The Physical Society of Japan: First (2020) Fumiko Yonezawa Memorial Prize

Fumiko Yonezawa
1938-2019

The late Fumiko Yonezawa, emeritus professor, Keio University, made major contributions to physics, such as the development of the coherent potential approximation, and the theory of the metal-insulator transition in liquid selenium, and she served as the first female president of the Physical Society of Japan (JPS). Moreover, as the president of the Society for Women Scientists for a Bright Future, she also promoted women scientists.

The JPS has established the "Fumiko Yonezawa Memorial Prize" to celebrate the achievements of Professor Yonezawa and to honor and encourage the activities of woman members of the JPS.

A few prize winners will be selected each year, with a maximum of about five. The prize ceremony will be held during the annual meeting of the JPS. The winners will receive items such as certificates and honorary shields, and will give commemorative lectures in JPS meetings within a period of one year after receiving the prize, as well as additional prizes, namely: (1) participation fees for JPS meetings for the next three years, (2) a total of 200, 000 yen exemption from publication fees and open access fees for the Journal of Physical Society of Japan, and from the article processing charge for the journal, Progress of Theoretical and Experimental Physics (valid for three years for submissions after the prize is received).

The followings are the first (2020) winners of Fumiko Yonezawa Memorial Prize with their citations.

Yuki Kawaguchi
Associate Professor,
Department of Applied Physics,
Graduate School of Engineering,
Nagoya University
Theoretical studies on cold atomic Bose-Einstein condensates with internal degrees of freedom

Dr. Yuki Kawaguchi has been studying theoretically Bose–Einstein condensates (BECs) of cold atomic gases. In particular, she has focused on the novel physical properties arising from the spin degrees of freedom of the BECs (spinor BECs). In the case of BECs with spins and dipole–dipole interactions, she has revealed that (1) the Einstein-de-Haas effect occurs, by means of which the spin angular momentum is converted into the orbital angular momentum, (2) a non-uniform magnetic structure appears in the ground state, due to which a circular supercurrent is induced, and (3) a helical spin structure appears, by means of which the existence of the dipole-dipole interaction can be detected, no matter how weak it is. She has also studied topological excitations in spinor BECs. She has showed that a knot (a three-dimensional excitation without singularity), can exist in such BECs, and has proposed a simple way of creating the knot experimentally. The most noticeable feature of her works is that she has proposed, based on non-trivial mathematics, methods for the experimental realization of her theoretical results. In fact, several of her proposed experiments, which have already been realized by many groups, have made significant impacts on researchers working on BECs. Further, her review article on spinor BECs has been cited more than 300 times, and has been indicated as a highly cited article in the Web of Science. Moreover, Dr. Kawaguchi has also contributed to outreach activities such as lectures for the students of junior high schools and high schools.

Hiroko Tokoro
Professor,
Division of Materials Science, Faculty of Pure and Applied Sciences, University of Tsukuba
Development of novel functional properties based on phase transitions

Prof. Tokoro began her research career by discovering the charge-transfer phase transition with a large thermal hysteresis in Rubidium Manganese Hexacyanoferrates. Using photo irradiation, she demonstrated this conversion from a hidden metastable phase at low temperature to a stable phase and named the phenomenon a "phase collapse," which was later extended to metal oxides. For the first time in this class of materials, she identified a reversible photo-induced metal-semiconductor transition at room temperature in lambda-type trititanium pentoxide. The availability of nanoparticle samples suggests this is a promising material for application as a high-density optical recording medium.

In stripe-type lambda-trititanium pentoxide, she found that a metal-semiconductor transition could be stimulated by applying external pressure. Following first-principle calculations of the phonon modes in the two phases with different titanium configurations, she developed a full thermodynamic understanding of the pressure-induced phase transition. This ceramic became a potential candidate material for use as stable heat-storage, as was later demonstrated by direct heat measurements.

Prof. Tokoro discovered several new phase transitions induced by external fields through a variety of experimental techniques in materials synthesized with chemical methods and achieved thermodynamic understandings of these mechanisms through calculations based on first principles. The outstanding quality of her achievements is internationally recognized. Furthermore, most of her fundamental research successes are closely related to applications from which 30 domestic or international patents were awarded.

Aya Bamba
Associate Professor,
Department of Physics, University of Tokyo
Study of the origin and acceleration mechanisms of cosmic rays with X-ray and gamma-ray observations

Dr. Bamba has been involved in vigorous research on the origin of cosmic rays and their acceleration mechanism, and has numerous achievements, mainly on the observational research of supernova remnants using X-ray astronomy satellites and the TeV gamma-ray telescope. In particular, she has contributed greatly to the development of high-energy astronomy and cosmic ray physics by evaluating the cosmic ray acceleration efficiency of celestial bodies centered on supernova remnants. For instance, in her 2003 study on the spatial distribution of synchrotron X-rays emitted by accelerated cosmic ray electrons, she discovered that the region of synchrotron X-ray emission has a filament shape much smaller than the emission region of the thermal plasma, indicating that the efficiency of cosmic ray acceleration is much better than conventional expectations. Dr. Bamba further extended her research scope to energetic TeV gamma rays, which are nine orders of magnitude higher in energy than X-rays, and organized a close collaboration with gamma-ray researchers at the HESS TeV telescope to promote proton acceleration, which had previously been difficult to do. She has paved the way for interdisciplinary research and systematically promoted collaboration between the two fields of X-rays and TeV gamma rays, contributing to the development of both fields.

Dr. Bamba has also made significant contributions to the research community, including establishing a team centered at RIKEN and launching a service to bridge the gap between the analysts and the detector teams. In addition, in the ASTRO-H (Hitomi) satellite project, in which Japan played a leading role internationally and made significant achievements in the initial observations, she was assigned the Education and Public Relations team which she accomplished successfully by setting up a three-stage plan of general public relations, primary education, and higher education.

Dr. Bamba has also been a lecturer at the summer school organized by the Physics Society of Japan and an instructor at the "Science Seminar". In addition, she has acted as an editor of the Astronomical Monthly Report, chairperson of the Gender Equality committee, and is at present, a vice president of the Astronomical Society of Japan. This proves her credentials as a trustworthy opinion leader in a wide range of fields, and there is no doubt that she will continue to be an active international researcher.

Hiroko Miyahara
Associate Professor, Humanities and Sciences / Museum Careers, Musashino Art University
Research on Cosmic Ray Variations during Grand Solar Minimum/Development of a New Method for Reconstructing Past Cosmic Ray Variations

Understanding the patterns of cosmic ray activities has gained importance as it is widely recognized that they may have significant impacts on the earth's environment. Dr. Hiroko Miyahara has made great contributions toward research on cosmic rays for many years. She has revealed that cosmic rays show a singular modulation with a period of several decades during the grand solar activity minimum, caused by drift effect in the heliosphere, by performing precise measurements of cosmogenic nuclides left inside annual tree rings and ice cores with high time resolution, and has also found that consequently, the modulation had a huge influence on the earth's climate. The derived information on solar cycle lengths has also contributed to the understanding of the solar dynamo mechanism. Recently, she proposed a new technique to precisely reproduce the intensity modulation of past cosmic ray activities. This may become an important tool in cosmic ray research in the future. She is also active in science outreach. For example, she has written books about science for the general public, one of which has received a Kodansha Scientific Publication Award.

Miho Yanagisawa
Associate Professor, Graduate School of Arts and Sciences, University of Tokyo
Physics in cell structure and function

Miho Yanagisawa's research has treated phospholipid membrane vesicles and polymer droplets as entity models of living cells and elucidated the phenomena that occur specifically in such systems from the viewpoint of soft matter physics. She is also involved in research for the application of these results.

She has discovered a law for the growth of phase-separated domains based on the relation between phase separation and shape deformation in lipid membranes. The membranes can be considered to be a kind of entity model of the microdomain of the cell membrane (lipid raft). She has also found that the phase transitions in polymer droplets covered by lipid membranes differ significantly from those known, according to the size and boundary conditions. The combined systems can serve as a physical model of the cell. Using her discoveries, she has succeeded in developing novel techniques, such as allowing the directional insertion of a membrane protein into a lipid membrane. The above works are significant and highly original results for both biology and physics and have great potential in applications.

Dr. Yanagisawa has not only published these results in scientific journals but also widely conducted outreach activities through public media.