

# **URSI-Japan Centennial Celebration Symposium 1922-2022**

**Progress in Radio Science Research in Japan  
and  
the 100 Years Activities of the Japan National Committee of URSI**

**November 12, 2022**

## **Program and Abstracts**



**Science Council of Japan  
7-22-34 Roppongi, Minato-ku, Tokyo, Japan**

# Table of Contents

Conference Organization.....	1
Aims and Scope of the Symposium.....	2
Scientific Program.....	3
Abstracts (Commemorative Lecture and Special Lectures) .....	7
Biographical Sketches of Invited Attendees.....	15
Japan National Committee of URSI 1922-2022.....	35

# Conference Organization

- Sponsored by:  
Japan National Committee of URSI  
Steering Committee for the URSI-Japan Centennial Celebration Symposium 1922-2022 (URSI-JPN CCS Steering Committee)
- Technically Co-sponsored by:  
International Union of Radio Science (URSI)
- Supported by:  
Ministry of Internal Affairs and Communications  
Ministry of Education, Culture, Sports, Science and Technology (*planned*)  
Ministry of Land, Infrastructure, Transport and Tourism  
Ministry of Economy, Trade and Industry (*planned*)  
Japan Tourism Agency  
Japan National Tourism Organization

# Aims and Scope of the Symposium

The “URSI-Japan Centennial Celebration Symposium 1922-2022” is an important scientific event associated with the “XXXVth General Assembly and Scientific Symposium of the International Union of Radio Science” (URSI GASS 2023) to be held on August 19 – 26, 2023 in Sapporo, Japan. The URSI GASS 2023 is currently under preparation by the Japan National Committee of URSI. The International Union of Radio Science (URSI) was established in 1919. Japan became an URSI member country in 1922, three years after URSI was established. Therefore, the year 2022 is a very important year marking centennial celebration of URSI-Japan. At this Symposium, we will review the history from the born of URSI-Japan in 1922 to today, Japan’s contributions to various URSI activities, and advanced radio science research being conducted in Japan. This Symposium aims at addressing the great importance of radio science to the researchers working in the field of radio science and to general public.

On the occasion of this Symposium, we have invited URSI Officials (URSI President, Immediate Past URSI President, Past URSI President, URSI Vice-Presidents, URSI Secretary-General, URSI Assistant Secretary-Generals, etc.). During the lunch break of the Symposium, they will pay a courtesy call to the Executive Board Members of the Science Council of Japan (SCJ) and the Governing Board Officers (Japanese members) of the International Science Council (ISC), and discuss international collaborations among these organizations.

The first part of this Symposium will include welcome speeches by SCJ and URSI representatives, guest speeches, and a keynote lecture by the URSI Secretary-General for commemorating the 100th anniversary of URSI-Japan. In the second and third parts, prominent Japanese scientists working in the area of radio science will deliver special lectures on the history as well as present and future prospects of the cutting-edge radio science research in Japan.

URSI marked the centennial year in 2019 and organized various special events worldwide during 2019-2021. One of them was the publication of the book entitled, “100 Years of the International Union of Radio Science” (Editors: Philip Wilkinson, Paul S. Cannon, and W. Ross Stone; 618 pages, URSI Press, Gent, Belgium, 2021). URSI-Japan contributed to this book by one chapter (40 pages), where the history of URSI-Japan since its born in 1922, contributions of URSI-Japan to various URSI activities, and the leading radio science research conducted by URSI-Japan are addressed in detail. This book is available by free of charge via the following URSI website:

<https://www.ursi.org/publications.php>



# Scientific Program

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## ◆ Part I: Commemorative Session for URSI-Japan Centennial Celebration

10:00 – 12:00

(Auditorium, 1st Floor)

### ◆ Session Chair:

Kazuya Kobayashi (Associate Member, Science Council of Japan; Vice-President, URSI; Assistant Secretary-General (AP-RASC), URSI; Vice-President, Japan National Committee of URSI; Professor, Chuo University, Japan)<sup>1</sup>

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|---------------|---|
| 10:00 – 10:10 | Opening Remarks / Welcome Speech:<br>Satoshi Yagitani (Associate Member, Science Council of Japan; President, Japan National Committee of URSI; Professor, Kanazawa University, Japan)                                  |
| 10:10 – 10:20 | Welcome Speech on behalf of Science Council of Japan:<br>Takaaki Kajita (President, Science Council of Japan; 2015 Nobel Prize Laureate in Physics; Distinguished University Professor, The University of Tokyo, Japan) |
| 10:20 – 10:25 | Welcome Speech on behalf of URSI (Video message):<br>Piergiorgio L. E. Uslenghi (President, URSI; Distinguished Professor Emeritus, The University of Illinois at Chicago, USA)   |
| 10:25 – 10:35 | Welcome Speech on behalf of URSI:<br>Peter Van Daele (Secretary-General, URSI; Professor, Ghent University, Belgium)  |
| 10:35 – 10:45 | Guest Speech:<br>Hiroshi Matsumoto (Past President, URSI; Director, International Institute for Advanced Studies, Japan; Professor Emeritus, Kyoto University, Japan)   |
| 10:45 – 10:55 | Welcome Speech from URSI Official:<br>Makoto Ando (Associate Member, Science Council of Japan; Immediate Past President, URSI; Professor Emeritus, Tokyo Institute of Technology, Japan)                                |
| 10:55 – 11:05 | Welcome Speech from URSI Official:<br>Sana Salous (Assistant Secretary-General (WIRS), URSI; Professor, Durham University, UK) <sup>2</sup>   |
| 11:05 – 11:50 | Commemorative Lecture for URSI-Japan Centennial Celebration:<br>“URSI: 100 Years of Radio Science Activities”<br>Peter Van Daele (Secretary-General, URSI; Professor, Ghent University, Belgium)                        |
| 11:50 – 12:00 | Guest Speech:<br>Sawako Shirahase (Council Member, Section I, Science Council of Japan; Vice President, International Science Council; Professor, The University of Tokyo, Japan)                                       |

Lunch Break

(General Participants: 12:00 – 13:30, Courtesy Call Attendees: 12:00 – 12:40)

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<sup>1</sup> AP-RASC: Asia-Pacific Radio Science Conference

<sup>2</sup> WIRS: Women In Radio Science

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◆ Courtesy Call by the Board Members of URSI to the Executive Board Members of the Science Council of Japan and the Governing Board Officers of the International Science Council  
12:40 – 13:25

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Attendees for the Courtesy Call:

- Executive Board Members, Science Council of Japan; Governing Board Officers, International Science Council  
Takaaki Kajita (President, Science Council of Japan; 2015 Nobel Laureate in Physics; Distinguished University Professor, The University of Tokyo, Japan)  
Yukari Takamura (Vice-President, Science Council of Japan; Professor, The University of Tokyo, Japan) (Online)  
Sawako Shirahase (Council Member, Section I, Science Council of Japan; Vice President, International Science Council; Professor, The University of Tokyo, Japan)
- Current and Past Officers of the Board, URSI  
Paul Cannon (Past President, URSI; Professor, University of Birmingham, UK)  
Peter Van Daele (Secretary-General, URSI; Professor, Ghent University, Belgium)  
Giuliano Manara (Vice-President, URSI; Professor, University of Pisa, Italy)  
Willem Baan (Assistant Secretary-General (AT-RASC), URSI; Senior Scientist Emeritus, Netherlands Institute for Radio Astronomy (ASTRON), the Netherlands)<sup>3</sup>  
W. Ross Stone (Assistant Secretary-General (GASS and Publications); President, Stoneware Ltd., USA) (Online)  
Sana Salous (Assistant Secretary-General (WIRS), URSI; Professor, Durham University, UK)  
Makoto Ando (Associate Member, Science Council of Japan; Immediate Past President, URSI; Professor Emeritus, Tokyo Institute of Technology, Japan)  
Kazuya Kobayashi (Associate Member, Science Council of Japan; Vice-President, URSI; Assistant Secretary-General (AP-RASC), URSI; Vice-President, Japan National Committee of URSI; Professor, Chuo University, Japan)  
Hiroshi Matsumoto (Past President, URSI; Director, International Institute for Advanced Studies, Japan; Professor Emeritus, Kyoto University, Japan)
- Officers, Japan National Committee of URSI  
Satoshi Yagitani (Associate Member, Science Council of Japan; President, Japan National Committee of URSI; Professor, Kanazawa University, Japan)  
Yasuhide Hobara (Designated Associate Member, Science Council of Japan; Secretary, Japan National Committee of URSI; Professor, The University of Electro-Communications, Japan)
- Speakers of Special Lectures  
Masashi Hayakawa (Past Chair, Commission E, URSI; Professor Emeritus, The University of Electro-Communications, Japan; CEO, Hayakawa Institute of Seismo Electromagnetics Co. Ltd., Japan)

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<sup>3</sup> AT-RASC: Atlantic Radio Science Conference

Michiko Kuroda (Associate Member, Science Council of Japan; Chair, WIRS Chapter in Japan, URSI; Professor Emeritus, Tokyo University of Technology, Japan)

Hiroko Shinnaga (Associate Member, Science Council of Japan; Co-Chair, WIRS Chapter in Japan, URSI; Professor, Kagoshima University) (Online)

Ryuji Kohno (Associate Member, Science Council of Japan; Professor Emeritus, Yokohama National University, Japan; Vice-President, YRP International Alliance Institute, Japan)

Yoshiharu Omura (Past Chair, Commission H, URSI; Professor, Kyoto University, Japan)

Koichi Ito (Designated Associate Member, Science Council of Japan; Chair, Commission K, URSI; Professor Emeritus and Visiting Professor, Chiba University, Japan)

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◆ Part II: Leading Radio Science Research and Future Prospects in Japan 1

13:30 – 15:45

(Auditorium, 1st Floor)

◆ Session Chair:

Yasuhide Hobara (Designated Associate Member, Science Council of Japan; Secretary, Japan National Committee of URSI; Professor, The University of Electro-Communications, Japan)

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13:30 – 14:15 Special Lecture 1:

“Study of electromagnetic noise for 50 years”

Masashi Hayakawa (Past Chair, Commission E, URSI; Professor Emeritus, The University of Electro-Communications, Japan; CEO, Hayakawa Institute of Seismo Electromagnetics Co. Ltd., Japan)

14:15 – 15:00 Special Lecture 2:

“URSI-Japan centennial celebration and Women in Radio Science”

Michiko Kuroda (Associate Member, Science Council of Japan; Chair, WIRS Chapter in Japan, URSI; Professor Emeritus, Tokyo University of Technology, Japan)

15:00 – 15:45 Special Lecture 3 (Online):

“Radio astronomy — A century of the history”

Hiroko Shinnaga (Associate Member, Science Council of Japan; Co-Chair, WIRS Chapter in Japan, URSI; Professor, Kagoshima University)

Break (15:45 – 16:15)

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◆ Part III: Leading Radio Science Research and Future Prospects in Japan 2

16:15 – 18:35

(Auditorium, 1st Floor)

◆ Session Chair:

Satoshi Yagitani (Associate Member, Science Council of Japan; President, Japan National Committee of URSI; Professor, Kanazawa University, Japan)

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- 16:15 – 17:00 Special Lecture 4:  
 “Harmonization of scientific and commercial radio uses, and their social services and industrial innovation”  
 Ryuji Kohno (Associate Member, Science Council of Japan; Professor Emeritus, Yokohama National University, Japan; Vice-President, YRP International Alliance Institute, Japan)
- 17:00 – 17:45 Special Lecture 5:  
 “Active experiments of plasma wave excitation in space environments”  
 Yoshiharu Omura (Past Chair, Commission H, URSI; Professor, Kyoto University, Japan)
- 17:45 – 18:30 Special Lecture 6:  
 “Therapeutic technologies of electromagnetic fields for cancer treatment”  
 Koichi Ito (Designated Associate Member, Science Council of Japan; Chair, Commission K, URSI; Professor Emeritus and Visiting Professor, Chiba University, Japan)
- 18:30 – 18:35 Closing Remarks:  
 Kazuya Kobayashi (Associate Member, Science Council of Japan; Vice-President, URSI; Assistant Secretary-General (AP-RASC), URSI; Vice-President, Japan National Committee of URSI; Professor, Chuo University, Japan)

## **Abstracts**

### **(Commemorative Lecture and Special Lectures)**

## **Commemorative Lecture for URSI-Japan Centennial Celebration**

### **URSI: 100 Years of Radio Science Activities**

Peter Van Daele  
Secretary-General, URSI  
Professor, Ghent University, Belgium  
Email: Pet.VanDaele@UGent.be

By the end of the 19th century communications “without wires” developed rapidly. Ranges were initially very modest, but Marconi managed to increase them progressively, reached 110 km over water in 1899, and finally succeeded in creating a radio link across the Atlantic Ocean in 1901, from Cornwall to Newfoundland.

The new technology fired the interest of the industrialized world, and the use of “radio” spread explosively. By 1904 daily bulletins were provided for the passengers of the Cunard line, by means of signals picked up from shore stations which successively came within radio range during the transoceanic journey.

From 1900 on, a fierce competition started for the domination of the radiocommunication market. Several systems were soon available but to remedy the chaotic situation, a series of administrative conferences were organized, the first held in Berlin in 1903. These conferences made recommendations on such matters as the allocation of frequencies, the form of signals from radio beacons, or the transmission of weather reports and time data. The meetings were government affairs, and only around 1913 did the need for scientific cooperation come to the fore and also lead to the foundation of URSI in 1919 as the International Union of Scientific Radio Telegraphy. The stated objective was to promote scientific studies of radiotelegraphy and to encourage research requiring international cooperation in this field.

This presentation will provide some background information on what scientific discoveries lead to the establishment of URSI and will shine a light on how URSI evolved over all those years.

## Special Lecture 1

### Study of Electromagnetic Noise for 50 Years

Masashi Hayakawa

- 1) Professor Emeritus, The University of Electro-Communications (UEC)
- 2) Visiting Professor, UEC, Advanced Wireless and Communications research Center (AWCC)
- 3) CEO, Hayakawa Institute of Seismo Electromagnetics, Co. Ltd. (Hi-SEM)  
UEC Alliance Center #521, Kojima-cho, Chofu, Tokyo Japan  
Email: hayakawa@hi-seismo-em.jp

The author has been engaged in the study of electromagnetic (radio) noises in the terrestrial environment, which is the core subject of URSI Commission E. The noise is regarded as an obstacle in the telecommunications, but we want to emphasize that these electromagnetic noises are our good friend, by providing us with invaluable information on the terrestrial environment.

The works the author studied during the last five decades include (with the order of studying), (i) electromagnetic (radio) noises in the upper atmosphere (ionosphere/magnetosphere) (lightning-induced whistlers and magnetospheric VLF/ELF emissions) to study the structure and dynamics of upper atmosphere, (ii) electromagnetic noise in the atmosphere (sferics), originated in lightning discharges: Especially ELF observations of Schumann resonances for the study of global warming and ELF transients to study a new phenomenon of Sprites in the mesosphere (atmosphere-ionosphere coupling), (iii) EMC (Electromagnetic Compatibility) characterizing electromagnetic noises from electrical/electronic equipment and suppression of noises, (iv) Electromagnetic noises from the lithosphere and electromagnetic precursors to earthquakes (Lithosphere-atmosphere-ionosphere coupling, for the sake of short-term earthquake prediction).

I am greatly honored to have been offered an opportunity of a tutorial talk in the URSI-Japan centennial celebration symposium, which enables me to have a chance to review extensively our previous research activities with respect to world activity and to summarize our scientific findings. Together with introducing the history of my research activity, we have experienced a lot of difficulties and happiness, and we have also learned useful suggestions during the long period, and I hope that some of those lessons would be of some use to your future research.

## Special Lecture 2

### URSI-Japan Centennial Celebration and Women in Radio Science

Michiko Kuroda

Professor Emeritus, Tokyo University of Technology

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We are pleased to announce that the Women in Radio Science (WIRS) Japan was launched in June, 2022. The establishment of WIRS Japan in the year of the centennial celebration of URSI-Japan is of great significance.

Currently, WIRS chapters have been established in Czech Republic, Egypt, Poland, United States of America, United Kingdom and Japan, with Prof. Sana Salous of United Kingdom as a General Chair.

The primary objectives of WIRS Japan are as follows;

- (1) To promote the work and leadership of women in Radio Science.
- (2) To mentor women in all phases of their career in Radio Science.
- (3) To encourage students to consider Radio Science as one of their future career choices.

The current status of women researchers in Japan and abroad will be explained with reference to two documents. First, with reference to the Global Gender Gap Report 2022[1], the status of women in science and engineering researchers and students worldwide will be explained. Next, with reference to the White Paper on Gender Equality 2021[2] by the Gender Equality Bureau Cabinet Office, the current status of women researchers and students in science and engineering in Japan will be explained.

Based on these data, we will discuss why the number of women students pursuing careers in science and engineering has not increased. Environment, curiosity, and role models are important for girls to pursue careers in science and engineering. Several case studies will be presented on these items.

#### Reference

1. “Global Gender Gap Report 2022”, Insight Report, World Economic Forum, July, 2022
2. “The White Paper on Gender Equality 2021”, Gender Equality Bureau Cabinet Office, Government of Japan, June, 2021



## Radio Astronomy — A Century of the History

Hiroko Shinnaga

Associate Professor, Department of Physics and Astronomy;

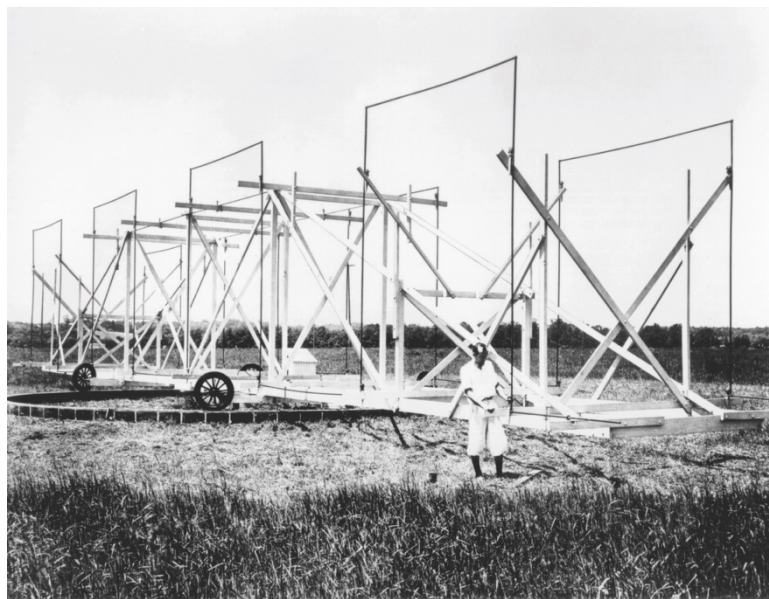
Amanogawa Galaxy Astronomy Research Center (AGARC), Kagoshima University

Korimoto, Kagoshima 890-0065, Japan

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On the occasion that "URSI-Japan" will be celebrating a century anniversary next year, I will briefly summarize a "nearly" century of the history of radio astronomy. Radio Astronomy is directly related to the activities of Commission J. Radio astronomy was started by a young electronic engineer, Karl G. Jansky, who acquired a BSc in physics a few years before the discovery of radio continuum emission from the Galactic Center. Under the mission given to him by Bell Telephone Laboratory, i.e., transatlantic telecommunication using radio, he built a 30-m wide, 6-m tall radio antenna array that captures radio emission ( $\lambda=14.6$  m or  $\nu=20.5$  MHz) from almost all directions. He carefully examined all radio emission components the antenna array received; he concluded one of the three major radio components was coming outside of the Solar System and from the region whose coordinate was about right ascension  $\sim 18$  hours and declination  $\sim -10$  degrees (1).

I will review critical discoveries directly in radio astronomy and key technologies that made radio astronomy and science/technology fields flourish. I will also highlight the progress the Japanese radio community made to push forward to the frontline of the radio astronomy field (2).



**Figure 1. Karl G. Jansky and his antenna array that was called "Jansky's Marry-go-round."**  
(Courtesy of NRAO/AUI/NSF)

### References

1. K.G. Jansky, *Nature*, Volume 132, Issue 3323, pp. 66 (1933).
2. M. Ishiguro, K. Chiba, and S. Sakamoto, "From Nobeyama Radio Observatory to the international project ALMA –Evolution of millimeter and submillimeter wave astronomy in Japan," *Proceedings of the Japan Academy, Series B*, Vol. 98, No. 8, pp. 439-469, 2022. (DOI: <https://doi.org/10.2183/pjab.98.023>)

## Harmonization of Scientific and Commercial Radio Uses, and Their Social Services and Industrial Innovation

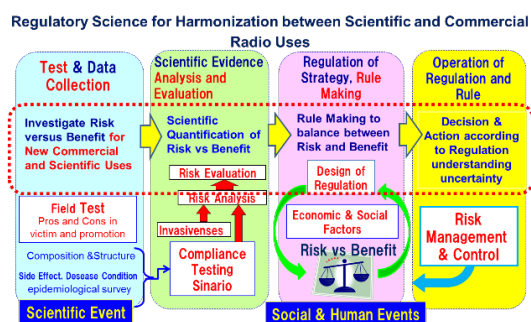
Ryuji Kohno

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Harmonization for scientific radio use such as radio astronomy and commercial business radio use such as 5G cellular networks must be an important common subject among all commissions A-K of which the URSI can study and derive a fair solution to keep using radio resource from various viewpoints. In particular, demand for commercial radio uses has been drastically increasing for these decades in global while scientific radio uses have a huge impact in origin of the universe and other academic progress. Conventionally electromagnetic interference between scientific and commercial radio uses has been taken care in several venues; ITU-R, CISPR. Regional and international regulators have been making various rules and recommendation to harmonize commercial and non-commercial radio uses considering benefit versus risk for individual radio users, but it seems insufficient in a scientific reason for some cases due to urgent demands and majority opinion. For this discussion on harmonization for non-commercial scientific and commercial business radio uses, we have been taken into account in several events of URSI, i.e. special sessions on URSI-ITU relations in URSI-GASS2011, workshops in AP-RASC2013 and URSI-JRSM2015. However, such argument has not been converged yet while increasing requirement to solve such an urgent and serious problem. The reason why the URSI is a best venue to discuss on the harmonization is obvious because URSI is a community of mature representatives of both scientific and commercial radio uses. Scientific use side could be represented in commissions F, G, H, and J and commercial use side could be from standardization of cell operators, industry alliance, and radio broadcasting association in commissions C, D, F, and K while mutual benefit and measurement have been discussed in all commissions particularly commissions A,B, and E. URSI-Japan has been trying to establish a venue; “Regulatory Science Center for Harmonization of Scientific and Commercial Radio Uses,” by applying for the Master Plan2014, 2017, and 2020 to make a consensus by scientific approach for making global rules and on promoting social services and industrial innovation for SDGs.



This invited speech in URSI-Japan Centennial Celebration Symposium 1922-2022 will approach to resolve remained issues in the harmonization with “regulatory science,” that is a multidisciplinary concept and subject. Regulatory science has been applied for medicine and medical devices for instance because risk versus benefit to apply newly invented medicine and devices to medical healthcare can be scientifically analyzed with numerical evaluation. Then a guideline or regulation for the medicines and devices can be made with scientific manner. Regulatory body will

examine the medicines and devices compliant to the regulation. A plan of establishing the regulatory science center for the harmonization of radio uses by Science Council of Japan in Cabinet Office will be also introduced.

### References

1. Ryuji Kohno, “Harmonization in Ultra -Wide Band Regulation for both Scientific and Commercial Radio Usages,” Special session on URSI-ITU relations in URSI-GASS2011, Istanbul, Aug.18, 2011
2. Ryuji Kohno, Special workshop in AP-RASC2013, Taipei, Sept. 4, 2013
3. Ryuji Kohno, “Harmonization Based on Regulatory Science for Scientific and Commercial Radio Uses,” URSI-JRSM2015, 2015. Wiley, Journal on Radio Science, Vol.51, Issue 12, pp.1923-1936, Dec 2016

### Active Experiments of Plasma Wave Excitation in Space Environments

Yoshiharu Omura

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Electromagnetic wave emissions in the Earth's magnetosphere are frequently generated by artificially transmitted VLF waves from the ground as well as natural electromagnetic whistler waves due to lightning discharges. Because of the peculiar and mysterious frequency variations of whistler-mode waves, the VLF triggered emissions have been studied by active experiments in space, laboratory experiments, and numerical simulations for more than half a century [1,2]. While the VLF wave experiments have been conducted for purely scientific purposes of understanding nonlinear wave-particle interaction and nonlinear wave-wave interaction in space plasmas, there arose renewed interest on VLF waves because of their association with the Earth's radiation belts in late 1990s. It has been found that the VLF rising-tone emissions called as chorus waves can effectively accelerate energetic electrons of 10 – 100 keV up to relativistic energy of MeV, and they contribute to rapid formation of the radiation belts [3]. In the acceleration process of a small fraction of the energetic electrons, majority of energetic electrons are precipitated into the polar atmosphere, resulting in diffuse aurora. Similar nonlinear processes are found in the generation of electromagnetic ion cyclotron (EMIC) waves with rising and falling tones, which are excited by energetic protons. Both acceleration and pitch angle scattering of energetic protons take place, and some of them are precipitated as proton aurora. EMIC emissions can also be in anomalous resonance with relativistic electrons due to the Doppler effect. EMIC rising-tone emissions can scatter pitch angles of relativistic electrons very effectively [4], resulting in rapid depletion of substantial amount of the radiation belt electrons. This gives us possible means to eliminate a part of the radiation belts for safer human activities in the space radiation environment. In search of effective methods to generate whistler-mode waves and EMIC waves in the magnetosphere, various active experiments such as Barium atom release and electron beam injection have been proposed. A review on active experiments in the past and future [5] for generation of waves in space plasmas is presented.

#### References

1. Y. Omura, D. Nunn, H. Matsumoto and M. J. Rycroft, A Review of Observational, Theoretical and Numerical Studies of VLF Triggered Emissions, *Journal of Atmospheric and Terrestrial Physics*, vol. 53, pages 351 - 368, 1991.
2. M. Gołkowski, V. Harid, and P. Hosseini, Review of controlled excitation of non-linear wave-particle interactions in the magnetosphere, *Front. Astron. Space Sci.* 6:2. doi: 10.3389/fspas.2019.00002, 2019
3. Y. Omura, Y. Miyashita, M. Yoshikawa, D. Summers, M. Hikishima, Y. Ebihara, and Y. Kubota, Formation process of relativistic electron flux through interaction with chorus emissions in the Earth's inner magnetosphere, *J. Geophys. Res. Space Physics*, 120, 9545–9562, doi:10.1002/2015JA021563, 2015.
4. Y. Omura and Q. Zhao, Relativistic electron microbursts due to nonlinear pitch-angle scattering by EMIC triggered emissions, *J. Geophys. Res.*, 118, 5008–5020, doi: 10.1002/jgra.50477, 2013.
5. J. E. Borovsky and G. L. Delzanno, Active experiments in Space: The Future, *Front. Astron. Space Sci.* 6:31. doi: 10.3389/fspas.2019.00031, 2019.

## Therapeutic Technologies of Electromagnetic Fields for Cancer Treatment

Koichi Ito

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URSI Commission K widely covers the topics related to Electromagnetics in Biology and Medicine. Its terms of reference include medical applications of electromagnetic fields (EMFs). The presentation focuses on cancer treatment with EMFs.

There are different approaches to cancer treatment such as surgery, radiotherapy, chemotherapy, gene therapy, immunotherapy, electrochemotherapy, hyperthermia and ablation. Two or more different ways are sometimes combined for better clinical outcome. Technologies based on EMFs have greatly contributed to cancer treatment with collaboration of medical people.

Hyperthermia and ablation utilize temperature elevation in the human tissue caused by EM energy and are sometimes referred to as thermal therapy. On the contrary, a few different types of cancer treatment such as electrochemotherapy are based on non-thermal effects of EMFs. Hyperthermia exploits the difference of thermal sensitivity between tumor and normal tissue. The target tumor is usually heated up to the range between 42 and 45°C that results in less damage to the surrounding normal tissues. Moreover, therapeutic effects of other cancer treatments such as radiotherapy and chemotherapy can be enhanced by combining with hyperthermia. Ablation has been applied mainly for treatment of small-sized tumors. During the treatment, a thin antenna is directly inserted into the tumor to heat well over 60 °C and its treatment time is usually around a few minutes.

Recently, with the advent of sophisticated medical imaging technologies, image-guided thermal therapy has been developed and employed to further improve QOL (quality of life) of patients and to ease an operation for medical doctors. A typical example is a magnetic resonance guided annular phased array hyperthermia which can produce therapeutic temperatures in the human body and visualize real-time 3D temperature mapping. Another example is a focused microwave hyperthermia for breast cancer treatment guided by thermoacoustic tomography. As for ablation, image-guided microwave ablation (MWA) has emerged as a minimally invasive therapeutic modality for cancer treatment.

Unlike antennas for telecommunications, SAR (specific absorption rate) and temperature distributions in a human body are essential parameters of antennas for thermal therapies. It is almost impossible to use real human bodies for experimental evaluation of such thermal therapies. Instead, computer simulation is usually performed with sophisticated digital human-body models or human digital twins. Multiphysics simulation with digital phantoms is a powerful tool for the development and evaluation of various medical devices. A recent program announced by the FDA (U.S. Food and Drug Administration) will qualify such tools which may eliminate or mitigate much of the risk and uncertainty in product development.

However, experiments with physical phantoms are indispensable to validate the results of numerical simulations or to minimize animal experiments. Various types of physical human phantoms have been developed and utilized for experimental investigations. Semi-solid phantoms are suitable to the experiments for in-body medical devices.

Finally, a couple of further challenges will be briefly addressed including “theranostics” that means a combination of therapeutics and diagnostics for cancer treatment as well as advanced physical phantoms for evaluation of antennas for thermal therapy.

## **Biographical Sketches of Invited Attendees**

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## **Takaaki Kajita**

**Distinguished University Professor, The University of Tokyo, Japan**

**President, Science Council of Japan; 2015 Nobel Laureate in Physics**

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**Takaaki Kajita** has been serving as the President of Science Council of Japan since October 2020. He is the Distinguished University Professor at The University of Tokyo, and also the Director of Institute for Cosmic Ray Research (ICRR) of The University of Tokyo. He received his Ph.D. from The University of Tokyo School of Science in 1986, and has been researching at Kamiokande and Super-Kamiokande detectors at Kamioka Observatory in central Japan. In 1998, at the Neutrino International Conference held in Takayama, Gifu, he showed the analysis results which provided strong evidence for atmospheric neutrino oscillations. In 2015, he shared the Nobel Prize in Physics for his role in discovering atmospheric neutrino oscillations. Currently, he is the project leader for KAGRA Project, aiming to explore the gravitational wave astronomy.

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## **Yukari Takamura**

**Professor, The University of Tokyo, Japan**

**Vice-President, Science Council of Japan**

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**Yukari Takamura** serves as Vice President since October 2020. She is Professor at the Institute for Future Initiatives, The University of Tokyo.

After receiving Master of Laws (Public International Law) from Hitotsubashi University, Tokyo, she was appointed Associate Professor at Shizuoka University. Before joining the University of Tokyo in 2018, she worked as Professor at Ryukoku University, Kyoto, and Professor at Nagoya University, Japan. She also studied at Graduate School of University of Paris II (Panthéon-Assas), France and was Visiting Researcher at University of London, U.K.

Specializing international law and environmental law, her research focuses on legal and governance issues relating to multilateral environmental agreements as well as climate and energy laws and policies.

She is member of the Editorial Board of Journal Sustainability Science and of the Editorial Advisory Board of Journal Climate Policy. She is member of Board of Directors of Japanese Society for Environmental Economics and Policy Studies as well as member of Board of Executive Directors of Japanese Society for Environmental Law and Policy Studies.

She serves as member of governmental advisory bodies, among others, Central Environmental Council as President, and Procurement Price Calculation Committee for Feed-in Tariff Scheme for Renewable Energy as chair. She is member of Advisory Group on Climate Change and Sustainable Development of ADB. She received Environmental Conservation Merit's Minister of the Environment Award in 2018.

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## Sawako Shirahase

Professor, The University of Tokyo, Japan

Council Member, Section I, Science Council of Japan; Vice President, International Science Council

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**Sawako Shirahase** is a professor of sociology at the Graduate School of Humanities and Sociology, the University of Tokyo. She received her D.Phil in sociology from University of Oxford in 1997, and joined the University of Tokyo in 2006. She became a professor at the Department of Sociology in 2010. She served as Vice President of the University of Tokyo in 2018 and has been an Executive Vice President for International Affairs at the University of Tokyo for two years since 2019. She is currently Director of the UTokyo Center for Contemporary Japanese Studies (TCJS). She also has served as a Senior Vice Rector at the United Nations University since 2021.

Her main research interests include social stratification and social demography, inequality in income and wealth, and family and social security system in cross-national perspectives. She has run several large research projects as a principal investigator. They are (1) the research project on “A Comprehensive Study Examining the Forms of Social Stratification in an Aging Society and Constructing Public Norms” (Grand-in-Aid for Scientific Research (S), 2008-2012), (2) the research project on “A Comprehensive Study of the Structural Change in Social Stratification and the Mechanism of Generating Inequality in the Ageing Society with Low Fertility” (Grant-in-Aid for Specially Promoted Research, 2013-2017), and (3) research on “An Empirical Research on how to Generate the Structure of Social Stratification in the Aged Society with Low Fertility,” (Grant-in-Aid for Scientific Research, 2018-2020).

She has published books and articles on these issues including *Social Stratification in an Aging Society with Low Fertility: The Case of Japan* (ed.) (2022, Springer), *The Structure of Stratification in the Aged Society with Low Fertility*, Vol. 1-3 (eds.) (2021, University of Tokyo Press, in Japanese), *Todai Juku: Demography and Society: Looking for the Future in Japan* (ed.) (2019, University of Tokyo Press, in Japanese), *Social Inequality in Japan* (2014, Routledge), *Demographic Change and Inequality in Japan* (ed.) (2011, Trans Pacific Press), “Social Stratification Theory and Population Aging Reconsidered” (2021, : 277-288), “Income inequality among older people in rapidly aging Japan” (2014, *Research in Social Stratification and Mobility* 41:1-15).

She is a Vice President for Finance for International Science Council since 2020, and has also served as a Vice President of the International Sociological Association since 2018.



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**Piergiorgio L. E. Uslenghi**

**Distinguished Professor Emeritus, The University of Illinois at Chicago, USA**

**President, URSI**

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**Piergiorgio L. E. (George) Uslenghi** is a Distinguished Professor Emeritus in the University of Illinois at Chicago, and is the current President of URSI. He has published extensively on electromagnetics, optics, acoustics, microwaves, scattering theory, complex electronic materials, and applied mathematics. He is a Member of the Phi Beta Kappa and Sigma Xi Honorary Societies, a Fellow of URSI, a Life Fellow of IEEE, a recipient of the IEEE Third Millennium Medal, a Honorary Member of USNC-URSI, a Member of the Academy of Sciences of Turin, a Past President of the IEEE Antennas and Propagation Society, a University of Illinois Scholar, and a Distinguished Alumnus of the Polytechnic of Turin.

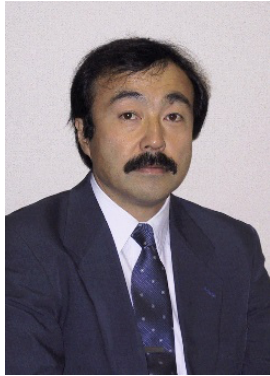
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## **Makoto Ando**

**Professor Emeritus, Tokyo Institute of Technology, Japan**

**Associate Member, Science Council of Japan; Immediate Past President, URSI**

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**Makoto Ando** received his doctorate of engineering in electrical engineering from Tokyo Institute of Technology in 1979. He subsequently joined NTT and was engaged in the development of antennas for satellite communication. He moved to Tokyo Institute of Technology in 1982 and served as a Professor and 2015-2018 Executive Vice President for Research. In 2018, he moved to National Institute of Technology (KOSEN) and served as the senior executive director until his retirement in 2020. Since 2020, He is the Program Director of Strategic Information and Communications R&D Promotion Programme (SCOPE) of Ministry of Internal Affairs and Communications, Japan (MIC). He also chairs the selection committee for Beyond 5G R&D Promotion Project of NICT issued by MIC.

His main interests have been field and waves in radio science, especially high frequency diffraction theory, the design of waveguide planar arrays, and millimeter-wave antennas for future wireless communication. He plays a leading role in the promotion of a wide range of applications of millimeter-wave wireless communications in Japan.

His international activities have included service as 2009 president of the IEEE Antennas and Propagation Society (AP-S), 2018-2019 President of The Institute of Electronics, Information and Communication Engineers (IEICE), Japan and 2017-2021 president of the International Union of Radio Science (URSI),

Professor Ando is a fellow of IEEE, URSI and an honorary member of IEICE.

Recognized by the IEICE with the Distinguished Achievement and Contributions Award, he has also received the Inoue Prize for Science, both the Meritorious Award on Radio and the Meritorious Award on Contributions to the Promotion of Computerization from the Minister of Internal Affairs and Communications (MIC) and the 2016 Culture Award from the Japan Broadcasting Corporation (NHK).

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## Peter Van Daele

Professor, Ghent University, Belgium

Secretary-General, URSI

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**Peter Van Daele** is Secretary General of URSI, the International Union of Radio Science, non-governmental and non-profit organisation under the International Council for Science, responsible for stimulating and coordinating, on an international basis, studies, research, applications, scientific exchange, and communication in the fields of radio science, radio communications, radio propagation and electromagnetic waves.

Peter Van Daele was elected as Secretary General of URSI in 2017 and served as Assistant Secretary General already since 1993. He is also professor at Ghent University, Belgium and permanent member of staff from IMEC (Interuniversity MicroElectronics Center) in Belgium and more specifically with the IDLab (Internet Technology and Data Science Lab).

He was and is directly responsible for several EU-funded research projects both on a technological level as well as on a more coordinating level e.g. as project coordinator of projects in the field of microelectronics and later in the area of Future Internet and Next Generation Internet. Currently he is project coordinator of the European funded H2020-project “Fed4FIRE+” offering open access to the largest federation worldwide of facilities for experimental research in the area of Next Generation Internet.

Peter Van Daele is author or co-author of over 400 publications and presentations in international journals or at international conferences and is involved in the organization of some major conferences in the field, such as ECOC (European Conference on Optical Communications) as well as the URSI Flagship meetings.

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## Kazuya Kobayashi

Professor, Chuo University, Japan

Associate Member, Science Council of Japan; Vice-President, URSI; Assistant Secretary-General (AP-RASC), URSI; Vice-President, Japan National Committee of URSI

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**Kazuya Kobayashi** received his B.S., M.S., and Ph.D. degrees, all in electrical engineering, from Waseda University, Tokyo, Japan in 1977, 1979, and 1982, respectively. In 1982, he joined the Department of Electrical, Electronic, and Communication Engineering, Chuo University, Tokyo, Japan, where he has been Professor since 1995. He held central management positions at Chuo University including, Vice President (2006-2008), Director of International Center (2003-2006), and Secretary to President (2001-2003).

Dr. Kobayashi held Visiting Professor and Visiting Scientist positions at various institutions including: Macquarie University, Sydney, Australia (2014, 2016, 2017, 2019); Karpenko Physico-Mechanical Institute of the National Academy of Sciences of Ukraine, Lviv, Ukraine (2001, 2018); Physical Research Laboratory, Ahmedabad, India (2015); Institute of Radiophysics and Electronics of the National Academy of Sciences of Ukraine, Kharkov, Ukraine (2001); University of Wisconsin-Madison, Madison, Wisconsin, USA (1987-1988). He has been Adjunct Professor at The Electromagnetics Academy at Zhejiang University, Hangzhou, China (since 2004) and Honorary Professor, Amity University, Noida, India (since 2019).

Dr. Kobayashi received a number of distinguished awards including: The President's Award (2020) from URSI (International Union of Radio Science) for his leadership and untiring efforts in initiating, organizing and establishing AP-RASC as one of the URSI Flagship Meetings; The Governor's Award (2018) from Toyama Prefectural Government, Japan for outstanding contribution to the promotion of tourism in Toyama Prefecture and raising international recognition through the holding of large-scale international conferences; JNTO Best International Convention Award (2016, 2018) from Japan National Tourism Organization (JNTO), The Government of Japan for outstanding contribution to the invitation of large-scale international congresses to Japan; M. A. Khizhnyak Award (2016) at "16th International Conference on Mathematical Methods in Electromagnetic Theory" (MMET\*2016) for contribution to electromagnetic theory.

Dr. Kobayashi is a Member of Science Council of Japan, a Fellow of The Electromagnetics Academy, and a Fellow of URSI. He also serves as MICE Ambassador, JNTO since 2016. He has held various important positions in the international radio science and electromagnetics/optics communities including: Vice-President of URSI (since 2021); Vice-Chair (2014-2017) and Chair (2017-2021) of URSI Commission B; URSI Assistant Secretary-General AP-RASC (since 2015); President (2008-2018) and Vice-President (since 2021) of the Japan National Committee of URSI; Chair of the PIERS Awards Committee, The Electromagnetics Academy (since 2018); Series Editor of the book series "Springer Series in Optical Sciences", Springer Nature (since 2020); Editor of the journal "Radio Science" (since 2019).

Dr. Kobayashi has contributed significantly to organization of numerous international conferences including PIERS (Photonics & Electromagnetics Research Symposium) and URSI conferences as General Chair, General Co-Chair, and Chair/Co-Chair of the Technical Program Committee. He is currently involved in organizing "XXXV URSI General Assembly and Scientific Symposium" (URSI GASS 2023; August 2023, Sapporo, Japan) as General Chair and Associate Scientific Program Coordinator.

His research interests are in the areas including: analytical regularization methods; Wiener-Hopf methods; high-frequency methods; electromagnetic theory; canonical problems; scattering and diffraction; radar cross section.

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**Giuliano Manara**

**Professor, University of Pisa, Italy**

**Vice-President, URSI**

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**Giuliano Manara** is a Professor at the School of Engineering of the University of Pisa, Italy. Since 1980, he has been collaborating with the Department of Electrical Engineering of the Ohio State University, Columbus, Ohio, USA, where, in the summer and fall of 1987, he was involved in research at the ElectroScience Laboratory. His research interests have centered mainly on the asymptotic solution of radiation and scattering problems to improve and extend the uniform geometrical theory of diffraction. He has also been engaged in research on numerical, analytical and hybrid techniques (both in frequency and time domain), scattering from rough surfaces, frequency selective surfaces (FSS), and electromagnetic compatibility. More recently, his research has also been focused on the design of microwave antennas with application to broadband wireless networks, on the development and testing of new

microwave materials (metamaterials), and on the analysis of antennas and propagation problems for Radio Frequency Identification (RFID) systems.

Prof. Manara was elected an IEEE (Institute of Electrical and Electronic Engineers) Fellow in 2004 for “contributions to the uniform geometrical theory of diffraction and its applications.” In August 2008, he was elected the Vice-Chair of the International Commission B “Fields and Waves” of URSI (International Radio Science Union). He served as the International Chair of URSI Commission B for the triennium 2011-2014. Prof. Manara has been elected a URSI Fellow in 2017. In 2021 he has been elected Vice- President of URSI.

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**W. Ross Stone**

**President, Stoneware Ltd., USA**

**Assistant Secretary-General (GASS and Publications), URSI**

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**W. Ross Stone** has over 50 years of industry and consulting experience. He is an expert in antennas, propagation, cellular and wireless communications, cell phones, handsets, base station, mobile, RF, HF, VHF, UHF, microwave, and millimeter-wave technologies. He was Editor-in-Chief of the IEEE Antennas and Propagation Magazine and its predecessor publication for over 30 years. He is Editor of the Radio Science Bulletin of URSI (the International Union of Radio Science), a position he has held for more than 23 years. It is estimated he has edited over 10,000,000 peer-reviewed words in print. He is Assistant Secretary General (Publications) of URSI. Among other positions, he was Chief Scientist of McDonnell Technologies, Research Advisor of IRT Corp., and Executive Director of an international scholarship fund in telecommunications. He has been President of his own consulting firm for over 40 years, a Director and/or principal of five companies, and an investor in and/or active part of 16 startup companies. He has been an Adjunct Full Professor of the Polytechnic University of Turin, Italy, and is currently an Adjunct Full Professor of Beijing Jiaotong University. He is a Life Fellow of the IEEE, a Fellow of URSI, a Fellow of the CIE, a Fellow of the Electromagnetics Academy, an Honorary Life Member of the IEEE Antennas and Propagation Society Administrative Committee (AdCom), a Director of the European Association on Antennas and Propagation, and author/editor of seven books and over 100 journal and conference papers.

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## **Willem A. Baan**

**Senior Scientist Emeritus, Netherlands Institute for Radio Astronomy (ASTRON), the Netherlands**

**Assistant Secretary-General (AT-RASC), URSI**

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**Willem A. Baan** has received an Aerospace Engineer degree at TU Delft in the Netherlands and MSc (plasma physics) and PhD (theoretical astrophysics) degrees at MIT in the United States.

After a Postdoctoral Fellowship at the Institute for Advanced Study (Princeton, USA) he lectured Astronomy at the Pennsylvania State University and did astrophysical research at Arecibo Observatory (Cornell University). Upon returning to The Netherlands he served as Director of the Westerbork Observatory and Head of the Science Group at the Netherlands Institute for Radio Astronomy (ASTRON).

After his obligatory retirement, Baan worked as a Visiting Professor at the Shanghai Astronomical Observatory (CAS SHAO) and continues as a Foreign Expert Professor at the XinJiang Astronomical Observatory (CAS XAO) in Urumqi, CN.

After some theoretical work in X-ray astronomy, most research has in the area of extragalactic molecular spectroscopy using radio telescopes – or searching for and interpreting molecular emissions in the Galaxy and in other galaxies.

In addition to astronomical research, he was very active in legal and regulatory efforts to protect radio telescopes from outside interference (pollution of the radio spectrum).

Willem Baan has been active in URSI for many years. He has served on the URSI Board and as Program Chair for the recent AT-RASC meeting.



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**Sana Salous**

**Professor, Durham University, UK**

**Assistant Secretary-General (WIRS), URSI**

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**Sana Salous** holds the Chair of Communications Systems at Durham University since 2003. She has radio propagation experience from high frequency (HF) to millimeter wave frequency bands. To support these studies she has developed novel channel sounders based on digital frequency sweep techniques.

She acted as Chair of Commission C of the International Union of Radio Science (2014-2017) and co-chair of the Working Group on Radio Channels in the COST Action IRACON. She is a member of the UK delegation to the Study Group 3 of the International Telecommunications Union and a regular contributor to working party 3K. She is also Editor in Chief of the journal Radio Science.



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**Paul Cannon**

**Professor, University of Birmingham, UK**

**Past President, URSI**

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**Paul Cannon** is a physicist and an electronic engineer who works at the interface of the two disciplines. He is an academic at the University of Birmingham but spent the majority of his working life in government research laboratories and industry. Since joining the University of Birmingham in 2013, he has been a regular advisor to government departments and science advisors. His leadership of studies and authorship of reports on extreme space weather have guided the development of government policy in both Australia and the UK.

Paul has made numerous contributions to radio science and space weather especially in the fields of ionospheric radio propagation, measurement and real-time modelling. He has specialised in combining knowledge of radio systems with knowledge of the ionospheric medium and radio propagation to develop new and novel science and engineering solutions.

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## **Hiroshi Matsumoto**

**Director, International Institute for Advanced Studies, Japan**

**Professor Emeritus, Kyoto University, Japan**

**Past President, URSI**

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**Hiroshi Matsumoto** is the director of the International Institute for Advanced Studies. From 2015 to 2022, he was President of RIKEN. He is an expert in space radio science, space plasma physics, and space solar power transmission. He completed gained doctoral degree from Kyoto University in 1973. From 2002 to 2004, Director of the Research Institute for Sustainable and Radio Sciences, Kyoto University, and from 2004 to 2005, Director of the Research Institute for Sustainable Humanosphere.

He also served as President of Kyoto University from 2008 to 2014.

He has received numerous awards and honors, including the Gagarin Medal of the Russian Astronaut Federation, the Chevalier of the Order of Honor of the French Army, the Honorary Officer of the Order of Honor of the British Empire, and Grand Cordon of the Order of the Sacred Treasure of Japan in 2021.

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## Masashi Hayakawa

**Emeritus professor and Visiting professor, University of Electro-Communications (UEC), Japan  
CEO, Hayakawa Institute of Seismo Electromagnetics Co., Ltd., UEC Incubation Center, Japan**

**Past Chair, Commission E, URSI**

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**Masashi Hayakawa** was born in Nagoya, Japan on February 26, 1944. He got his MS degree and Doctor of Engineering degree, all from Department of Electrical Engineering of Nagoya University in 1968 and 1974 respectively. He joined the Research Institute of Atmospherics, Nagoya University as a research associate in 1970 and became Assistant Professor in 1968 and Associate Professor in 1969. Dr. Hayakawa worked for Sheffield University (UK) as a visiting lecturer in 1976 and for Laboratoire de Physique et Chimie de l'Environnement (LPCE) (France) as a visiting professor in 1980-81. Since 1991 he has been a professor of University of Electro-Communications (UEC) and retired from the university in 2009. Then he is an Emeritus Professor of UEC, and he has, in 2011, established a venture company of Hayakawa

Institute of Seismo Electromagnetics, Co. Ltd. (Hi-SEM) acting as CEO. He was the Vice-chair and Chair of Commission E of URSI, and the presidents of Atmospheric Electricity of Japan and of Earthquake Prediction Society of Japan. Also he was a co-editor of URSI journal, Radio Science, and is now Editor-in-Chief of Open Journal of Earthquake Research. He has authored and co-authored over 800 papers, and have published and edited more than 40 monographs. His interests are simply radio noises just around the Earth, but very diverse; plasma waves in the ionosphere/magnetosphere (their generation and propagation), atmospheric electricity (sferics, Schumann resonances, lightning physics etc.), seismo-electromagnetics (electromagnetic phenomena associated with earthquakes for earthquake prediction), EMC, signal processing (direction finding, inverse problems) etc.

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## **Michiko Kuroda**

**Professor Emeritus, Tokyo University of Technology, Japan**

**Associate Member, Science Council of Japan; Chair, WIRS Chapter in Japan, URSI**

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**Michiko Kuroda** received Ph.D. in Electrical Engineering from Waseda University, Tokyo, Japan, in 1978. She became an Associate Professor at Tokyo University of Technology in 1990. She was promoted to a Professor and then was a Dean of the School of Computer Science. Now, she is a Professor Emeritus. She has been a scientific advisor of guidance on the Ministry of Public Management, Home Affairs, Post and Telecommunications in Japan, a vice president of the electronics society of IEICE, a chair of IEEE Japan Council on Women in Engineering, a member of the Board of directors of ACES, a chair of the Technical Committee of Electromagnetic theory of IEEJ. From 2022, she is a chair of Women in Radio Science Japan. Her research interests are electromagnetic theory, and numerical methods including FDTD and grid generation methods. She is a Fellow of IEICE.

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## Hiroko Shinnaga

**Associate professor, Physics and Astronomy Department at Kagoshima University  
Amanogawa Galaxy Astronomy Research Center (AGARC), Japan**

**Associate Member, Science Council of Japan; Co-Chair, WIRS Chapter in Japan, URSI**

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**Hiroko Shinnaga** is a Japanese astrophysicist at the graduate school of Kagoshima University. She researches star formation and evolution using interstellar dust and molecular lines in Cosmos. Her current focus is on the interstellar/circumstellar magnetic fields to use as tools to diagnose the evolutionary status of astronomical objects and how they impact the evolution of our Milky-Way Galaxy (which is called Amanogawa Galaxy in Japanese).

After acquiring her DSc at the graduate school of Ibaraki University Japan, she joined the submillimeter array (SMA) groups at ASIAA, Taiwan, and at Harvard-Smithsonian Center for Astrophysics in the United States and worked as a postdoctoral fellow. She then joined the submillimeter group as a staff research scientist at California Institute of Technology (Caltech), which operated the Caltech Submillimeter Observatory (CSO) on the top of Mauna Kea, on the Hawaii island in the United States. She was one of the core members of the ESMA project that connected the SMA- the James Clerk Maxwell Telescope 15m – the CSO 10.4m Leighton Telescope. She moved back to Japan to join the Nobeyama Radio Observatory and the East Asia ALMA Regional Center of the Chile Observatory of the National Astronomical Observatory of Japan (NAOJ), which operates the ALMA telescope above 5,000 m altitude in the Atacama Desert of Chile. She served as the pipeline subsystem scientist at ALMA as an assistant professor of NAOJ. Now she is an associate professor of the Physics and Astronomy Department and a member of AGARC at Kagoshima University, Japan. She was a visiting research scholar at the National Radio Astronomy Observatory in the United States.

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## **Ryuji Kohno**

**Professor Emeritus, Yokohama National University, Japan**

**Vice-President, YRP International Alliance Institute, Japan**

**Associate Member, Science Council of Japan**

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**Ryuji Kohno** received the Ph.D. degree from the University of Tokyo in 1984. He was a Professor and the Director of Centre on Medical Information and Communication Technology, in Yokohama National University in Japan for 1998-2021 and then Professor Emeritus. In his career he played a part-time role of a director of Advanced Telecommunications Laboratory of SONY CSL during 1998-2002, directors of UWB Technology and medical ICT institutes of NICT during 2002-2012. For 2012-2020 he was CEO of University of Oulu Research Institute Japan – CWC-Nippon Co. and since 2020 Vice-President of YRP International Alliance Institute. The meanwhile for 2007-2020 a distinguished professor in University of Oulu in Finland and since 2006 a member of the Science Council of Japan. In IEEE he was a member of the Board of Governors of Information Theory Society in 2000-2009, and editors of Transactions on Communications, Information Theory, ITS, IEEE802.15 standardization TG6ma Chair and IEEE Life Fellow. In IEICE he was Vice-president of Engineering Sciences Society of IEICE during 2004-2005, Editor-in chief of the IEICE Trans. Fundamentals during 2003-2005 and IEICE Fellow. He is a founder and a chair of steering committee of international symposia of medical information and communication technologies (ISMICT) since 2006. He is a member of the Science Council of Japan since 2006.

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## **Yoshiharu Omura**

**Professor, Research Institute for Sustainable Humanosphere (RISH), Kyoto University, Japan**

**Past Chair, Commission H, URSI**

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**Yoshiharu Omura** received Ph.D from Faculty of Engineering of Kyoto University in 1985. He worked as research associate (1985-1988), associate professor (1988- 2000), and professor (2000-present) at Kyoto University. He also worked as NRC senior research associate at NASA Goddard Space Flight Center (1991-1992). He performed particle simulations and theoretical analysis of electrostatic solitary waves, and he has been working on nonlinear theory and simulations of chorus and ion cyclotron emissions and the associated acceleration and precipitation of radiation belt electrons. He received Zeldovich Award of Committee on Space Research (COSPAR), Commission D, 1992, Tanakadate Award of Society of Geomagnetism and Earth, Planetary and Space

Sciences (SGEPSS), 1996, Science and Technology Award presented by Minister of Culture, Sports, Science, and Technology in Japan, 2006, and Appleton Prize of URSI, 2017. He was appointed as Academician in Basic Science of International Academy of Astronautics (IAA), 2019 and Fellow of American Geophysical Union (AGU), 2022. He worked for URSI as Vice Chair of commission H (2005-2008), Chair of Commission H (2008-2011) , and Chair of Long Range Planning Committee (2011-2014). He currently serves as the president of Solar and Terrestrial Sciences Section of Asia Oceania Geosciences Society (AOGS) (2020 – present).

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## Koichi Ito

**Emeritus Professor, Chiba University, Japan**

**Designated Associate Member, Science Council of Japan; Chair, Commission K, URSI**

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**Koichi Ito** was born in Nagoya, Japan. He received the Ph.D degree from Tokyo Institute of Technology, Japan. He is currently a Professor Emeritus and Visiting Professor at the Center for Frontier Medical Engineering (CFME), Chiba University, Japan. He served as Deputy Vice-President for Research and Director of the CFME, Chiba University.

He was appointed as a Visiting Professor to various universities including Hiroshima University, Japan. He has also been appointed as an Honorary Professor of Xidian University, China.

His main research interests include antennas for medical applications, research on evaluation of the interaction between electromagnetic fields and a human body by use of phantoms, and antenna systems for body-centric wireless communications. He has authored and co-authored over 210 peer-reviewed journal papers, nearly 420 international conference papers and over 20 book chapters.

Dr. Ito is a Fellow of URSI, a Life Fellow of IEEE, and a Fellow of IEICE, Japan. He served as an Associate Editor for the IEEE Transactions on Antennas and Propagation, an AdCom member for the IEEE AP-S, a Distinguished Lecturer for the IEEE AP-S, General Chair of IEEE iWAT2008, a member of the Board of Directors, the Bioelectromagnetics Society, General Chair of ISAP2012, a Delegate to the European Association on Antennas and Propagation (EurAAP), a Vice-President of the Japanese Society for Thermal Medicine, Vice-Chair of URSI Commission K and IEEE AP-S President for 2019. He currently serves as Chair of Commission K, URSI, an IEEE AP-S AdCom member as a past-president, and Chair of IEEE AP-S New Technology Directions Committee.

He is the recipient of the 2020 Balthasar van der Pol Gold Medal from URSI.



# Japan National Committee of URSI 1922-2022

Edited by: Satoshi Yagitani and Kazuya Kobayashi

## 1. The Science Council of Japan and URSI

In January 1949, the Science Council of Japan (SCJ) was founded, as a special organization of the Cabinet Office to represent the country's scientists both domestically and internationally, under the jurisdiction of the Prime Minister. Its role is to deliberate on and realize important science matters independently from the government, promote communication of scientific research, and improve its efficiency.

SCJ consists of 210 Council Members and some 2,000 Associate Members, elected as representatives of the approximately 850,000 scientists nationwide. It conducts activities from a universal perspective and a comprehensive and multifaceted point of view, taking advantage of the fact that it is comprised of scientists from a broad-range of fields spanning over humanities and social sciences, life sciences, and physical sciences and engineering. SCJ's key activities are the following:

- Direct recommendations of opinions by Japanese scientists to the government and society.
- Contribute to academic promotion in local communities and enhancement of academic societies.
- Deepen mutual understanding of science through dialogue with civil society.
- Promote international academic exchanges as a leading science academy in Japan.

The SCJ organization comprises a General Assembly, three sections (Section I: Humanities and Social Sciences; Section II: Life Sciences; Section III: Physical Sciences and Engineering), an Executive Board, Administrative Committees for Operation, 30 Specialty Committees (depending on the categorization into 30 academic disciplines), and issue centered committees, and auxiliary committees. The details of the organization of SCJ are depicted in Figure 1.

One of the 30 Specialty Committees is the Specialty Committee on Electrical and Electronic Engineering, to which the Japan National Committee of URSI (JNC-URSI) belongs, [1, 2].

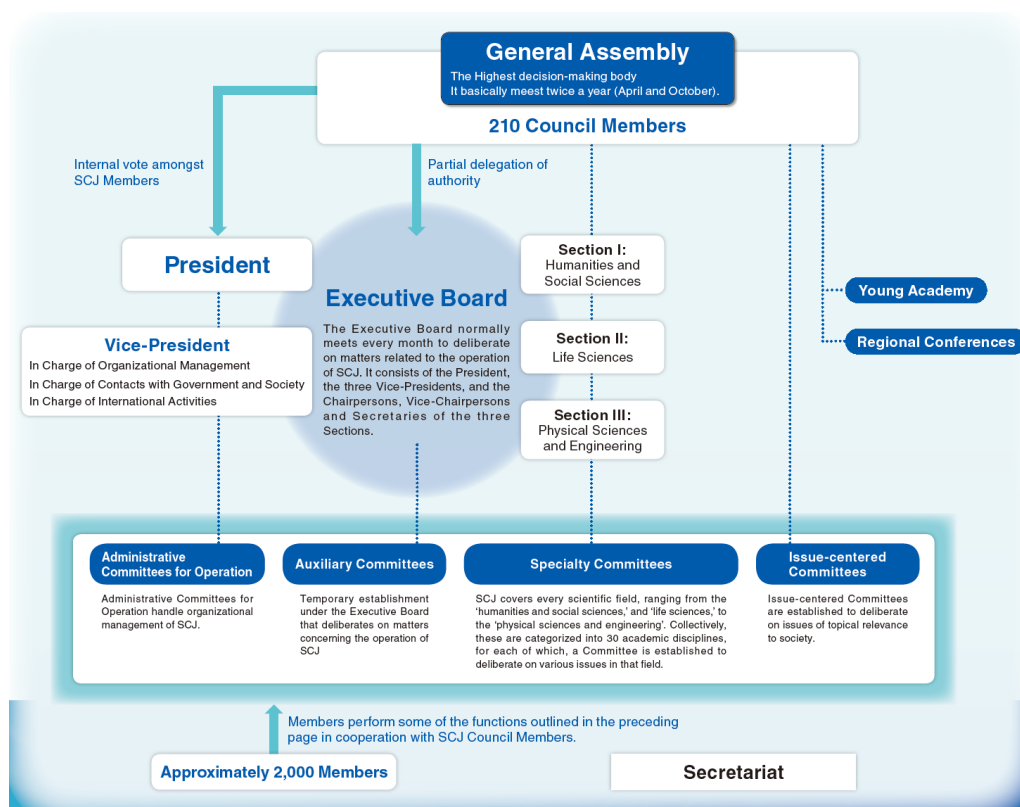


Figure 1. The organization of the Science Council of Japan (SCJ).

## References

1. Science Council of Japan, <http://www.scj.go.jp/en/index.html>.
2. Pamphlets of Science Council of Japan, <http://www.scj.go.jp/en/scj/pamphlets.html>.

(Kazuya Kobayashi and Satoshi Yagitani)

## 2. Japan National Committee of URSI

After URSI's foundation in 1919, the first URSI General Assembly (GA) was held in July 1922 in Brussels, Belgium. By this time four URSI Member Committees had been officially formed in Belgium, France, United Kingdom, and USA. In 1922 a further five URSI Member Committees adhered to URSI being Australia, Spain, Italy, Japan, and the Netherlands, [1].

The Japanese National Committee of URSI (JNC-URSI) was officially established in 1922 and when the second URSI GA was held in October 1927 in Washington, D.C., USA, Japan contributed for the first time with Dr. Tsutomu Minohara, Dr. Eitaro Yokoyama, Dr. Toyokichi Nakagami, and Dr. Sannosuke Inada attending as the official delegates [2].

Radio science research and related URSI activities in Japan are conducted under the leadership of JNC-URSI, which currently consists of about 200 official members nationwide. As a consequence of its importance it was placed under the supervision of the Science Council of Japan (SCJ) in 1949 when SCJ was founded by the Government of Japan. Since 1993, when the XXIVth URSI General Assembly was held in Kyoto, Japan, JNC-URSI has also adhered to The Institute of Electronics, Information and Communication Engineers (IEICE).

JNC-URSI has made significant contributions to various URSI activities since it was established in 1922. In addition to the research and developments Japan has also contributed to URSI management. In particular Japanese scientists, have and are currently serving, as URSI Officials including Honorary President, President, Vice-President, Assistant Secretary-General, Chairs, Vice-Chairs and Early Career Representatives (ECRs) of Commissions, and members of several Standing Committees.

JNC-URSI is a standing committee of SCJ, but this is reviewed and approved by the SCJ Executive Board at the beginning of each SCJ term. SCJ is now in its 25th term (three years from October 1, 2020 to September 30, 2023), and the JNC-URSI's purpose and agenda are currently:

### Purpose of installation

*The JNC-URSI is installed under the Special Committee of Electrical and Electronic Engineering in SCJ Section III, for the purpose that, on behalf of researchers and engineers in the field of radio science in Japan, JNC-URSI actively participates in various activities conducted by the URSI Headquarters, contributes to international collaboration on radio science, and promotes and strengthens radio-science-related activities in Japan.*

### Agenda items

*JNC-URSI deliberates on the following items and takes the necessary actions:*

- i) Collaboration with the URSI Headquarters from various aspects.*
- ii) Promotion and strengthening of domestic radio-science-related activities.*
- iii) Preparation and operation of the XXXVth URSI General Assembly and Scientific Symposium to be held in August 2023 in Sapporo.*

A list of Presidents, Vice-President, Secretaries, and Assistant Secretaries of the JNC-URSI from the 1st to 25th SCJ-terms is provided in Table 1. A list of Japanese URSI Officials are shown in Tables 2 and 3.

## References

1. URSI History: URSI origins, [http://www.ursi.org/ursi\\_history.php#tab-origins](http://www.ursi.org/ursi_history.php#tab-origins).
2. I. Koga, "On Forthcoming General Assembly of URSI," *The Journal of the Institute of Electrical Communication Engineers of Japan*, **46**, 1, January 1963, pp. 1-10 (in Japanese).

(Kazuya Kobayashi, Satoshi Yagitani, and Tsuneki Yamasaki)

**Table 1. Presidents, Vice-President, Secretaries, and Assistant Secretaries of the Japan National Committee of URSI (1949 to present).**

SCJ-term	Period	President	SCJ-term	Period	President
		Vice-President			Vice-President
		Secretary			Secretary
		Assistant Secretary			Assistant Secretaries
1st Term	1949-1951	Yusuke Hagihara	14th Term	1988-1991	Takanori Okoshi
		---			---
		---			Tomohiro Oguchi Masato Ishiguro Nobuo Matuura
		---			---
2nd Term	1951-1954	Yusuke Hagihara	15th Term	1991-1994	Saburo Adachi
		---			---
		Takeshi Nagata Toshihisa Sakamoto Takeo Hatanaka			Matsuichi Yamada Tomohiro Oguchi Tasuku Teshirogi
		---			---
3rd Term	1954-1957	Yusuke Hagihara	16th Term	1994-1997	Yoji Furuhamma
		---			---
		Toshihisa Sakamoto Takeo Seki			Yoshio Hosoya Tasuku Teshirogi Isamu Nagano
		---			---
4th Term	1957-1960	Issac Koga	17th Term	1997-2000	Yoji Furuhamma
		---			---
		Takeo Hatanaka Toshihisa Sakamoto Takeo Seki			Yoshio Hosoya Kazuo Sakai Masao Taki
		---			---
5th Term	1960-1963	Issac Koga	18th Term	2000-2003	Hiroshi Matsumoto
		---			---
		Takeo Hatanaka Yuichiro Aono Hisanao Hatakeyama Sogo Okamura			Yoshio Hosoya Masao Taki Kazuya Kobayashi
		---			---
6th Term	1963-1966	Atsushi Kimpara	19th Term	2003-2005	Hiroshi Matsumoto
		---			---
		Yuichiro Aono Sogo Okamura Masashi Miyaji Yasuo Taki			Yoshiharu Omura Masao Taki Kazuya Kobayashi
		---			---
7th Term	1966-1969	Atsushi Kimpara	20th Term	2005-2008	Hiroshi Matsumoto
		---			---
		Mochinori Goto Hideo Hirose Sogo Okamura Yasuo Taki Tatsuzo Obayashi			Kazuya Kobayashi
		---			Masao Taki Yoshiharu Omura

8th Term	1969-1972	Atsushi Kimpapa	21st Term	2008-2011	Kazuya Kobayashi
		---			---
		Mochinori Goto Hideo Hirose Sogo Okamura Yasuo Taki Tatsuzo Obayashi			Tsuneki Yamasaki
		---			Jun-ichi Takada Satoshi Yagitani
9th Term	1972-1975	Atsushi Kimpapa	22nd Term	2011-2014	Kazuya Kobayashi
		---			---
		Masahide Kamiyama Yoshihide Kozai Tatsuzo Obayashi Yasuo Taki			Satoshi Yagitani
		---			Jun-ichi Takada Tsuneki Yamasaki
10th Term	1975-1978	Atsushi Kimpapa	23rd Term	2014-2017	Kazuya Kobayashi
		---			---
		Kenji Akabane Tatsuzo Obayashi Bunichi Oguchi Yoshihide Kozai			Satoshi Yagitani
		---			Jun-ichi Takada Tsuneki Yamasaki
11th Term	1978-1981	Sogo Okamura	24th Term	2017-2020	Satoshi Yagitani
		---			---
		Kenji Akabane Takanori Okoshi Masaya Yamauchi Shigeru Yumi Hiroshi Yokoi			Shinichiro Ohnuki
		---			Yasuhide Hobara Keigo Ishisaka
12th Term	1981-1985	Haruo Tanaka	25th Term	2020-2023	Satoshi Yagitani
		---			Kazuya Kobayashi
		Takanori Okoshi Tomohiro Oguchi Yoshihide Kozai Masaki Morimoto Hisayoshi Yanai			Yasuhide Hobara
		---			Keigo Ishisaka Ryosuke Ozaki
13th Term	1985-1988	Takanori Okoshi			
		---			
		Nobuo Matuura Masaki Morimoto Yukio Hayakawa			
		---			

**Table 2. Present URSI Officials elected from Japan.**

Period	Name	Position
<b><i>Board of Officers</i></b>		
2021-present	Makoto Ando	Immediate Past President
2021-Present	Kazuya Kobayashi	Vice-President
<b><i>Secretariat</i></b>		
2015-present	Kazuya Kobayashi	Assistant Secretary-General (AP-RASC)
<b><i>Commission Officers (Chairs, Vice-Chairs, Early Career Representatives)</i></b>		
2021-present	Naoki Shinohara	Chair, Commission D
2021-present	Koichi Ito	Chair, Commission K
2021-present	Atsushi Kanno	Vice-Chair, Commission D
2021-present	Motoyuki Sato	Vice-Chair, Commission F
2017-present	Motoharu Sasaki	ECR, Commission F
2017-present	Kensuke Sasaki	ECR, Commission K

**Table 3. Past URSI Officials elected from Japan.**

Period	Name	Position
<b><i>Honorary Presidents</i></b>		
1981-1983	Issac Koga	Honorary President
<b><i>Presidents</i></b>		
2017-2021	Makoto Ando	President
1999-2002	Hiroshi Matsumoto	President
1963-1966	Issac Koga	President
<b><i>Vice-Presidents</i></b>		
2011-2017	Makoto Ando	Vice-President
1995-1999	Hiroshi Matsumoto	Vice-President
1990-1994	Takanori Okoshi	Vice-President
1981-1987	Sogo Okamura	Vice-President
1957-1962	Issac Koga	Vice-President
1928-1946	Hantaro Nagaoka	Vice-President
<b><i>Chairs of Commissions</i></b>		
2017-2021	Kazuya Kobayashi	Chair, Commission B
2014-2021	Yasuhiro Koyama	Chair, Commission A

2011-2014	Masao Taki	Chair, Commission K
2008-2011	Takashi Ohira	Chair, Commission C
2008-2011	Yoshiharu Omura	Chair, Commission H
2002-2005	Makoto Ando	Chair, Commission B
2002-2005	Masami Akaike	Chair, Commission C
2002-2005	Makoto Inoue	Chair, Commission J
1999-2002	Yoji Furuhashi	Chair, Commission F
1999-2002	Shoogo Ueno	Chair, Commission K
1996-1999	Masashi Hayakawa	Chair, Commission E
1987-1989	Takanori Okoshi	Chair, Commission D
1987-1989	Hiroshi Kikuchi	Chair, Commission E
1987-1989	Hiroshi Matsumoto	Chair, Commission H
1978-1980	Sogo Okamura	Chair, Commission A
1978-1980	Haruo Tanaka	Chair, Commission J

### 3. URSI Conferences Held in Japan

#### 3.1 URSI General Assemblies

The URSI General Assembly (GA) and subsequently URSI General Assembly and Scientific Symposium (GASS) have been held at intervals of three years to review current research trends, present new discoveries, and make plans for the future research and special projects in all areas of radio science. The URSI GA has been held twice in Japan. The first was the 14th GA held in Tokyo in 1963 and the second was the 24th GA held in Kyoto in 1993. The 35th GA is planned to be held again in Japan in 2023 (30 years after the Kyoto GA), and its venue city will be Sapporo [1]. The GAs held in the past are listed on the URSI website [2].

##### 3.1.1 XIVth URSI General Assembly in Tokyo

The XIVth (14th) GA was held September 9-20, 1963 in the Shinagawa Prince Hotel, Tokyo, [3, 4]. Table 4 shows the number of delegates in terms of URSI Member Committees, totaling 477. Table 5 shows the number of participants per participant category. As seen from this table, the grand total of participants including all the categories was 841. The number of URSI Member Committees was 28 before the 1963 GA (see the list of URSI Member Committees in Table 4), but this increased to 32 as a result of approved membership applications from Argentina, Ghana, Kenya, and China CIE.

##### 3.1.2 XXIVth URSI General Assembly in Kyoto

The XXIVth (24th) GA was held August 23-September 3, 1993 at the Kyoto International Conference Center, Kyoto [5, 6]. The numbers of submitted, accepted, and presented papers were 1600, 1358, and 1331, respectively. The detailed paper submission statistics in terms of Commissions are provided in Table 6. The total number of registrants was 1241 (regular: 1037, student: 204). In addition, a total of 113 students were selected as recipients of the Young Scientist Award (YSA), from among 204 applicants. The detailed registration statistics are provided in Table 7.

**Table 4. The number of delegates per URSI Member Committee at GA 1963 in Tokyo.**

URSI Member Committee	Number of delegates	URSI Member Committee	Number of delegates
Australia	10	Netherlands	6
Austria	0	New Zealand	2
Belgium	4	Norway	1
Canada	12	Peru	1
Czechoslovakia	1	Poland	1
Denmark	1	Portugal	0
Finland	1	Spain	1
France	39	Sweden	11
Germany	15	Switzerland	3
Greece	1	South Africa	3
India	3	United Kingdom	18
Italy	11	USA	144
Japan	166	USSR	21
Morocco	0	Yugoslavia	1
<b>TOTAL</b>		<b>477</b>	

**Table 5. The number of participants per participant category at GA 1963 in Tokyo.**

Participant category	Overseas	Japan
Delegate	311	166
Guest observer	4	8
Observer appointed by LOC Japan	0	189
Accompanying person	103	60
Subtotal	418	423
<b>Grand Total</b>	<b>841</b>	

**Table 6. The numbers of submitted, accepted, and presented papers per Commission at GA 1993 in Kyoto.**

Commission	Submitted	Accepted	Presented
A	64	62	62
B	262	150	143
C	145	128	127
D	112	93	91
E	132	103	102
F	132	116	111
G	224	209	207
H	249	248	245
J	145	143	139
K	117	88	87
YS	18	18	17
<b>TOTAL</b>	<b>1600</b>	<b>1358</b>	<b>1331</b>

**Table 7. The number of registrants per country/region at GA 1993 in Kyoto. The numbers in parentheses denote the number of registrants who did not show up onsite.**

Country/region	Regular	Student	Subtotal	Accompanying persons	Total
ARGENTINA	1	1	2	1	3
AUSTRALIA	25	3	28	5	33
AUSTRIA	2	1	3	0	3
BELARUS	0	1	1	0	1
BELGIUM	15	3	18	1	19
BRAZIL	5	0	5	1	6
BULGARIA	2	2	4	0	4
CANADA	22	2	24	3	27
CHINA-CIE(BEIJING)	13	11(1)	24(1)	0	24(1)
CHINA-SRS(TAIBEI)	6	3	9	2	11
CYPRUS	0	1	1	0	1
CZECH REP.	2	3	5	0	5
DENMARK	8	2	10	0	10
EGYPT	3	1	4	0	4
FINLAND	6	2	8	1	9
FRANCE	62	7(1)	69(1)	8	77(1)
GERMANY	46(2)	7	53(2)	6	59(2)
GREECE	2	1	3	0	3
HON GKONG	1	2	3	0	3
HUNGARY	5	2	7	0	7
INDIA	6	7	13	0	13
IRELAND	1	1	2	0	2
ISRAEL	10	0	10	2	12
ITALY	31	1	32	8	40
JAPAN	395(4)	85(1)	480(5)	7	487(5)
MALAYSIA	1	1	2	0	2
NETHERLANDS	14	2	16	0	16
NEW ZEALAND	4	0	4	0	4
NIGERIA	1	2(1)	3(1)	0	3(1)
NORWAY	7(1)	2	9(1)	0	9(1)
PERU	1	0	1	0	1
POLAND	6	1	7	0	7
PORTUGAL	1	0	1	0	1
RUSSIA	31	18	49	1	50
SINGAPORE	0	2	2	0	2
SOUTH AFRICA	5	1	6	2	8
SPAIN	2	2	4	0	4
SRILNKA	0	1	1	0	1
SWEDEN	33	1	34	6	40
SWITZERLAND	5	1	6	1	7
THAILAND	2	0	2	0	2
TURKEY	4	1	5	0	5
UK	43	3	46	13	59
UKRAINE	1	5	6	0	6
USA	207(1)	11	218(1)	43	261(1)
UZBEKISTAN	0	1	1	0	1
<b>GRAND TOTAL</b>	<b>1037</b>	<b>204</b>	<b>1241</b>	<b>111</b>	<b>1352</b>



### 3.1.3 XXXVth URSI General Assembly and Scientific Symposium in Sapporo

The XXXVth (35th) GASS will be held August 19-26, 2023 at the Sapporo Convention Center, Sapporo, (see Figure 2), <https://www.sora-scc.jp/eng/>, and Sapporo Business Innovation Center, Sapporo [1].

Sapporo is the fifth largest city in Japan by population, and the largest city of the northernmost Hokkaido Prefecture. Sapporo is particularly known outside Japan for having hosted the 1972 Winter Olympics, the first ever held in Asia. Annually, over 13 million tourists visit Sapporo from other parts of Japan and abroad. According to TripAdvisor's 2013 World's Top 10 Destinations on the Rise rankings, Sapporo is second in Asia and seventh worldwide. Meanwhile, Hokkaido was named the Best in Asia in 2017 by Lonely Planet. Summers in Sapporo are generally warm but importantly not humid, and are very comfortable. The average high/low temperatures in Sapporo in July and August are 24.9 °C/17.3 °C and 26.4 °C/19.1 °C, respectively. The Sapporo area is served by one of the busiest airports in Japan – New Chitose Airport, which can be easily reached directly from major cities in Asia. New Chitose Airport also provides over 70 flights connecting to Tokyo/Narita and Tokyo/Haneda. The Sapporo New Chitose – Tokyo Haneda route has been the busiest air route in the world since 2006, with more than 10 million passengers carried per year (see Figure 3 for flight connections to Sapporo). Various useful information on travel to Japan and to Sapporo is available on the websites of the Japan National Tourism Organization (JNTO) [7] and the City of Sapporo [8].

JNC-URSI has appointed Convention Linkage, Inc. <http://www.c-linkage.co.jp/en/> as the professional conference organizer (PCO). We have also set up the GASS 2023 Organizing Committee and the GASS 2023 Steering Committee, and started to make various local arrangements.



Figure 2. The Sapporo Convention Center (GASS 2023 venue).

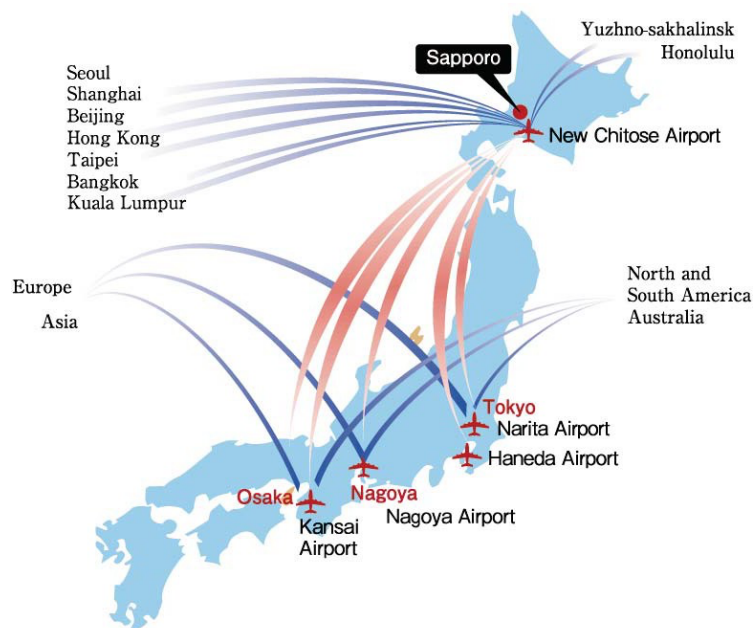


Figure 3. Flight connections to Sapporo.

### 3.2 URSI Asia-Pacific Radio Science Conferences

The JNC-URSI has made significant contributions to regional URSI activities in the Asia-Pacific area. One of the JNC-URSI's most important activities is the organization of the Asia-Pacific Radio Science Conference (AP-RASC) which is held every three years. Like other URSI meetings, the objective of AP-RASC is to review current research trends, present new discoveries, and make plans for future research and special projects in all areas of radio science, especially where international cooperation is desirable. A particular emphasis was initially placed on promoting various URSI activities in the Asia-Pacific area.

AP-RASC was established based on the initiatives of the JNC-URSI, and was held for the first time in Tokyo, Japan during August 1-4, 2001. It was a great success with 601 papers and 704 participants from 34 countries/regions [9]. The third AP-RASC (AP-RASC 2010) was held in Toyama, Japan on September 22-26, 2010; it was also successful, with 605 registered participants and 529 papers from 31 countries/regions [10]. Figures 4-7 show photographs taken at some of the conference events. The meeting had a very strong young scientist program consisting of the Student Paper Competition (SPC) and the Young Scientist Award (YSA), which had a great impact to the worldwide URSI community.

In 2016, AP-RASC was renamed as the URSI Asia-Pacific Radio Science Conference (URSI AP-RASC), and became an URSI Flagship Meeting. At present, there exist three URSI Flagship Meetings that include the URSI GASS, the URSI Atlantic Radio Science Conference (URSI AT-RASC), and URSI AP-RASC. Since URSI is currently involved in organization of the URSI AP-RASC from various aspects, the conference has been expanding and attracting more international participants. Data on the past AP-RASC conferences are shown in Table 8.



**Figure 4. The AP-RASC 2010 Opening Ceremony. Top (from left): K. Kobayashi, AP-RASC 2010 General Chair; F. Lefeuvre, President of URSI; T. Ishii, Governor of Toyama Prefecture; H. Matsumoto, Past President of URSI. Middle: Venue of Opening Ceremony. Bottom (from left): K. Kobayashi, AP-RASC 2010 Conference Chair; H. Matsumoto, Past President of URSI; T. Ishii, Governor of Toyama Prefecture; E. Takami, Interpreter; P. Lagasse, Secretary-General of URSI; P. Wilkinson, Vice-President of URSI; F. Lefeuvre, President of URSI.**





Figure 5. The Young Scientist Reception (SPC finalists and YSA recipients were invited to join).



Figure 6. The welcome address, conference dinner, and special entertainment at the AP-RASC 2010 Banquet. Top (from left): K. Kobayashi, AP-RASC 2010 General Chair; M. Mori, Mayor of Toyama City; P. Wilkinson, Vice-President of URSI; P. Lagasse, Secretary-General of URSI. Bottom (from left): Conference Dinner; Piano Performance by K. Kobayashi, AP-RASC 2010 General Chair.



Figure 7. The awards ceremony at the AP-RASC 2010 Banquet: (a) AP-RASC 2010 Student Paper Competition; (b) AP-RASC 2010 Young Scientist Award.

**Table 8. Past AP-RASC Conferences.**

Name of Conference	Dates	Venue	Statistics
(1st) AP-RASC 2001	August 1-4, 2001	Korakuen Campus, Chuo University, Tokyo, Japan	601 papers; 704 participants from 34 countries/regions
(2nd) AP-RASC 2004	August 24-27, 2004	Qingdao, China	not known
(3rd) AP-RASC 2010	September 22-26, 2010	Toyama International Conference Center, Toyama, Japan	566 papers; 605 registrants from 33 countries/regions
(4th) AP-RASC 2013	September 3-7, 2013	Howard International House, Taipei, Taiwan	618 papers; 576 registrants from 28 countries/regions
(5th) URSI AP-RASC 2016	August 21-25, 2016	Grand Hilton Seoul, Seoul, South Korea	687 papers; 789 registrants from 31 countries/regions
(6th) URSI AP-RASC 2019	March 9-15, 2019	India Habitat Centre, New Delhi, India	952 papers; 686 registrants from 31 countries/regions
(7th) URSI AT-AP-RASC 2022 <sup>1</sup>	May 29-June 3, 2022	The ExpoMeloneras Convention Centre, Gran Canaria, Spain (onsite/online hybrid)	826 papers; 792 registrants from 53 countries/regions

### 3.3 URSI - Japan Radio Science Meetings

The URSI-JRSM, organized by JNC-URSI, provides a regional scientific forum for radio scientists and engineers in Japan and the Asian region with similar objectives to the international meetings. A particular emphasis is placed on enhancing the visibility of URSI in Asia and encouraging young scientists to contribute to various URSI activities. The URSI-JRSM covers a wide range of topics in radio science specified by the 10 URSI Commissions, A-K.

The first URSI-JRSM was held in Tokyo, Japan, on September 8, 2014 [14]. A one-day program was organized as plenary sessions with three keynote lectures and ten invited talks from the URSI Commissions A-K by outstanding researchers from Japan and Asia. The meeting was successful with 204 participants.

The second URSI-JRSM was also held in Tokyo, Japan on September 3-4, 2015 [15], where scientific sessions were composed of plenary sessions with two keynote lectures, two special lectures and ten invited talks, and a poster session of contributed papers. The meeting was successful with 132 participants, and 74 papers (14 oral and 60 poster) being presented. The Student Paper Competition (SPC) was organized for full-time university students in a degree program and was financially supported by URSI. Among a total of 13 applicants for the SPC, three finalists were selected and awarded the first, second and third prizes. The papers by the three SPC awardees were published in the Special Section on URSI-JRSM 2015 Student Paper Competition in the March 2016 issue of the Radio Science Bulletin (RSB) [16]. A total of 13 papers, consisting of nine papers based on the keynote lectures, special lectures and invited talks, and four papers based on poster presentations at URSI-JRSM 2015 were published in a Special Issue of the 2015 URSI-Japan Radio Science Meeting in Radio Science [17].

The third URSI-JRSM was again held in Tokyo, Japan on September 5-6, 2019 [18]. The scientific programs consisted of plenary sessions with one keynote lecture and ten invited lectures by the ten URSI Commissions. Oral and poster sessions were arranged by each Commission for invited and contributed papers, with a total of 75 oral and 78 poster presentations. A number of the topics in the oral sessions addressed the history and perspective of radio science research in Japan, on the centennial anniversary of URSI. The meeting was successful with a total of 232 scientists and engineers attending from three countries. A SPC was organized again and the papers by the three awardees (first, second and third prizes)

<sup>1</sup> Due to the COVID-19 pandemic, URSI AP-RASC 2022 was held combined with URSI AT-RASC 2022, as URSI AT-AP-RASC 2022.



among seven applicants were published in the URSI-JRSM 2019 Student Paper Competition Special Issue in the March 2020 issue of the RSB [19]. A total of six papers based on the keynote and invited lectures at URSI-JRSM 2019 were published in a Special Issue of the 2019 URSI-Japan Radio Science Meeting in Radio Science.

The fourth URSI-JRSM was held in Tokyo, Japan on September 1-2, 2022 [20]. As with the previous URSI-JRSM 2019, it consisted of two keynote lectures, ten invited lectures by the A-K Commissions, oral sessions and a poster session. The meeting was successful with a total of 201 participants, 68 oral and 50 poster presentations. A total of nine students applied for the SPC, among which the three awardees (first, second and third prizes) were selected whose papers will be published in the URSI-JRSM 2022 Student Paper Competition Special Issue of the RSB. Two special issues of the 2022 URSI-Japan Radio Science Meeting are planned to be published in Radio Science and URSI Radio Science Letters, which will provide a collection of papers presented at URSI-JRSM 2022.

Figures 8-11 show some photos taken at URSI-JRSM 2014, 2015, 2019 and 2022, respectively.



**Figure 8. The URSI-JRSM 2014 Opening Ceremony: (a) Welcome address by K. Kobayashi, URSI-JRSM 2014 General Chair. Keynote Lectures: (b) D. Guha, Commission B Chair, India National Committee of URSI; (c) L.-C. Lee, President, China (SRS) National Committee of URSI; (d) S. Ueno, Past Chair, URSI Commission K.**



**Figure 9. (a) Special Lecture by M. Ando, Vice-President, URSI, and (b) Poster Session, at URSI-JRSM 2015.**



**Figure 10. (a) Student Paper Competition, and (b) banquet at URSI-JRSM 2019.**



**Figure 11. (a) Opening Ceremony, (b) Student Paper Competition, and (c) Oral session at URSI-JRSM 2022.**

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(Kazuya Kobayashi and Satoshi Yagitani)

## 4. JNC-URSI Report

An important activity of JNC-URSI is to publish the URSI National Report every three years on the occasion of the URSI GASS. This report provides an extensive summary of radio science research in Japan for the triennium between the two successive GASS. The National Reports published after 1993 are archived and available on the JNC-URSI website [1]. The JNC-URSI National Reports were distributed at the URSI General Assemblies (GA) in Kyoto, Japan (1993), Lille, France (1996), Toronto, Canada (1999), Maastricht, The Netherlands (2002), New Delhi, India (2005), and Chicago, USA (2008), and for the URSI GASS in Istanbul, Turkey (2011), Beijing, China (2014), Montreal, Canada (2017), and Rome, Italy (2021).

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(Satoshi Yagitani and Kazuya Kobayashi)

## 5. Issac Koga Gold Medal

Professor Issac Koga was born in Saga, Japan on December 5, 1899. He received the degrees of Bachelor of Engineering and Doctor of Engineering from Tokyo Imperial University (later renamed as the University of Tokyo) in 1923 and 1930, respectively. He joined the Electrotechnical Research Institute of Tokyo Municipality in 1923. In 1929 he became Associate Professor, and later Professor in the Electrical Engineering Department of the Tokyo University of Engineering (later renamed as Tokyo Institute of Technology). He moved to the Faculty of Engineering, Tokyo Imperial University in 1946, and served as the Dean of Engineering from 1958 to 1960. In 1960, he was granted the title of Professor Emeritus from The University of Tokyo and Tokyo Institute of Technology, and joined the Research Laboratories of Kokusai Denshin Denwa Co. (now KDDI Corporation). He passed away on September 2, 1982.

Professor Koga devoted himself to the research on frequency standards and piezoelectric crystals (Figure 12). The most famous of his inventions is a piezoelectric crystal unit with zero frequency temperature coefficient, which has been widely used for various applications. The IEEE milestone plaque presented to Tokyo Institute of Technology in 2017, states:

### **Invention of a Temperature-Insensitive Quartz Oscillation Plate, 1933**

In April 1933, Issac Koga of the Tokyo Institute of Technology reported cutting angles that produced quartz crystal plates having a zero-temperature coefficient of frequency. These angles,  $54^{\circ} 45'$  and  $137^{\circ} 59'$ , he named R<sub>1</sub> and R<sub>2</sub> cuts. Temperature-insensitive quartz crystals were used at first for radio transmitters and later for clocks, and have proven indispensable to all radio communication systems and much of information electronics.





**Figure 12. (a) Professor Issac Koga (1899-1982) and (b) his invention of a temperature-insensitive quartz oscillation plate.**



**Figure 13. Memorial stamp of URSI GA1963 in Tokyo.**



**Figure 14. Issac Koga Gold Medal.**

Professor Koga became a member of URSI Commission I in 1934, and served as Vice-President of URSI from 1957 to 1963. He was elected President for the period 1963-1966, and remained a member of the Board as Past President until 1969. The title of Honorary President was conferred on him at the General Assembly in Washington, D.C. in 1981. When the 14th General Assembly of URSI was held in Tokyo in 1963, he was Chairman of the Organizing Committee, and it was thanks to his great efforts that this event is regarded as one of most successful General Assemblies in the history of URSI (Figure 13).

The Isaac Koga Gold Medal (Figure 14) was established in 1982 commemorating Professor Koga's long-time distinguished services to URSI. The Isaac Koga Gold Medal is awarded to a young scientist who has made an outstanding contribution to any of the branches of science covered by the URSI Commissions. Candidates must not be older than 35 on September 30 of the year preceding the URSI GASS. The award is for career achievements of the candidate with evidence of significant contributions within the most recent six-year period. The Issac Koga Gold Medal is presented by the Japan National Committee of URSI on the occasion of URSI GASS.

(Jun-ichi Takada and Satoshi Yagitani)



## 7. Contribution to the URSI Young Scientists Program

The JNC-URSI understands that one of the key activities of URSI is to attract and encourage more young scientists to join various URSI events including GASS. Therefore, it has contributed to the funding of the Young Scientist Award (YSA) at every GA/GASS since 2002, starting when financial support from ICSU and UNESCO terminated. Japan's financial contribution to the YSA at the GASS is shown in Table 9.

(Tsuneki Yamasaki and Kazuya Kobayashi)

**Table 9. Financial support for the YSA at GA/GASS.**

Year	GA/GASS	Location	Amount of support (USD)
2002	27th GA	Maastricht, Netherlands	4,000
2005	28th GA	New Delhi, India	6,000
2008	29th GA	Chicago, Illinois, USA	6,000
2011	30th GASS	Istanbul, Turkey	6,000
2014	31st GASS	Beijing, China CIE	5,000
2017	32nd GASS	Montreal, Canada	2,000
2020/2021	33rd/34th GASS	Rome, Italy	2,000

## 8. Large Research Project Plan Selected by the Science Council of Japan

SCJ has accepted a JNC-URSI proposal (as described below) to be part of the SCJ Master Plan 2020 on Large Research Projects [1]. It is one of 146 such projects, and although the result does not mean that the project is funded, the master plan serves as a pool of ideas for future research.

The radio spectrum use is administered by ITU in the form of Radio Regulations at the international level, and various services are allocated to the fragmented spectra. Coexistence conditions are described in its Recommendations. On the other hand, CISPR regulates unwanted radio emissions from electric/electronic equipment through standards. Both parties issue regulations and recommendations to facilitate coexistence, but negotiations are led by different stakeholders which results in inconsistent conditions and outcomes. For example, (1), digital communication systems are robust against the interference from other systems, but this is not necessarily considered within the coexistence criteria which were established in the analog era. (2), the number of new types of equipment with unwanted emission is increasing, but the inclusion of such sources into the standards lags behind. (3), passive services such as for radio astronomy or earth exploration are very sensitive and strong protection is needed, while subsurface radar or wireless power transfer requires high power.

The project plan is entitled, Regulatory science center for the harmonization and coexistence of scientific and commercial radio spectrum use (Figure 15). The goal of the project is to experimentally derive objective coexistence conditions among radio spectrum users for various applications including scientific use such as radio astronomy, earth exploration satellites and ground penetrating radar, and commercial use such as mobile communications and wireless power transfer. The JNC-URSI, research community will contribute to the studies. Regulatory science will be employed as a norm to determine the coexistence conditions among different usages by quantifying the risk and the benefit tradeoff, together with uncertainty and costs. The center will be equipped with test facilities so that experimental investigations are possible. The center will be run by a neutral institution such as a university, serving the national and international researchers and stakeholders.

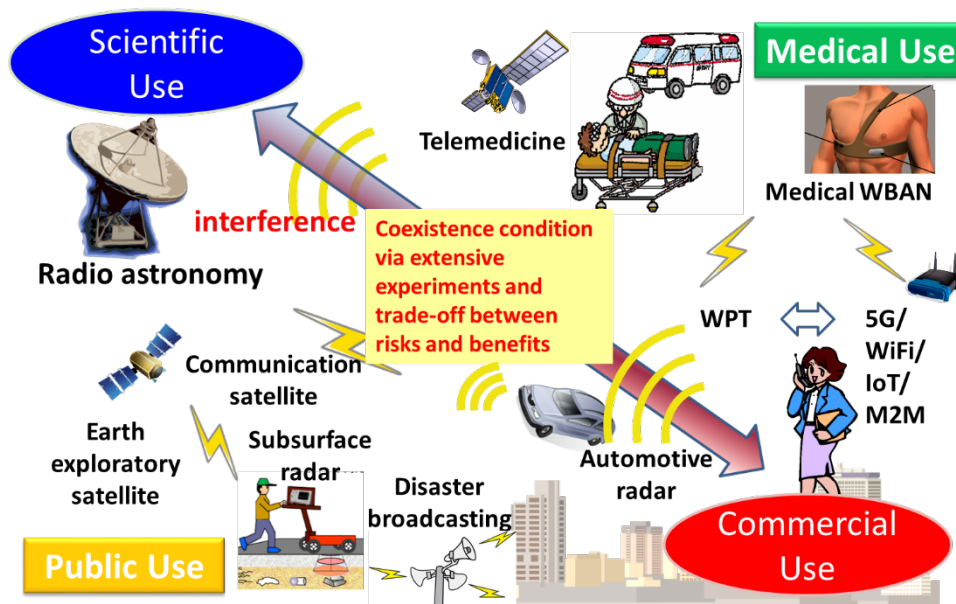


Figure 15. The regulatory science center for the harmonization and coexistence of scientific and commercial radio spectrum use.

## References

1. “Recommendation: SCJ 24th-term Master Plan on Large Academic Research Projects (Master Plan 2020),” Subcommittee on Research Plan and Funding, Committee of Scientists, Science Council of Japan, January 2020 (in Japanese).

(Kazuya Kobayashi and Satoshi Yagitani)

## 9. Summary and Future Prospects

The Japan National Committee of URSI (JNC-URSI) has taken the lead in conducting radio science research in Japan since its establishment in 1922. It has also conducted various national and international URSI activities under the auspices of the Science Council of Japan (SCJ) (since 1949) and The Institute of Electronics, Information and Communication Engineers (IEICE) (since 1993). The JNC-URSI has made significant contributions to various activities of URSI with several Japanese scientists serving as URSI Officials. Another important contribution of the JNC-URSI is the establishment of the triennial “Asia-Pacific Radio Science Conference” (AP-RASC) in 2001, which was substantially expanded as one of the URSI Flagship Meetings from 2016. Recently the “URSI-Japan Radio Science Meeting” (URSI-JRSM) was initiated to provide a regional scientific forum for radio scientists and engineers in Japan and the Asia region. It should be mentioned that following the 14th General Assembly of URSI in Tokyo, Japan in 1963 and the 24th General Assembly of URSI in Kyoto, Japan in 1993, both of which were led to a great success, the 35th General Assembly and Scientific Symposium (GASS 2023) will be held in Sapporo, Japan in 2023.

In the coming decades, the JNC-URSI will continue to coordinate the radio science community in Japan, and contribute to various URSI activities, including research and supporting international activities. It is particularly important to attract and encourage young scientists to participate actively in the URSI community, through the international and domestic URSI conferences, as these young scientists will lead the next generation of radio science research in Japan and in the world.

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