OIST OKINAWA INSTITUTE OF SCIENCE AND TECHNOLOGY GRADUATE UNIVERSITY

Joint ISSP-OIST Symposium:

Lighting Up New Frontiers – From Tokyo to Okinawa, From Materials to Neurons

Poster Session

**Posters in alphabetical order (ISSP, name of presenter, OIST name of presenter)*
***ISSP = The University of Tokyo, The Institute for Solid State Physics*
****OIST = Okinawa Institute of Science and Technology Graduate University*

ISSP Posters

Mamoru Endo, ISSP (D1, Kobayashi-G)

Title: *Multi-GHz, mode-locked laser and its application*

The ultra-high repetition rate mode-locked oscillator is attractive because it has very wide comb spacing in a frequency domain. If the repetition rate exceeds the resolution of the spectrometer, we can use one comb tooth as a cw laser. We are developing 6-GHz rep rate laser and sub-GHz resolution spectrometer for precision measurement.

Florian Geier, ISSP (D1, Itatani-G)

Title: *Development of a 100-kHz Ti:sapphire amplifier for high-repetition-rate high harmonic generation*

High-repetition-rate operation of intense femtosecond lasers is important for tracing ultrafast molecular dynamics as well as time-resolved photoemission spectroscopy. We report on the current status of our high-repetition-rate Ti:sapphire amplifier for producing extreme ultraviolet (EUV) pulses via high harmonic generation.

Henning Geiseler, ISSP (PD, Itatani-G)

Title: *High-energy above-threshold ionization using carrier-envelope phase-stabilized few-cycle pulses*

High-energy above-threshold ionization is a well-known phenomenon in high-field physics. Electrons are tunnel-ionized from an atom or molecule, and subsequently gain substantial kinetic energy due to rescattering off the ionic core. By using carrier-envelope phase-stabilized few-cycle pulses, the scattering event is mapped onto the final electron kinetic energy spectrum. We report on a novel method to probe electron scattering on an attosecond time scale, which builds on this mapping.

Kenta Kitano, ISSP (PD, Itatani-G)

Title: *Controlling molecular rotational wavepackets with intense THz pulses*

Optical control of rotational wavepackets can induce field-free alignment or orientation of gas-phase molecules, which is crucial to explore stereoscopic chemical dynamics as well as molecular dynamic imaging using strong laser fields. We report on a novel technique to orient small asymmetric molecules with a combination of intense THz and visible femtosecond pulses.

Masakazu Kobayashi, ISSP (M1, Shin-G)

Title: *Antiferromagnetic-to-ferromagnetic phase transitions and magnetic anisotropy of FeRh thin films*

We observed spin quantization axes of FeRh thin films with antiferromagnetic-to-ferromagnetic phase transitions using photoemission electron microscopy.

Takayuki Kurihara, ISSP (D1, Suemoto-G)

Title: *Observation of ferro- and antiferro-magnetic resonances excited by enhanced magnetic near-field of spilt ring resonator*

Some metamaterials have the ability to locally enhance the magnetic field of terahertz radiation. In this poster, we will introduce our attempt and progress towards the realization of nonlinear dynamic control of antiferromagnetic spin precession by combining the metamaterials with an intense THz radiation source.

Junki Nakajima, ISSP (M1, Haradai-G)

Title: *Observation of electronic states of water confined in titanium oxide nanosheets*

Dispersion state of exfoliated titania nanosheets is highly dependent on temperature, cation concentration, and solid/solution ratio. SAXS experiments suggest that layered compounds forms tens nm-thick water layer between host layers due to osmotic swelling. In order to investigate the role of water in the dynamics of restacking and dispersion of titania nanosheets, we observed the element-specific electronic structure of water, nanosheets and added ions separately using soft X-ray emission spectroscopy. In the presentation we will demonstrate how unique property appears for water confined by the titania nanosheets and discuss its possible relation with dispersion and restacking of the exfoliated nanosheets.

Mitsuhiro Nakayama, ISSP (M1, Shin-G)

Title: *Observation of a quadratic Fermi node in pyrochlore iridate Pr2Ir2O7*

In the iridium oxides, the spin-orbit coupling, kinetic energy, and coulomb interaction compete with each other due to their comparable energy scales, which foster various electronic states such as topological insulator, weyl semimetal and quantum spin hall effect. We performed Angle-resolved Photoemission Spectroscopy and found the Fermi node state that is a key feature for the realization of exotic topological quantum phases.

Hideharu Niwa, ISSP (PD, Haradai-G)

Title: *Operando analysis of electronic states in carbon-based oxygen reduction catalysts for polymer electrolyte fuel cell*

We report a novel electrochemical cell system developed for in situand operando soft X-ray

emission spectroscopy of cathode catalysts for polymer electrolyte fuel cells. We have successfully observed the electronic structure of iron in the iron phthalocyanine-based cathode catalyst under various working conditions. At open circuit potential, an iron site exists and is active for oxygen adsorption, strongly suggesting the importance of in situ and operando soft X-ray emission spectroscopy.

Alissa Silva, ISSP (PD, Kobayashi-G)

Title: *Development of Yb-fiber optical frequency comb*

The optical frequency comb based on Yb-fiber laser is suitable for the optical atomic clock since it has good long- and short- term stability. We are improving the comb system to realize the comparison of two optical lattice clocks.

Hiroshi Watanabe, ISSP (Res. Assoc., Suemoto-G)

Title: *Observation of spin precession induced by high power terahertz pulse*

Recently, nonlinear phenomena caused by high-power terahertz (THz) pulses are reported. In this poster, we will introduce our experimental set up which can observe the Faraday rotation induced by high power THz pulses. The peak magnetic field of THz wave reached 0.15T (500kV/cm). We also show the experimental results of the spin precession induced by the high power THz pulse on orthoferrite.

Lin Zhu, ISSP (D2, Akiyama-G)

Title: *A Study of Detailed-Balance Theory on Conversion Efficiency in Multi-Junction Tandem Solar Cells for External and Internal Luminescence Quantum Yield Less Than 100%*

For instructing the design of practical high efficiency solar cells, we calculated theoretical conversion efficiency ( ) and optimized sub-cell band-gap energies in double-junction tandem solar cells via a detailed-balance theory, paying particular attention to their dependence on internal luminescence quantum yields of the top and bottom sub-cell materials. And we also extend this formulation and conclusion to 3-, 4-, and 5-junction tandem solar cells. These results provide realistic efficiency limits as reference for designs of practical high-efficiency tandem solar cells. It shows that the tandem solar cells made of realistic moderate materials with low should be designed with much larger band-gap energies than those optimized for the familiar ideal cases of = 1.

OIST Posters

Alexander Badrutdinov, OIST (Konstantinov Unit)

Cyclotron resonant photoresponse of a two-dimensional electron system on liquid helium

Bolometric photoresponse is observed in a variety of systems, including semiconductor-based two-dimensional electron systems, carbon nanotubes, and graphene. Apart from being of great scientific interest, it has strong potential for applications in novel bolometric and solar energy

devices. Here we report our study of a cyclotron resonant photoresponse in a model two-dimensional electron system, formed on a surface of liquid helium. We observe that the photoresponse is accompanied by significant spatial redistribution of electrons. Analysis of redistributed charges indicates that the system is driven into a strongly non-equilibrium state, which cannot be described by a generally accepted effective electron temperature approximation.

Albert Benseny Cases, OIST (Busch Unit)

Title: *Hybrid Systems of Ions and Dipolar Condensates*

In this work we will look at a hybrid quantum system consisting of a chain of trapped ions and a Bose-Einstein condensate of electric-dipolar molecules. The electric polarisation of the condensed molecules can be large enough to screen the interaction between the ions and can be modified with an external electric field, thus providing an additional control parameter of the system.

Tamoghna Das, OIST (Bandi Unit)

Title: *Equilibrium and non-equilibrium aggregates in two-dimensional systems with competing interaction*

A two-dimensional (2D) system of monodisperse particles with competing interactions (short-range attraction and long-range repulsion) is investigated through molecular dynamics (MD) simulations. With repulsion length (ξ) as the only control parameter tuning the effective interaction, the simulations chart the repulsion length (ξ) - Temperature (T) - Density (ρ) parameter space. In agreement with prior works, particulate states in this parameter space include equilibrium and non-equilibrium clusters, gels, and ergodic liquids. In particular, a critical repulsion length ξc, critical density (ρc) and critical temperature (Tc), separate thermodynamically, morphologically, and dynamically distinct states. At $\rho < \rho c$ and $T < Tc$, ξc separates an equilibrium non-compact cluster phase ($\xi > \xi c$) from a compact cluster forming, non-equilibrium Wigner glass ($\xi < \xi c$). When $T > Tc$, thermal fluctuations allowing particles to cross the repulsive barrier render only the bare attractive potential relevant, thus resulting in ergodic liquid states. A percolating gel state exists for $\rho > \rho c$ that exhibits different structural properties across ξc. We posit the thesis that ξc, ρc and Tc together help reconcile seemingly conflicting results reported in literature.

Eleftheria G. Kavousanaki, OIST (Dani Unit)

Title: *Manipulation of magnetization in symmetric graphene quantum dots using optical selection rules*

Graphene nanostructures have been known to exhibit exotic electronic, optical and magnetic properties specifically based on their shape, size and edge structure. Using the discrete rotational symmetry in triangular and hexagonal graphene quantum dots, we identify anomalous optical selection rules, and show that the symmetry of the eigenstates determines their behavior in the presence of an external magnetic field. These properties allow for a way to optically induce a

non-zero magnetic moment in symmetric graphene quantum dots independent of their size, edge structure and specific shape.

Bala Murali Krishna Mariserla, OIST (Dani Unit)

Title: *Novel opto-electronic behavior of hBN/G van der waals hetrostructures*

Two dimensional materials are quite interesting due to their novel opto-electronic properties. The potential of combining different two dimensional materials to form new heterostructures with new functionality offers intriguing possibilities. Here, we present the opto-electronic response of artificially stacked hBN/G heterostructures.

Lee James O'Riordan, OIST (Busch Unit)

Title: *3D Simulations of Coherent Transport by Adiabatic Passage on Atom Chips*

Adiabatic techniques offer some of the most promising tools for achieving high-fidelity control of the center-of-mass degree of freedom of single atoms. We present a detailed example of a technique to adiabatically transport a single atom between different waveguides on an atom chip. Full three three-dimensional simulations of the system are carried out using experimentally realistic parameters, leveraging the power of GPU computing.

Andrew Winchester, OIST (Dani Unit)

Poster 1: Title: *Low Temperature Phonon Shifts in Liquid Phase Exfoliated MoS2*

Authors: A. Winchester[1,2], M. Connolly[1,2], P. Hale[2], K. M. Dani[2], S. Talapatra[1,2]

(1) Southern Illinois University Carbondale
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The effect of temperature on the frequency shifts of in-plane E12g and out-of-plane A1g Raman modes of liquid-phase exfoliated few-layer molybdenum disulfide (MoS2) will be presented. Room temperature Raman studies performed using a 532 nm laser line indicates that the frequency difference ($\Delta\omega$) between the E12g (~381.4 cm-1) and A1g mode (~405.8 cm-1) is 24.4 cm-1 which corresponds to ~ 5 -7 layer flakes in the exfoliated samples. Both the peak positions shift towards lower frequency with increasing temperature (293 K < T < 77 K). A linear dependence in the peak shift was observed. The measured temperature coefficients of these modes will be presented and compared with other similar experimental and theoretical data available.

Poster 2: Title: *Electrochemical Characterization of Liquid Phase Exfoliated 2D Layers of Molybdenum Disulfide*

Authors: A. Winchester1, S. Ghosh1, S. Feng2, A. L. Elias2, M. Terrones2, S. Talapatra1

(1) Southern Illinois University Carbondale Department of Physics
(2) Pennsylvania State University Department of Physics

Resounding from the recent discovery of graphene, there has been a significant increase involving research on other 2D layered materials, such as the semiconductor molybdenum disulfide (MoS2). The attractiveness of these materials arises from their desirable properties allowing for many

varied applications; one particular area of which is energy storage. Here, we present a detailed electrochemical characterization of thin films consisting of few-layer MoS2 flakes synthesized via a liquid phase exfoliation method. We discuss the capacitive charge storage behavior in the presence of several electrolytes, where an order of magnitude increase in storage capacity is seen simply by exfoliating the material from its natural bulk state.

Angela White, OIST (Busch Unit)

Title: *Stability and Decay of Toroidally Trapped Two-component Spinor Condensates*

Motivated by recent experiments demonstrating multiply charged superflow and persistent currents in toroidal two-component spinor Bose-Einstein condensates [1,2], we numerically investigate the stability of two-component spinor condensates. In particular, we look at the phase-separation of immiscible two-component condensates with large differences in winding number. A tapered optical fibre potential is employed to achieve a quasi-two-dimensional toroidal-shaped trap in our numerical simulations.

[1] S. Moulder, S. Beattie, R. P. Smith, N. Tammuz, and Z. Hadzibabic, Phys. Rev. A., 86 (2012) 103629.

[2] S. Beattie, S. Moulder, R. J. Fletcher, and Z. Hadzibabic, Phys. Rev. Lett., 110, (2013) 025301.