

# Conferences and Workshops

## *International Conferences and Workshops*

### **New Perspectives in Spintronic and Mesoscopic Physics (NPSMP2015)**

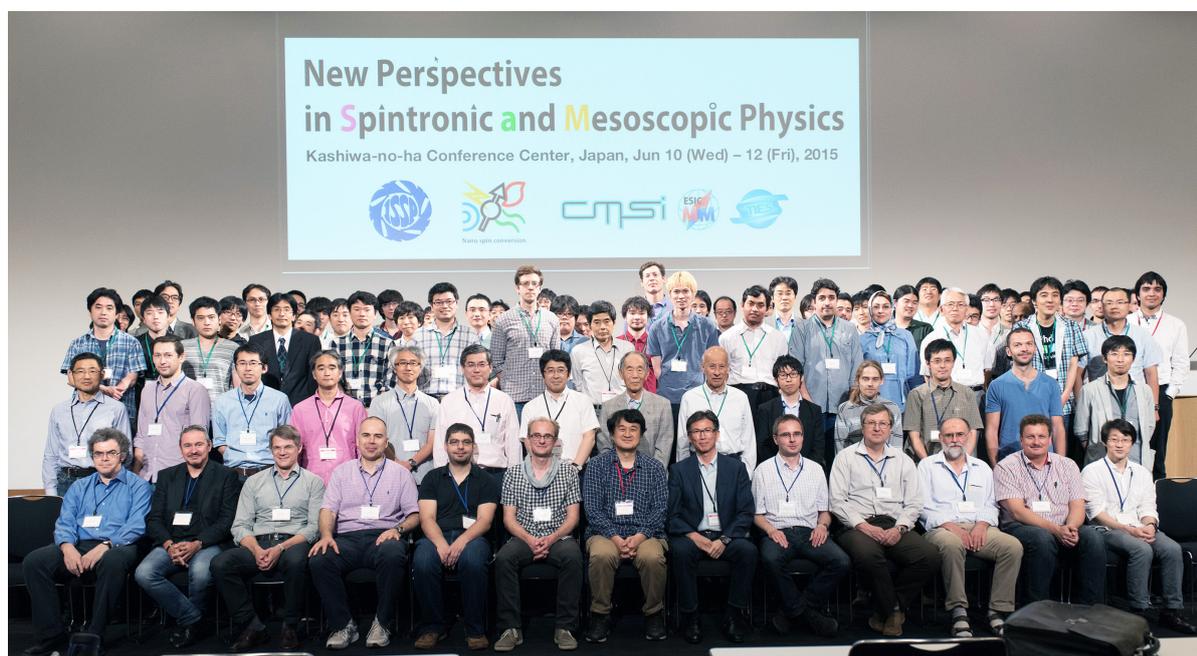
June 1 - 19, 2015  
T. Kato and Y. Otani

Since 2006, the ISSP has organized an annual series of three-week workshops, with the only exception in 2011 due to the aftermath of the Tohoku earthquake. The last two in the series are “Emergent Quantum Phases in Condensed Matter – from topological to first-principles approaches” (EQPCM2013) and “New Horizon of Strongly Correlated Physics” (NHSCP2014). In 2015, the ISSP organized the ninth workshop, “New Perspectives in Spintronic and Mesoscopic Physics” (NPSMP2015), held for three weeks starting from the beginning of June.

The targets of this workshop are two important and related research areas, mesoscopic physics and spintronic physics. Recent theoretical and experimental development deepens physics of mesoscopic systems, strengthening relationship to other research areas such as nonequilibrium statistical mechanics, quantum information, many-body quantum theory, fundamental theory of quantum mechanics, and so on. On the other hand, the spintronic physics covers spin-related phenomena such as spin-dependent transport, spin injection, spin dynamics and so on. Although activity in spintronic physics is originally oriented to application, it includes important fundamental topics related to mesoscopic physics such as control and measurement of spin diffusion and spin current, physics of the Berry phase, and phenomena originated from spin-orbit interaction. The purpose of this workshop is to share recent developments in these two research fields, to discuss important future issues, and to stimulate participants' motivation toward breakthrough in the interdisciplinary research area between spintronic and mesoscopic physics. The program and presentation materials are available on the web at the URL <http://www.issp.u-tokyo.ac.jp/public/npsmp2015/index.html>.

Following the tradition of the series, the workshop contained the intensive three-day symposium during Jun. 10–12, and 34 oral and 53 poster presentations (the largest number so far) were made there. The remaining part was arranged into a more relaxing style providing a long discussion time, and 14 one-hour oral presentations and 15 half-a-hour oral presentations were made. This style of workshop attracted many people; the cumulative number of participants during the three weeks summed up to 649, and 320 of them attended the symposium part.

The NPSMP2015 workshop was organized by the ISSP and the Grant-in-Aid for Scientific Research on Innovative Areas “Nano Spin Conversion Science”. It was also supported by Computational Materials Science Initiative (CMSI), Elements Strategy Initiative Center for Magnetic Materials (ESICMM), and Tokodai Institute for Element Strategy (TIES). The workshop organizers were Takeo Kato (Chair, ISSP), Yoshichika Otani (Chair, ISSP), Sadamichi Maekawa (ASRC, Japan Atomic Energy Agency), Gerrit E. W. Bauer (IMR, Tohoku University), Shingo Katsumoto (ISSP), Yasuhiro Tokura (University of Tsukuba), Mikio Eto (Keio University), Gen Tatara (CEMS RIKEN), and Kensuke Kobayashi (Osaka University).



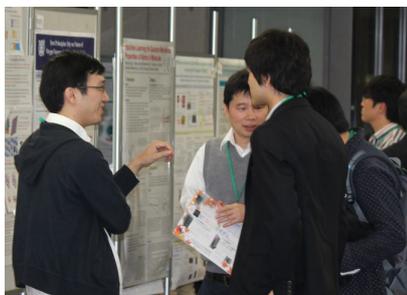
# The 18th Asian Workshop on First-Principles Electronic Structure Calculations

November 9 - 11, 2015

T. Ozaki, H. Akai, Y. Tatada, and O. Sugino

First-principles electronic structure calculations have been playing an invaluable role in characterizing and understanding properties of materials and even in designing novel materials having better performance and/or exotic physical properties. The Asian workshop is an annual series starting in 1998 to provide a forum for discussing all the important issues in computational condensed matter physics and materials science. The principal purpose of the workshop is to offer an opportunity for exchanging ideas and enjoying in-depth discussion both in the methodology in computational physics and chemistry and its application to a wide variety of materials having not only fundamental significance and but also industrial importance. In this time five plenary speakers in European countries and United States of America were invited, and 18 speakers were invited from Asian countries. The discussion was focused on methodological development in first-principles methods, applications of DFT to electric devices, molecular and spin dynamics, materials informatics, and topological insulators. Prof. Hutter of Zurich University reported efficient implementations of many-body perturbation theories such as MP2 and RPA, and showed that it is now possible to accurately perform molecular dynamics simulations even for bulk systems consisting of several hundred atoms based on such many-body perturbation theories. The direction may lead to a wide variety of applications of MP2 and RPA to hydrogen bonded systems and molecular crystals in near future. Prof. Oganov of Skolkovo Institute of Science and Technology presented evolutionary algorithms to investigate unknown crystal structures and its impressive applications to high pressure phases including the H<sub>2</sub>S superconductor. Though it was considered even up to recent years that searching new crystal structures is fundamentally difficult, the series of studies that his group did clearly demonstrates that prediction of crystal structures is now feasible by combining DFT calculations and the evolutionary algorithms. The prediction of crystal structures is a fundamental technology in materials informatics that many computational materials scientists have been recently involved, and thereby his talk was a good occasion for researchers in Asian area to know the impressive progress. Prof. Weng of Chinese Academy of Sciences discussed materials exploration for topological insulators based on first-principles calculations in a very concise and informative style, which is one of emerging fields. It was quite impressive to hear that a lot of novel materials proposed by his group have been already confirmed by experiments, which also demonstrates a recent progress of first-principles calculations. We also had a poster session on the second day where there were more than a hundred presentations on methodological developments and applications. The accumulated number of participants is counted 409, suggesting the workshop was successful. It was announced by the international committee members that the next workshop in 2016 will be held in Hsinchu in Taiwan.

This workshop was financially supported by Institute for Solid State Physics (ISSP), the University of Tokyo, Computational Materials Science Initiative, The Asia Pacific Center for Theoretical Physics (APCTP), Elements Strategy Initiative for Structural Materials, National Institute for Materials Science, SGI Japan, Ltd., Real Computing Inc., and X-Ability Co., Ltd. The management of the workshop was performed by the research staffs and secretaries of the related laboratories and CMSI.



# International Workshop: Topological Phenomena in Novel Quantum Matter: Laboratory Realization of Relativistic Fermions and Spin Liquids

February 29 - March 4, 2016  
C. Broholm, M. Oshikawa, and A. Rosch

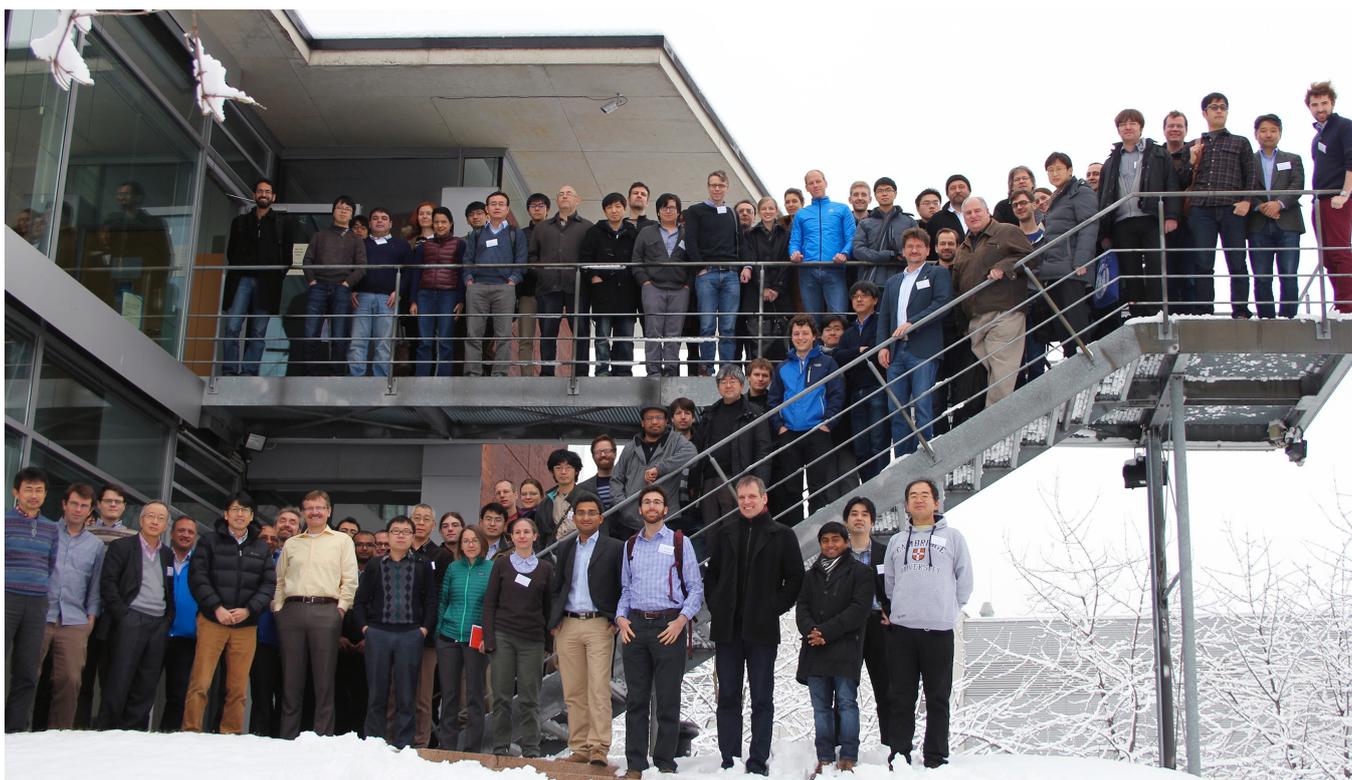
Topology is a field of mathematics which classifies properties of mathematical structures which are robust under deformations. This field has recently emerged as a powerful paradigm to discover, classify, and investigate quantum properties of materials. The international workshop exploring the forefront of this exciting field was held at and sponsored by Max-Planck Institute for Physics of Complex Systems in Dresden, Germany, co-sponsored by TOPONET program of ISSP and by the profile area "Quantum Matter and Materials" of the University of Cologne.

The workshop, which was attended by 90 participants, has focused on two classes of such topological quantum materials. First, in Dirac matter topological properties are often intrinsically linked to the relativistic Dirac equation. Second in spin systems geometry and spin-orbit coupling can suppress magnetic ordering and give rise to novel topological spin liquid states. The workshop brought together experimental and theoretical physicists working in the two fields. It gave an overview on the tremendous scientific development especially in the last few years in the two fields.

The experimental and theoretical investigation of new topological quantum materials, such as topological insulators, topological superconductors, and magnetic materials with strong spin-orbit interactions and frustration, was central to many key contributions to the workshop. The classification of interacting topological states and routes towards their realization were also a major theme. Applications of concepts from solid state physics to quantum optics experiments were also discussed.

The latest development on magnetic skyrmion materials including their controlled creation and destruction by electric fields, the quest for experimental signature of Majorana fermions in spin liquids, the observation of the topologically quantized electromagnetic response of topological insulators, magnetic quantum oscillations without Fermi surfaces, and anomalous magnetotransport were presented in inspiring talks.

Overall, the workshop was characterized by lively and intensive discussions until late in the night. In particular the poster sessions offered a wealth of fresh experimental results and theoretical insights and highlighted the passion of young scientists for the field. A brainstorming session on the most important future research directions in topological quantum matter showed that this field is still at its infancy. Interacting topological states, experiments probing projective symmetries, strange metals and the experimental realization of emergent gauge fields were only some of the research areas where the participants expect major advances in the near future.



## ISSP Workshops

### ISSP Series Workshop on Synergetic Science for Functional Material Systems: (2) Soft Dynamics

April 2 - 3, 2015

O. Yamamuro, H. Mori, J. Yoshinobu, F. Komori, M. Shibayama, T. Suemoto,  
H. Akiyama, O. Sugino, H. Noguchi, Y. Harada, I. Matsuda, and M. Lippmaa

This workshop is the second one among the series workshops on synergetic science for functional material systems, which were proposed and organized by the 12 members of ISSP working group for a future plan on a new research group of interdisciplinary area. The workshop was not on usual soft matter science, but focusing on the dynamics and related functionality characteristic of the soft materials listed below. We organized presentations including 18 invited talks and 26 contributed posters.

The topics of this workshop were (1) non-equilibrium dynamics and autonomic motor systems which are recently remarked in statistical physics, (2) dynamics of proteins and DNA which has been a central research subject in biophysics, (3) dynamics on surfaces and interfaces, (4) functional solids and polymers, and (5) dynamics of liquids, mesophases and membranes. These spread across a wide research area.

We had 80 and 74 attendances for the first and second days, respectively, including many young researchers and people from other universities and institutes. There was very active and fruitful discussion even though the subjects of the workshop are not common in ISSP. This may show a high demand for a new research area in ISSP.



## International Workshop on Condensed Matter Physics & AdS/CFT

May 25 - 29, 2015

R. Meyer (Kavli IPMU), S. Nakamura, H. Ooguri, M. Oshikawa, M. Yamazaki, and H. Zhang

In 1997, a new duality between quantum field theories and gravity called the “gauge/string duality” (AdS/CFT correspondence) originated from string theory. Recently, this duality is also applied to strongly correlated states of condensed matter such as the electronic states in high- $T_c$  superconductors. This subject attracts the interest of string theorists, condensed matter physicists and the gravitational community. The goal of this joint workshop with Kavli IPMU was to bring together key members from these three communities to foster exchange in this direction and ignite further collaboration.

The program of the workshop consisted of 20 hour-long talks by internationally recognized experts, who gave excellent overviews over their respective topics and at the same time presented cutting-edge research. In total 122 participants (80 from Japan) attended the workshop. 33 researchers from Japan and abroad used the opportunity to present their work in the gong show and poster presentation. The workshop focused on three topics: (1) AdS/CFT, non-Fermi liquid phenomenology and high temperature superconductivity, (2) non-equilibrium physics and AdS/CFT, and (3) topological states of matter and entanglement entropy.

This workshop, supported by Kavli IPMU, ISSP, and EU HoloGrav network, was unique in bringing together condensed matter physicists and string theorists nearly in a half-half ratio, which made it very successful.



## New Perspectives in Spintronic and Mesoscopic Physics (NPSMP2015)

June 10 - 12, 2015

T. Kato and Y. Otani

This ISSP workshop was held as the symposium part of the international workshop of the same title. See the section of “International Conferences and Workshops”.

## ISSP Workshop: Basic Science for Supporting Materials Developments

June 10, 2015

M. Takigawa, H. Mori, O. Sugino, Y. Harada, and F. Komori

For society, industry, and economy of Japan, it is essential to develop useful and superior materials. Therefore, it is wished that the results of basic scientific research are effectively utilized for industrial applications for society and economy. In the problems that industry really faces, there are a lot of the research subjects that are essential for the development of the basic science. The workshop was held from viewpoints how the basic science contributes to the solution to industrial problems, and how the material scientists examine the scientific significance in them. Nine lectures on these subjects were delivered in the workshop, and there was fruitful discussion among 98 participants. The workshop provided an opportunity to remind a sentence in the prospectus of Institute for Solid State Physics; a general and systematic study of solid state physics raises the research standard of our country and contributes to development of the industrial engineering. It is not easy to find a conclusive answer to the question how to promote the basic science to support materials developments under the present severe financial and economic conditions. Importance of the continuous examinations and discussion on this subject is recognized again from the wide viewpoints such as this workshop was realized.



# ISSP Series Workshop on Synergetic Science for Functional Material Systems: (3) Reaction and Transport

June 24 - 26, 2015

J. Yoshinobu, H. Mori, F. Komori, M. Shibayama, T. Suemoto, O. Yamamuro, H. Akiyama, O. Sugino, H. Noguchi, Y. Harada, I. Matsuda, and M. Lippmaa

This workshop focusing on “Reaction and Transport” in inhomogeneous systems is the third one among the series workshops on synergetic science for functional material systems, which were proposed and organized by the 12 members of ISSP working group for a future plan on a new research group of interdisciplinary area. In this workshop, we organized presentations including 29 invited talks and 40 contributed posters.

The topics of this workshop consists of (1) reaction and transport phenomena at surface and interface, such as catalysis, photocatalysis, thin film growth etc. (2) charge dynamics in bulk and at interface (3) transport of atoms and ions such as hydrogen and proton in various materials and electrochemistry, and (4) reaction and transport in the systems from single molecule to more complex bio-molecules.

We had 76, 85 and 50 attendances for the first, second and third days, respectively, including young researchers and students from other universities and institutes. At the last session on 26 June, the present activities and the future plan of ISSP for functional materials were presented, and we discussed on this issue and exchanged opinions between the organizers and participants very actively.



## ISSP Workshop on Glass Transition and Related Science

July 30 - August 1, 2015

O. Yamamuro, T. Odagaki, H. Tanaka, K. Miyazaki, K. Fukao, R. Nozaki, Y. Saruyama, and N. Yamamuro

This is the largest domestic workshop on the glass transition which has been held every 2 – 4 years since 2002. The glass transition is a mysterious phenomenon that a liquid is solidified without any structural change and its mechanism has not been clarified yet. In the physical properties of glasses, there are also many unsolved problems (e.g., boson peaks) originating from its non-periodic and disordered structure. Other than the works on the glass itself, there are many interesting phenomena related to the glass transition such as spin glass transition, jamming transition of granular materials, dynamical transition in proteins, etc. It is meaningful to assemble both experimental and theoretical researchers of the areas mentioned above to exchange current information and make discussion for future researches. We organized 32 oral and 41 poster presentations.

The topics of this workshop were (1) structures and entropy of glasses, (2) theories and computer simulations on glasses and supercooled liquids, (3) glass transitions in polymer systems, (4) polyamorphism and liquid-liquid transitions, (5) dielectric spectroscopy for glasses and liquids, (6) glass transition and shear thickening, (7) glass transition and jamming transition, (8) glass transition and phase transition in solid state physics, and (9) glassy dynamics of soft matters and biological systems.

We had 95, 95 and 73 attendances for the first, second and third days, respectively, including many young researchers and people from outside of ISSP. There was very active and fruitful discussion throughout the workshop.



## Frontier of Physics on the Spin Systems

November 16 - 18, 2015

M. Oshikawa, N. Kawashima, K. Kindo, M. Takigawa, H. Tsunetsugu, M. Tokunaga, S. Nakatsuji, Z. Hiro, H. Kawamura, H. Tanaka, H. Nojiri, M. Hagiwara, H. Kaneyasu, and T. Sakai

The physics of spin systems has been investigated very extensively. Even in the 21st century many new phenomena have been experimentally discovered, as well as many new theoretical concepts, in this field. At the present workshop we focused on the following new phenomena; the quantum spin liquid, the quantum spin ice, the Bose-Einstein condensation of magnons, the spin nematic phase, the chiral order, the Skirmion, the  $Z_2$  vortex, etc. More than 100 people attended the workshop and very fruitful discussions were performed there. Particularly, young scientists' presentations and comments were encouraged. One of important purposes is to encourage communications between the experimentalists and the theoreticians, as well as between the expertized and young scientists. We hope that the discussion at this workshop would lead to creations of some new concepts, trends, or breakthroughs in this field in the near future.



## New Aspects of Excitonic Phases in Low-Dimensional Electronic Systems

November 26 - 28, 2015

T. Mizokawa, H. Fukuyama, H. Takagi, Y. Ohta, H. Sawa, Y. Uwatoko, H. Okamura, H. Yaguchi, and M. Tokunaga

Some semimetals or small-gap semiconductors may exhibit a phase transition to excitonic insulator that is characterized by condensation of electron-hole pairs and can be described in BCS or BEC manners. Although the excitonic phase was theoretically predicted almost half a century ago, solid experimental evidence of the excitonic phase was not established until recently due to limitation of candidate materials. Very recently, possibility of excitonic phases has been examined in new excitonic insulator candidates such as  $\text{TiSe}_2$ ,  $\text{Ta}_2\text{NiSe}_5$ , and graphite. In addition, the concept of the excitonic phase would be extended to describe charge fluctuations in various strongly correlated materials including cuprates, Fe pnictide/chalcogenide, organic conductors, and heavy Fermion systems. In order to discuss the new aspects of the excitonic phase and its future prospects, the present workshop was held at ISSP from November 26 to 28, 2015. In addition to the exciting results on the new excitonic insulator candidates, fundamental relationship between the excitonic phase and the spin/charge/orbital fluctuations in various strongly correlated systems has been reported and discussed by the speakers and the audiences during the workshop.



## Research Frontier of Quantum Matter

December 8 - 9, 2015

T. Arima, K. Ishida, N. Nagaosa, K. Miyake, M. Oshikawa, S. Nakatsuji, and Z. Hiroi

In the past decade, large-scale research facilities have become increasingly important for the Institute's mission, and the three centers have been built: the LASOR laboratory houses unique laser and spectroscopy facilities, the IMGSL provides magnetic fields of record strength, and a supercomputer center (SCC-ISSP) operated by the MDCL provides computational resources. Each of these facilities provides a platform for in-house research and also serves a sizable outside user community. In the next step, the ISSP expects an organizational reform of small science groups so as to stimulate interdisciplinary cooperation within ISSP. To accelerate this, the ISSP has a strategic plan that generates two new cross-divisional research groups; "quantum materials" and "functional materials" groups. The former will focus on topological quantum phases in correlated-electron materials, while the latter aims to conduct fundamental research on materials with significant functional properties in areas of immediate societal needs.

This ISSP workshop was planned to give a chance to discuss on the direction and future prospect of the quantum materials group both from inside and outside of the ISSP. Four review and fourteen presentations were given both from theory and experimental sides. 79 (25 from inside) and 86 (38) people attended the workshop in the first and second days, respectively. In addition, lively discussion was carried out among participants from various communities and from different points of view, which made the workshop very successful.



## Meeting of Quantum Turbulence and Classical Turbulence

January 5 - 7, 2016

M. Tsubota, T. Gotoh, K. A. Takeuchi, Y. Tsuji, Y. Fukumoto, H. Yano, and M. Yamashita

Quantum turbulence (QT) has been studied in the field of low temperature physics. Quantum turbulence refers to turbulence appearing in quantum condensed systems like superfluid helium and atomic Bose-Einstein condensates etc., typically consisting of quantized vortices and giving a prototype of turbulence. On the other hand, classical turbulence (CT) has a long research history, studied in the field of fluid mechanics. However, there has been little scientific communication between the scientists of quantum turbulence and those of classical turbulence. This workshop organized for the first time the scientific collaboration between two different communities. There were 135 cumulative participants over three days, attending 28 oral and 7 poster presentations and lively discussions. Starting with review talks in both fields, the novel original works were reported. In the afternoon of the last day, a free discussion session “What can QT learn from CT and what can CT learn from QT?” was held. Very active discussions were performed about the basic themes such as definition of turbulence.



## ISSP Workshop: Status of SPring-8 BL07LSU -Integration of X-Ray Spectroscopy and Diffraction

March 1, 2016

H. Wadati, S. Shin, F. Komori, I. Matsuda, and Y. Harada

Synchrotron radiation laboratory has a Harima branch to maintain and develop a high-brilliance soft X-ray beamline BL07LSU at SPring-8. There we are performing time-resolved, spatial-resolved and energy-resolved soft X-ray spectroscopy to study electronic states and their dynamics of new materials. In this workshop, recent research activities at our beamline were reported and we discussed our new experimental techniques which integrate x-ray spectroscopy and diffraction. The speakers talked about their recent results from each end station (time-resolved spectroscopy, 3D nano-ESCA, emission spectroscopy, and so on). There were two invited talks; one is about synthesizing novel superconductors and the advantage of using synchrotron x-rays for finding new materials, and the other is about coherent x-ray scattering using synchrotron x-rays and x-ray free electron lasers. There were a lot of discussions for each talk, and we successfully

started to obtain a clear vision about our future experimental techniques combining x-ray spectroscopy and diffraction. We also encouraged the young generation in this research field by awarding the best poster prize to one graduate student.



## ISSP Workshop: $\pi$ -Electron and Hydrogen Coupled Functional Properties in Molecular Materials

March 29, 2016  
H. Mori and M. Yamashita

This workshop was intended to deepen the understanding and to make discussions on “ $\pi$ -electron-hydrogen coupled functional properties in molecular materials”. Recently, “ $\pi$ -electronic properties” and “hydrogen-related properties” have been coupled towards novel “ $\pi$ -electron and hydrogen coupled functional properties” by the development of the coupled system, a series of catechol-fused tetrathiafulvalene (TTF), in ISSP. In collaboration of chemists and physicists, several coupled functional properties have been unveiled: “the metallic state of purely organic single-unit crystal of  $\kappa$ -H<sub>3</sub>(Cat-EDT-ST)<sub>2</sub>”, “the quantum spin liquid state of  $\kappa$ -H<sub>3</sub>(Cat-EDT-TTF)<sub>2</sub>”, and “electronic switching induced by deuterium and charge transfer of  $\kappa$ -D<sub>3</sub>(Cat-EDT-TTF)<sub>2</sub> and  $\kappa$ -D<sub>3</sub>(Cat-EDT-ST)<sub>2</sub>”. However, the mechanism of the novel “hydrogen- $\pi$ -electron coupled functional properties” is still non-trivial and the future prospects are open question.

The workshop consisted of two parts, experiment and theory sessions. The 10 experts and a graduate student gave 30 min talks. The first talk was given by Dr. A. Ueda (ISSP) on the development  $\pi$ -electron-hydrogen coupled organic conductors based upon Cat-TTFs. This talk was followed by Dr. T. Isono (NIMS) on the quantum spin liquid state observed by torque and magnetic susceptibility measurements of the  $\pi$ -electron-hydrogen coupled organic magnet. In the afternoon session, Prof. T. Itoh (Tokyo Science University) gave a talk on the quantum spin liquid and charge-ordered states of Cat-TTF system observed by <sup>13</sup>C-NMR and <sup>1</sup>H-NMR. Continuously, the quantum paraelectric state by dielectric measurement and thermochromism by optical measurement of  $\kappa$ -H<sub>3</sub>(Cat-EDT-TTF)<sub>2</sub> was given a talk by Dr. K. Hashimoto (IMR, Tohoku Univ.). Dr. S. Yamashita (Osaka Univ.) gave a talk on the ground states for the gapless quantum spin liquid state of  $\kappa$ -H<sub>3</sub>(Cat-EDT-TTF)<sub>2</sub> and non-magnetic state of  $\kappa$ -D<sub>3</sub>(Cat-EDT-TTF)<sub>2</sub> by heat capacity measurements. The peculiar anisotropic thermal conductivity of  $\kappa$ -H<sub>3</sub>(Cat-EDT-TTF)<sub>2</sub> was given by Dr. M. Shimozawa (ISSP). Then, Prof. H. Okamoto introduced the responses by Tera-hertz electric field for molecular conductors.

In the last session, the theoretical aspects of “ $\pi$ -electron-hydrogen coupled functional properties” were introduced and discussed. Dr. A. Naka (Tohoku Univ.) gave a talk on charge excitation and optical spectra of  $\pi$ -electron-hydrogen coupled model. Then, Mr. R. Yamamoto (Yokohama city Univ.) introduced the theoretical study of large H/D isotope effect by multi-component DFT method. This talk was followed by Dr. T. Tsumuraya (NIMS) on the first-principal calculation of  $\kappa$ -H<sub>3</sub>/D<sub>3</sub>(Cat-EDT-TTF)<sub>2</sub>. Finally, Dr. H. Watanabe (Riken) gave a talk on covering weak to strong  $\pi$ -electron-hydrogen coupling region with Variational Monte Carlo (VMC) method.

Although this workshop was organized in the end of academic year, 32 participants joined and made active discussion on the current topics and future issues to be address for shedding light on the novel “ $\pi$ -electron-hydrogen coupled functional properties” in the course of workshop. The program is available on the web at the URL: [http://hmori.issp.u-tokyo.ac.jp/pdf/program\\_201603\\_ISSPWS.pdf](http://hmori.issp.u-tokyo.ac.jp/pdf/program_201603_ISSPWS.pdf)