol.54, pp.166-170.

➢ A pilot project is carried out to measure circumstellar CO emission from three OH/IR, stars close to the GC using the Nobeyama Millimeter Array at 115 GHz and the Sub-Millimeter Array at 230 GHz. An interferometer is necessary as a 'spatial' in this region of space because of the confusion with interstellar CO emission. The intention is to find out whether it is possible to later conduct a large-scale survey for mass-loss rated using, for example, ALMA. Thus an important parameter would be added to our understanding of the evolution of the Galactic Bulge. Sources have been detected towards two of the stars with 'correct' positions and radial velocities. However, for one of the stars the line profile is not what one expects for expanding circumstellar envelopes. This surprising result is discussed and our plans for future observations are presented.

- Xu, Y., Z.-Q. Shen, J. Yang, X. W. Zheng, A. Miyazaki, K. Sunada, H. J. Ma, J. J. Li, J. X. Sun, and C. C. Pei [2006], "Molecular Outflows around High-Mass Young Stellar Objects," Astron. J., vol.132, pp.20-26.

➢ We present a study of molecular outflows using high-resolution mapping of the CO (1-0) line emission toward eight relatively nearby 6.7 GHz methanol masers that are associated with

massive star-forming regions. Outflows were detected in seven out of eight sources, and five of them clearly show bipolar or multiple outflow morphologies. These outflows have typical masses of a few solar masses, momenta of tens of M_{solar} km s^{-1}, kinetic energies of $\sim 10^{45}$ ergs, and mass entrainment rates of a few 10^{-5} M_{solar} yr^{-1}. The have significantly more mass and kinetic energy than their low-mass counterparts. In some of the sources, the massive outflow is obviously associated with a particular massive star in the cluster, while in others the origin remains uncertain. The high detection rate of outflows toward methanol masers suggests that the outflow phase of massive protostars encompasses the methanol maser phase.

- Yamada, M. M., H. Kiuchi, T. Kawanishi, T. Sakamoto, M. Tsuchiya, J. Amagai, and M. Izutsu [2006], "Phase Stability Measurement of an Optical Two-Tone Signal Applied to a Signal Reference Source for Millimeter and Sub-Millimeter Wave Interferometer," Publ. Astron. Soc. Japan, vol.58, pp.787-791.

➢ Local signal generation with high phase stability is one of the key elements of an interferometer system. In the ALMA (Atacama Large Millimeter/Submillimeter Array) project, we have planes to generate and transmit a micro/millimeter-wave LO (Local Oscillator) reference signal as an optical two-tone signal. To realize this, we introduce a method to generate an optical two-tone signal by double sideband suppressed carrier modulation with a lithium niobate (LiNbO$_3$) Mach-Zehnder optical modulator. The phase instability of the LO signal causes a loss of coherence in the interferometer. We measured the phase instability and estimated the coherence loss while assuming the highest frequency of ALMA LO. The observed Allan standard deviation for 22GHz was 1.9×10^{-14} at 1s. Additional noise was found at a longer time scale than 4s; however, the reason is not well understood at this stage. If this additional noise was classified as white frequency noise, the estimated coherence loss was 5.2% when 938 GHz frequency and a 100-s integration time were assumed. On the other hand, if this additional noise was caused by some other effect, for example phase fluctuation of the amplifier, the coherence loss was estimated to be 0.33% at 938 GHz frequency (100s).

- Yamauchi, A., N. Nakai, N. Sato, and P. Diamond [2005a], "Water-Vapor Maser Emission from the Seyfert 2/LINER NGC 3079," Proc. of the "Future Directions in High Resolution Astronomy: A Celebration of the 10th Anniversary of the VLBA", eds. J. D. Romney, and M. J. Reid, ASP Conf. Ser. vol.340, pp.241-243.

➢ Water-vapor maser emission of NGC 3079 has been observed with the VLBA by two groups to date. They proposed a compact masing disk in its nuclear region, but their interpretations of the disk were very different from each other. To clarify which model is correct, we performed a VLBA observation of blue- to red-shifted maser features. As a result, maser positions of some red-shifted features were newly determined and most features were distributed along a line near the north-south direction. We propose a nearly edge-on disk whose position angle is roughly -7°.

- Yamauchi, A., N. Sato, T. Hirota, and N. Nakai [2005b], "Detection of the Velocity Drift of High-Velocity Water Maser Features of a LINER NGC 4258: Evidence of a Spiral Maser Disk," Publ. Astron. Soc. Japan, vol.57, pp.861-869.

➢ We monitored the velocities of high-velocity features for a H_2O megamaser, NGC 4258, using the 45-m telescope of the Nobeyama Radio Observatory. The spiral shock model of maser disks predicts that the red-shifted features of observed maser spectra decelerate and the blue-shifted features accelerate for trailing arms. To confirm this model, we measured the velocity drift rates. Using the data of 1992-2005, the drift rate was detected to be $\overline{a}$ = -0.036 ± 0.007 km s^{-1} yr^{-1} on the average for 10 red-shifted features. The drift rate of a blue-shifted feature was a = 0.20 ± 0.10 km s^{-1} yr^{-1}. These results are consistent with a prediction of the spiral shock model. The pitch angles of the spirals were obtained to be $\overline{\theta}_P$ = 2° ± 1° on the average for the red-shifted features and θ_p = 13° ± 7° for the blue-shifted feature from the measured drift rates.

- Yasui, C., N. Kobayashi, A. T. Tokunaga, H. Terada, and M. Saito [2006], "Deep Near-Infrared Imaging of an Embedded Cluster in the Extreme Outer Galaxy: Census of Supernova-Triggered Star Formation," Astrophys. J., vol.649, pp.753-758.

➢ While conducting a near-infrared (NIR) survey of "Digel clouds," which are thought to be located in the extreme outer Galaxy (EOG), Kobayashi & Tokunaga found two embedded young clusters in "Cloud 2," a giant molecular cloud at the Galactic radius of ~20 kpc. Because the molecular cloud is located in the vicinity of a supernova remnant (SNR) HI shell, GHS

138-01-94, it was suggested that the star formation activity in Cloud 2 was triggered by this expanding HI shell. We obtained deep NIR images of one of the embedded clusters in Cloud 2 with high sensitivity (K~20 mag, 10 sigma). We identified 52 cluster members. The estimated stellar density (~10 pc^{-2}) suggests that the cluster is a Tassociation. This is the deepest NIR imaging of an embedded cluster in the EOG. The observed K-band luminosity function (KLF) suggests that the underlying initial mass function (IMF) of the cluster down to the detection limit of ~0.1 M_{solar} is not significantly different from the typical IMFs in the field ad in the nearby star clusters. The overall characteristics of this cluster appear to be similar to those of other embedded clusters in the far outer Galaxy. The estimated age of the cluster from the KLF, which is less than 1 Myr, is consistent with the view that the star formation was triggered by the HI shell chose age was estimated at 4.3 Myr (Stil & Irwin). The three-dimensional geometry of the SNR shell, the molecular cloud, and the embedded cluster, which is inferred from our data, as well as the cluster's age, strongly suggest that the star formation in Cloud 2 was triggered by the SNR shell.

- Yasui, C., N. Kobayashi, A. T. Tokunaga, and M. Saito [2007], "Deep NIR Imaging of Star-Forming Region in the Extreme Outer Galaxy," Proceedings in "Protostars and Planets V", LPI contribution no. 1286, p.8638.

➢ Not Available

- Yokogawa, S., Y. Kitamura, M. Momose, and R. Kawabe [2007], "Detailed CO Observations of the Protostellar Envelopes in the Taurus Molecular Cloud," Proceedings in "Protostars and Planets V", LPI contribution no. 1286, p.8498.

➢ Not Available

- Yonekura, Y., S. Asayama, K. Kimura, H. Ogawa, Y. Kanai, N. Yamaguchi, P. J. Barnes, and Y. Fukui [2005], "High-Mass Cloud Cores in the Carina Giant Molecular Cloud," Astrophys. J., vol.634, pp.476-494.

➢ We carried out an unbiased survey for massive dense cores in the giant molecular cloud associated with eta Carinae with the NANTEN telescope in the ^{12}CO, ^{13}CO, and C^{18}O J=1-0 emission lines. We identified 15 C^{18}O cores, whose typical line width DeltaVcomp, radius r, mass M, column density N(H$_2$), and average number density n(H$_2$) were 3.3 km s^{-1}, 2.2 pc, 2.6×10^3 M_{solar}, 1.3×10^{22} cm^{-2}, and 1.2×10^3 cm^{-3}, respectively. Two of the 15 cores are associated with IRAS point sources whose luminosities are larger than 104 Lsolar, which indicates that massive star formation is occurring within these cores. Five cores, including the two with IRAS sources, are associated with MSX point sources. We detected H^{13}CO$^+$ (J=1-0) emission toward four C^{18}O cores, two of which are associated with IRAS and MSX point sources; another one is associated only with an MSX point source, and the other is associated with neither IRAS nor MSX point sources. The core with neither IRAS nor MSX point sources shows the presence of a bipolar molecular outflow in ^{12}CO (J=2-1), which indicates that star formation is also occurring in the core, and the other three of the four H^{13}CO$^+$ detections show winglike emission. In total, 6 C^{18}O cores out of 15 (=40%) have experienced star formation, and at least 2 of 15 (=13%) are massive star-forming cores in the eta Car GMC. We found that massive star formation occurs preferentially in cores with larger N(H$_2$), M, and n(H$_2$) and a smaller ratio of M_{vir}/M. We also found that the cores in the eta Car GMC are characterized by large DeltaV and M_{vir}/M on average compared to the cores in other GMCs observed with the same telescope. These properties of the cores may account for the fact that as much as 60%-87% of the cores do not show any signs of massive star formation. We investigated the origin of a large amount of turbulence in the eta Car GMC. We found that turbulence injection from stellar winds, molecular outflows, and supernova remnants that originated from stars formed within the GMC are not enough to explain the existing turbulence. We propose the possibility that the large turbulence was preexisting when the GMC was formed and is now dissipating. Mechanisms such as multiple supernova explosions in the Carina flare supershell may have contributed to form a GMC with a large amount of turbulence.

- Young, K. H., T. R. Hunter, D. J. Wilner, M. A. Gurwell, J. W. Barrett, R. Blundell, R. Christensen, D. Fong, N. Hirano, P. T. P. Ho, S. Y. Liu, K. Y. Lo, R. Martin, S. Matsushita, J. M. Moran, N. Ohashi, D. C. Papa, N. Patel, F. Patt, A. Peck, C. Qi, M. Saito, A. Schinckel, H. Shinnaga, T. K. Sridharan, S. Takakuwa, C. E. Tong, and D. V. Trung, [2004], "Submillimeter

Array Observations of CS J = 14-13 Emission from the Evolved Star IRC +10216," Astrophys. J. (Letters), vol.616, pp.L51-L54.

➢ We present imaging observations of the evolved star IRC +10216 in the CS J=14-13 line at 685.4 GHz and the associated submillimeter continuum at ~2" resolution made with the partially constructed Submillimeter Array. The CS J=14-13 line emission from the stellar envelope is well resolved both spatially and spectrally. The strong central concentration of the line emission provides direct evidence that CS is a parent molecule that forms close to the stellar photosphere, in accord with previous images of the lower excitation CS J=2-1 line and inferences from unresolved observations of vibrationally excited transitions. The continuum emission is dominated by a compact, unresolved component, consistent with the photospheric emission, that accounts for ~20% of the broadband 450 mum flux. These are the first interferometer imaging observations made in the semitransparent 450 mum atmospheric window.

● Yusef-Zadeh, F., H. Bushouse, C. D. Dowell, M. Wardle, D. Roberts, C. Heinke, G. C. Bower, B. Vila-Vilaro, S. Shapiro, A. Goldwurm, and G. Belanger [2006], "A Multiwavelength Study of Agr A*: The Role of Near-IR Flares in Production of X-Ray, Soft Gamma-Ray, and Submillimeter Emission," Astrophys. J., vol.644, pp.198-213.

➢ Although Sgr A* is known to be variable in radio, millimeter, near-IR, and X-rays, the correlation of the variability across its spectrum has not been fully studied. Here we describe highlights of the results of two observing campaigns in 2004 to investigate the correlation of flare activity in different wavelength regimes, using a total of nine ground- and space-based telescopes. We report the detection of several new near-IR flares during the campaign based on HST observations. The level of near-IR flare activity can be as low as ~0.15 mJy at 1.6 mum and continuous up to ~40% of the total observing time, thus placing better limits than ground-based near-IR observations. Using HST NICMOS, XMM-Newton, and CSO, we also detect simultaneous bright X-ray and Near-IR flare in which we observe for the first time correlated substructure as well as simultaneous submillimeter and near-IR flaring. X-ray emission is arising from the population of near-IR-synchroton-emitting particles, which scatter submillimeter seed photons within the inner 10 Schwarzschild radii of Sgr A* up to X-ray energies. In a addition, using the inverse Compton scattering picture, we explain the high-energy 20-120 keV emission from the direction toward Sgr A*, and the lack of one-to-one X-ray counterparts to near-IR flares, by the variation of the magnetic field and the spectral index distributions. In this picture, the evidence for the variability of submillimeter emission during a near-IR flare is produced by the low-energy component of the population of particles emitting synchrotron near-IR emission. Using the measurements of the duration of flares in near-IR and submillimeter wavelengths, we argue that the cooling could be due to adiabatic expansion with the implication that activity drives an outflow.

● Zaitsev, V. V., and K. Shibasaki [2005], "Dissipation of Diamagnetic Currents and Plasma Heating in Coronal Magnetic Loops," Astronomy Reports, vol.49, pp.1009-1017.

➢ SOHO and TRACE data have shown that the coronal plasma is heated most actively near sunspots, in magnetic loops that issue from the penumbral region. The source of heating is nonuniform in height, and its power is maximum near the footpoints of the magnetic loops. The heating process is typically accompanied by the injection of dense chromospheric plasma into the coronal parts of the magnetic loops. It is important that the radiative losses cannot be compensated for via electron thermal conduction in the loops, which have temperatures of 1.0-1.5 MK; therefore, some heating source must operate throughout the entire length of the loop, balancing radiative losses and maintaining a quasi-steady state of the loop over at least several hours. As observations show, the plasma density inside the loops exceeds the density of the ambient plasma by more than an order of magnitude. It is supposed that the enhanced plasma density inside the loops results from the development of the ballooning mode of a flute-type instability in the sunspot penumbra, where the plasma of the inner sunspot region, with β_i 1, comes into contact with the dense chromospheric plasma, which has β_e β_i (beta is the gas-to-magnetic pressure ratio). As the chromospheric plasma penetrates into the potential field of the sunspot, the generated diamagnetic currents balance the excess gas pressure. These currents efficiently decay due to the Cowling conductivity. Even if neutrals are few in number in the plasma (accounting for less than 10^{-5} of the total mass density), this conductivity ensures a

heating rate that exceeds the rate of the normal Joule dissipation of diamagnetic currents by 7-8 orders of magnitude. Helium is an important factor in the context of plasma heating in magnetic loops. Its relatively high ionization potential, while not forbidding dielectronic recombination, ensures a sufficiently high number of neutrals in the coronal plasma and maintains a high heating rate due to the Cowling conductivity, even at coronal temperatures. The heating results from the "burning-out" of the nonpotential component of the magnetic field of the coronal magnetic loops. This mechanism provides the necessary heating rate for the plasma inside the loops if the loops are thin enough (with thickness of the order of $10^5 \times 10^6$ cm). This may imply that the observed $(1-5) \times 10^8$-cm-thick loops consist of numerous hot, thin threads. For magnetic loops in hydrostatic equilibrium, the calculated heating function exponentially decreases with height on characteristic scales a factor of 1.8 smaller than the total-pressure scale height, since the scale heights for the total pressure and for the ^{4}He partial pressure are different. The heating rate is proportional to the square of the plasma pressure in the loop, in agreement with observational data.