

No.1

Name	Aunuddin Syabba Vioktalamo
Department	Physics
Position	D3
Research Title	RA: Investigation of stratified metal-dielectric metamaterial in optical regime

I. Summary of Research

1. In This Year, I studied a spatial dispersion effect in stratified metal-dielectric metamaterial. By applying Bloch boundary system in our study, the three cases are observed in different wave modes in SMDM. The first case is resonant crystal band gap mode. It appears when the refractive index is constant and the phase advance reach $\pi/2$. The second case is the propagating modes. The last case is evanescent modes. However, the evanescent wave cannot be observed experimentally because it occurs in higher wavelength regime.
2. The spatial effect results are consistent with our previous results retrieved by Transfer Matrix method.

II. Publications

1. Aunuddin S. Vioktalamo, R. Watanabe, T. Ishihara, Photonic and Nanostructure - Fundamentals and Application, xxx, xxx, (2011). (DOI: 10.1016/j.photonics.2011.08.005). *In press*.

III. Presentations

1. "Effect of imperfection in stratified metal dielectric metamaterial", A. S. Vioktalamo, R. Watanabe, S. Ohno, and T. Ishihara, The 5th International Conference on Surface Plasmon Photonics (May 15-20, 2011, BEXCO, Busan, Korea)
2. "The spatial dispersion effect in stratified metal-dielectric metamaterial", Aunuddin S. Vioktalamo, The 4rd GCOE International symposium on "Weaving Science Web beyond Particle-Matter Hierarchy" (Feb. 20-22, 2011, Tohoku University, Sendai, Japan)

No.2

Name	Kenta Abe
Department	Physics
Position	D3
Research Title	RA: Study of the vibrational state of excited state involved in the primary process of photosynthesis by wavelength tunable ultrashort excitation pulse.

I. Summary of Research

In photosynthesis, carotenoids play important roles in light harvesting (LH) and photoprotective functions. The S_2 and S_1 excited states in carotenoids are important in the LH function. Recently, efficient energy transfer has been found from an excited state above S_1 . The newly found state is named "hot S_1 " according to assignment to a vibrational excited level of S_1 . However, the dynamics and concerning vibrational mode have not been well understood. In this study, the vibrational dynamics of hot S_1 in β -carotene have been investigated by femtosecond stimulated Raman spectroscopy (FSRS). In FSRS experiment, the excited states generated by the first pump pulse were measured by stimulated Raman technique. The hot S_1 in β -carotene is generated by internal conversion from S_2 initially excited by the first pump (500 nm). The Raman spectra obtained by resonant and nonresonant FSRS are compared with numerical simulation of theoretical model. The hot S_1 is concluded to be the vibrational excited level of the ν_1 mode (C=C stretching).

II. Publications**III. Presentations**

1. "Resonance femtosecond stimulated Raman spectroscopy: development and application to vibration of excited state", K. Abe, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)
2. "Resonance femtosecond stimulated Raman spectroscopy of vibration in excited state", K. Abe, O. Yoshimatsu, R. Nakamura, H. Hashimoto and M. Yoshizawa, Japan Physical Society 2012 Spring Meeting (March 24-27, 2012, Kwansai Gakuin University, Nishinomiya, Hyogo, Japan)

No.3

Name	Hiroki Iida
Department	Physics
Position	D1
Research Title	RA: Systematic Study of Noncentrosymmetric Heavy-Fermion Ce-113 Superconductors Initiative A: Systematic Study of Noncentrosymmetric BaNiSn₃ Type Crystal-Structure Heavy-Fermion Superconductors

I. Summary of Research

1. In order to study properties of superconductivity in noncentrosymmetric materials, we performed single-crystal growth of Ce(Ir, Co)Si₃ and Ce(Rh, Co)Si₃ by using the Czochralski pulling method in a tetra-arc furnace. Although we optimized growth conditions for both systems, it was very difficult to obtain a large single-crystal enough for the transport and/or magnetic measurements.

2. Recently, it was revealed that the magnetic quantum critical point (QCP) is absent in CeRhSi_3 under zero magnetic field, which is unexpected phenomenon in the heavy-fermion system. We then searched a QCP of CeRhSi_3 in pressure- magnetic field plane. In order to verify that is a divergence phenomenon of the effective mass which is associated with the QCP, we have measured the electrical resistivity under pressure and magnetic field. The A-coefficient in $\rho(T) = \rho_0 + AT$ shows monotonous increase under pressure and magnetic field (Fig.(a)). It suggests that the effective mass does not diverge at any pressure and the field. The field dependence of the A-coefficient changes in slope at 6 on 10T. The field dependence of the residual resistivity exhibits a similar manner (Fig.(b)). We suspect that the changes are caused by the valence transition or crossover a change of electronic structure.

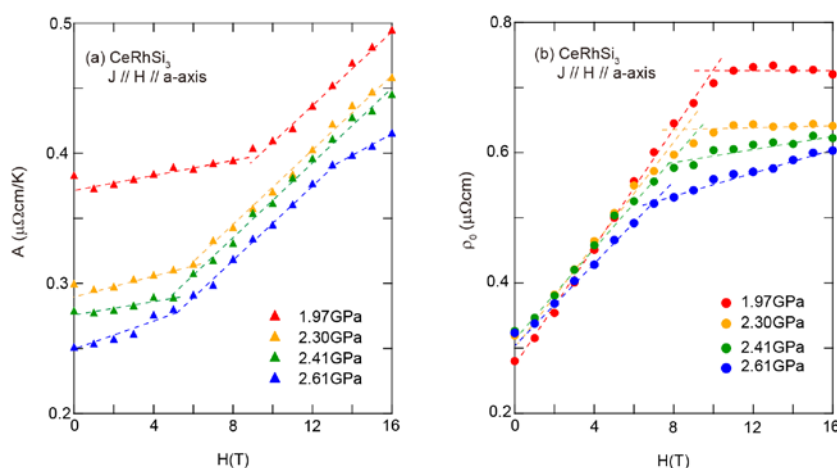


Fig. Magnetic field dependences of the coefficient A (a) and the residual resistivity ρ_0 (b).

II. Publications

1. "Fermi surface properties and antisymmetric spin orbit coupling in noncentrosymmetric CeCoSi_3 ", H. Iida, Y. Kadota, M. Kogure, T. Sugawara, H. Aoki, and N. Kimura, Journal of the Physical Society of Japan, **80**, 083701, (2011).

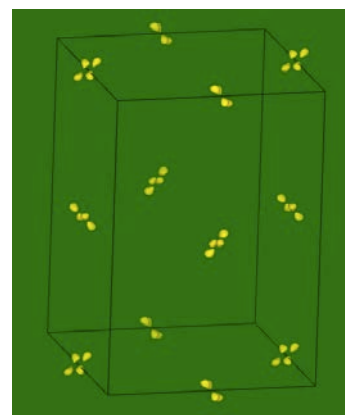
III. Presentations

1. "Electronic State and Superconducting of Heavy Fermion CeRhSi_3 ", H. Iida, The 4th GCOE International Symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (Feb. 20-22, 2012, Tohoku University, Sendai, Japan)
2. "Electronic State and Superconductivity of CeRhSi_3 ", H. Iida, T. Sugawara, T. Terashima, H. Aoki, and N. Kimura, The Physical Society of Japan 67th Annual Meeting, (Mar. 24-27, 2012, Kansai Gakuin University, Kobe, Japan)

No.4**Name** Yoshihisa Ishikawa**Department** Physics**Position** D3**Research Title** RA: X-ray Multipole Refinement of BaTiO₃ by photo induced UV-irradiation**I. Summary of Research**

In this year, I studied to analysis of orbital order materials. YTiO₃ is well known as one of orbital-ordering system materials. The orbital-ordering phenomenon of YTiO₃ have many studied the both side of theoretical and experimental method. I studied the 3d electron system of YTiO₃ by Synchrotron X-ray Diffraction.

Figure shows the electron density of Ti3d electron by Deformation Fourier Transformation method. To determine the coefficients of $|d_{zx}\rangle$ and $|d_{yz}\rangle$, Ti-O vector has a projection onto a local coordinate system. Since Ti valence electron density position is tilted 9 degree than $d_{zx} = d_{yz}$ line (45 degree: In the case of $d_{zx} = d_{yz}$, $c_1 = \sqrt{2}/2 = 0.71$), the coefficients of Ti3d of this experiment evaluates $c_1=0.81$. This result is consistent with NMR measurement.

**II. Publications****III. Presentations**

1. "Programming Package for 2D-PSD Neutron Single Crystal Experiments", Yoshihisa Ishikawa, ChangHee Lee, ShinAe Kim, MyungKook Moon, Yukio Noda, 1st Asia-Oceania Conference on Neutron Scattering, (November 20-24, 2011, Tsukuba International Congress Center, Tsukuba, Ibaraki, Japan)
2. "Accurate Crystal Structure Analysis of YTiO₃ by Synchrotron X-ray Diffraction", Yoshihisa Ishikawa, Terutoshi Sakakura, Hiroyuki Kimura, Yukio Noda, Yasuyuki Takenaka, Syunji Kishimoto, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

No.5

Name	Keisuke Ito
Department	Physics
Position	D1
Research Title	RA: Terahertz time-domain spectroscopy of large correlated triangular lattice systems

I. Summary of Research

In this year, I studied 1) terahertz pump probe experiments of large correlated triangular dimer Mott insulator k -(BEDT-TTF) $_2$ Cu $_2$ (CN) $_3$ and 2) Starting up of broadband and high frequency resolution optical systems.

1. We observed the collective excitation of electronic ferroelectricity in k -(BEDT-TTF) $_2$ Cu $_2$ (CN) $_3$. Due to photoinduced destabilization of dimer Mott phase, conflict between charge ordered/ferroelectric phase is enhanced and polar clusters are growth. This result means the photoinduced ferroelectric transition in the electric field is possible.
2. Frequency resolution of pump probe experiments are twice improvement due to replace new terahertz time domain spectroscopy systems. Moreover pump influence dependence and wavelength dependence can be measured due to make new near-mid infrared optical parametric amplifier.

II. Publications

1. "Ultrafast melting of charge ordering in LuFe $_2$ O $_4$ probed by terahertz spectroscopy", H. Itoh, K. Itoh, K. Anjo, H. Nakaya, H. Akahama, D. Ohishi, S. Saito, T. Kambe, S. Ishihara, N. Ikeda, S. Iwai., Journal of Luminescence, in press(doi:10.1016/j.jlumin.2011.12.051), (2011).

III. Presentations

1. "Terahertz Time Domain Spectroscopy of Dimer Mott Insulator", K. Itoh, H. Nakaya, Y. Kawakami, T. Fukatsu, H. Itoh, T. Sasaki, S. Saito, and S. Iwai, 2011 International Conference on Luminescence (June 26-July 1, 2011, Ann Arbor, Michigan, USA)
2. "Terahertz time domain spectroscopy of k -(ET) $_2$ Cu $_2$ (CN) $_3$ ", K. Itoh, K. Anjo, H. Itoh, S. Iwai, S. Ishihara, S. Shingo, T. Sasaki, Japan Physical Society 2011 Autumn Meeting (September 21-24, 2011, Toyama University, Gohoku, Toyama, Japan)
3. "Photoinduced ferroelectric fluctuation in dimer Mott insulator k -(ET) $_2$ Cu $_2$ (CN) $_3$ ", K. Itoh, H. Itoh, S. Iwai, S. Ishihara, and T. Sasaki, 9th International Symposium on Crystalline Organic Metals, Superconductors and Ferromagnets (September 25-30, 2011, Gniezno, Poland)
4. "Photoinduced ferroelectric fluctuation in dimer Mott insulator k -(ET) $_2$ Cu $_2$ (CN) $_3$ ", K. Itoh, H. Itoh, S. Iwai, S. Ishihara, and T. Sasaki, IMR WS on "Frontier of Ferroelectricity with Electron Degree of Freedom" (November 1-2, 2011, Institute of molecular and science, Sendai, Japan)

5. "Terahertz time domain spectroscopy of dimer Mott insulator", K. Itoh, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)
6. "Terahertz time domain spectroscopy of photoinduced phase transition in large-correlated organic conductors and oxides", K. Itoh, (March 15, 2012, Sendai mediatheque, Sendai, Japan)
7. "Interlayer dynamics of photoinduced phase transition in LuFe_2O_4 ", K. Itoh, K. Anjo, H. Itoh, S. Iwai, S. Ishihara, S. Shingo, J. Kano, T. Nagata, Y. Fukada, T. Kambe, N. Ikeda, Japan Physical Society 2012 Spring Meeting (March 24-27, 2012, Kwansai Gakuin University, Nishinomiya, Hyogo, Japan)

No.6**Name** Toru Ito**Department** Physics**Position** D1**Research Title** RA/Initiative A: Investigation of the topological order in the fractional quantum Hall effect**I. Summary of Research**

In this year, I studied new type of the order. That is called topological order which is not derive the symmetry breaking. In fractional quantum Hall states, the topological order is confined by calculating the entanglement entropy. It is said that the universal correction in the scaling law of entanglement entropy represents topological order. That correction is called topological entanglement entropy. I calculated topological entanglement entropy for several types of the quantum Hall states. Then I confirmed realization of the topological orders in several quantum Hall states.

Further, I calculate the topological entanglement entropy for some fractional filling where the ground state is not decided though quantum Hall effect is observed. Then I find the possibility of the parafermion ground state. In the parafermion state, electrons take Bose condensate by forming clusters which are like a Cooper pair. The quasiparticle excitation in that state has non-abelian statistics. Realizing Topological-quantum-computer is considered by using this statistics. My study increase the possibility of realization quantum computing.

II. Publications

1. "Spin-Orbit Interaction enhanced Fractional Quantum Hall States", Toru Ito, Kentaro Nomura, Naokazu Shibata, Journal of the Physical Society of Japan, Vol 79, (2010) 16147
2. "Quantum Phase Transition Induced by Spin-Orbit Interaction in The $N=1$ Landau Level", Toru Ito, Kentaro Nomura, Naokazu Shibata, Journal of the Physical Society of Japan, Vol 81, (2012) 64934.

III. Presentations

1. "The effect of the spin-orbit interaction for fractional quantum Hall states", Toru Ito, Japan Physical Society 2010 Autumn Meeting (September 23-26, 2010, Osaka Prefecture University, Osaka, Japan)
2. "The effect of the spin-orbit interaction for several fractional quantum Hall states", Toru Ito, Japan Physical Society 2011 Annual Meeting (March 25-28, 2011, Niigata University, Niigata, Japan)
3. "The Tunneling Effect Inter Edges of the Anti-Pfaffian State", Toru Ito, Japan Physical Society 2012 Annual Meeting (March 24-27, 2012, Kansai Gakuin University, Hyogo, Japan)

No.7

Name Yasuko Urata

Department Physics

Position D1

Research Title RA: A halo structure of ^{31}Ne by particle-rotor model

Initiative A: A structure of neutron-rich nucleus by particle-rotor model

I. Summary of Research

The Recent experimental data of a large interaction cross section and a Coulomb breakup cross section for ^{31}Ne suggest a halo structure of ^{31}Ne . The halo structure of ^{31}Ne cannot be described by a naive spherical shell model and one needs to consider a deformed potential in which the motion of the valence neutron has either s- or p- component. Assuming that ^{31}Ne consists of the deformed core nucleus ^{30}Ne and a weakly bound valence neutron, we have been studying the structure of the ^{31}Ne nucleus by taking into account the rotational excitation energy of the core nucleus with a particle-rotor model (PRM).

In the last year, we calculated the Coulomb breakup cross section and compared to the experimental data. We compared also to the adiabatic limit (i.e., the Nilsson model) in which the rotational excitation energy is neglected and investigated the effect of the excitation energy of the core nucleus on the E1 transition in the Coulomb breakup process. As a result, we showed that the state with the spin and parity of $I^\pi=3/2^-$ at a deformation parameter $\beta_2 \sim 0.2$ can reproduce the experimental data while the state with $I^\pi=3/2^-$ at $\beta_2 \sim 0.55$ can be excluded by the non-adiabatic effect.

In this year, we calculated the Coulomb breakup cross section with the core nucleus being in the ground state in the final state of the breakup reaction. We showed that due to the non-adiabatic effect, the state with $I^\pi=3/2^-$ at $\beta_2 \sim 0.2$ can reproduce the experimental data for both of the total cross section and the 0^+ cross section simultaneously.

Interaction cross sections can be well approximated by reaction cross sections for weakly bound nuclei. We calculated also the reaction cross section for ^{31}Ne with PRM. We found that the contribution of the last neutron with $I^\pi=3/2^-$ at $\beta_2 \sim 0.55$ to the enhancement of the reaction cross section for ^{31}Ne is small, that is consistent with the case of the Coulomb breakup cross section, because of the small probability of the

p-wave component in the ground state wave function. We investigated also the non-adiabatic effect on the reaction cross section. We found that there is only a small difference between the cross section in the adiabatic limit and that with the finite rotational excitation energy of the core nucleus. Consequently, Nilsson model works reasonably well on the reaction cross section for this nucleus. In addition, we investigated the dependence of the reaction cross section on the deformation parameter and the relation to the rms radius of ^{31}Ne . We are preparing a paper with these results of the reaction cross section.

II. Publications

1. "Ground state properties and Coulomb dissociation of the deformed halo nucleus ^{31}Ne ", Y. Urata, K. Hagino, H. Sagawa, Physical Review C, 83, 041303(R), (2011)
2. "An analysis of Coulomb breakup process in ^{31}Ne by Particle-Rotor Model", Y. Urata, K. Hagino, H. Sagawa, accepted by "Genshikaku-Kenkyu"

III. Presentations

1. "An analysis of Coulomb breakup process in ^{31}Ne by Particle-Rotor Model", Y. Urata, K. Hagino, H. Sagawa, Summer school of "Genshikaku-Sansha-Wakate" 2011 (October 16-21, 2011, Shirahama-so, Takashima, Siga, Japan)
2. "An analysis of Coulomb breakup process in ^{31}Ne by Particle-Rotor Model", Y. Urata, K. Hagino, H. Sagawa, Japan Physical Society 2011 Autumn Meeting (September 16-19, 2011, Hirosaki University, Hirosaki, Aomori, Japan)
3. "Coulomb dissociation of the deformed halo nucleus ^{31}Ne with particle-rotor model", Y. Urata, K. Hagino, H. Sagawa, The 10th CNS International Summer School (September 26 - October 01, 2011, Center for Nuclear Study, Wako, Saitama, Japan)
4. "Coulomb dissociation of the deformed halo nucleus ^{31}Ne with particle-rotor model", Y. Urata, K. Hagino, H. Sagawa, Frontier Issues in Physics of Exotic Nuclei (YKIS2011) (October 11-15, 2011, Yukawa Institute for Theoretical Physics, Kyoto, Japan)
5. "Structure of neutron-rich nucleus ^{31}Ne deduced from nuclear reactions", Y. Urata, K. Hagino, The 4th International GCOE Symposium on "Weaving Science Web beyond Particle-Matter Hierarchy" (February 20-22, 2012, Tohoku University, Sendai, Miyagi, Japan)
6. "Structure of deformed halo nucleus ^{31}Ne deduced from Coulomb dissociation and reaction cross section", Y. Urata, K. Hagino, Nuclear Physics and radioactivity (temporarily) (March 9-10, 2012, Aizu University, Aizu-Wakamatsu, Fukushima, Japan)
7. "An analysis of reaction cross section of $^{30,31}\text{Ne}$ by particle-rotor model", Y. Urata, K. Hagino, Japan Physical Society 2012 Spring Meeting (March 24-27, 2012, Kwansai Gakuin University, Nishinomiya, Hyogo, Japan)

No.8

Name	Daiki Endo
Department	Physics
Position	D3
Research Title	RA: Crack Patterns in Largely Deformed Material

I. Summary of Research

In this year, I conducted experiments of slow fracture of rubber films to investigate crack patterns in largely deformed material. In the experiments, a rubber film is strained uniaxially and ruptured on highly viscous fluid layer. Consequently, a crack propagates very slowly in the film and therefore we can neglect a sound wave effect on crack propagation. In this experiments, I observed straight crack patterns and oscillatory crack patterns. The transition from straight patterns to oscillatory patterns are observed near the characteristic strain at which the rubber exhibits a nonlinear stress-strain relation. Furthermore, I observed the oscillatory patterns have a finite wavelength near the transition. To explain these patterns, I conducted numerical simulations. In the simulations, nonlinear elastic neo-Hookean model is adopted to represent fracture of rubber. As a result, I obtained both straight and oscillatory crack patterns similarly to the experiments. I also obtained similar behavior of the wavelength and the amplitude against strain. On the other hand, I never obtained oscillatory patterns in linear elastic model. From the above results, I can conclude that the nonlinear elasticity plays a crucial role in oscillatory crack pattern formation and the transition may be a Hopf bifurcation.

II. Publications**III. Presentations**

1. "Oscillatory Instability of Slow Crack Propagation in Rubbers under Large Deformation",
D. Endo, International Symposium on Complex Systems 2011 (December 1-3, The University of Tokyo, Tokyo, Japan)
2. "Oscillatory Instability of Slow Crack Propagation in Rubbers under Large Deformation",
D. Endo, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

No.9

Name	Tomohiro Oishi
Department	Physics
Position	D1
Research Title	RA/ Initiative A: Structure of proton-rich unstable nuclei:

I. Summary of Research

1. From the 3-body model calculation for light proton-rich and neutron-rich nuclei, I showed the existence of a soft dipole excitation in proton-rich unstable nuclei. A soft dipole excitation is a characteristic excitation mode due to the weakly bound nucleon(s), which is discussed for neutron-rich unstable nuclei at first. I calculated the E1 transition probability of ^{17}Ne , a typical proton-rich nuclide, based on a $^{15}\text{O}+p+p$ model including the Coulomb repulsions. The E1 transition is a dominant component of electromagnetic processes and it excites the two protons with (0^+) spin-parity configuration to states with (1^-) . The result of my calculation shows the concentration of the E1 transition probability at a low energy region, namely the soft dipole excitation. This is qualitatively in good agreement with other studies in literature, including results of neutron-rich nuclei. In addition, I also studied the effect of Coulomb repulsion on the nuclear pairing interaction between two valence protons (pp). Our conclusion is that the Coulomb repulsion between pp plays a minor role in the soft dipole excitation, and its effect can be well mocked up by reducing the pairing interaction by 10%.

This work has been published as "Physical Review C84, 057301(2011)".

2. To study the two-proton decay which is a characteristic decay-mode of proton-rich unstable nuclei, I developed the time-dependent expansion method. We also applied it to a schematic 1-dimensional model for the two-proton decay. We checked its validity by comparing our results with the calculation of stabilization method which is often employed to analyze the quasi-bound state. With our method, performing the dynamical calculation, the density and the flux of two protons at each time can be described, and the decay width or the survival probability from the initial state is properly calculated. We showed that the survival probability well obeys the exponential decay-rule after a sufficient time evolution.

This work is now in preparation for a publication.

II. Publications

1. "Effect of proton-proton Coulomb repulsion on soft dipole excitations of light proton-rich nuclei", [T.Oishi](#), K.Hagino, H.Sagawa, Physical Review C84, 057301(2011)

III. Presentations

<refereed, poster>

1. "Role of Coulomb repulsion in E1 transition of ^{17}Ne ", [T.Oishi](#), K.Hagino, H.Sagawa, YKIS2011 symposium "Frontier Issues in Physics of Exotic Nuclei (YKIS2011)", on 11-15th October 2011, at Yukawa Institute for Theoretical Physics, Kyoto, Japan
2. "Properties of proton-rich unstable nuclei and two-proton radioactivity", [T.Oishi](#), K.Hagino, T.Maruyama, H.Sagawa, 4th GCOE International Symposium, on 20-22th February 2012, at Tohoku Univ., Sendai, Japan
3. "Properties and new decay-mode of proton-rich unstable nuclei", [T.Oishi](#), K.Hagino, T.Maruyama, H.Sagawa, Joint Symposium of 6-Majors (Faculty of Science, Tohoku Univ.), on 15th March 2012, at Sendai Mediatheque, Sendai, Japan

<not refereed, oral>

4. "Effect of Coulomb Interaction on E1-Transition of ^{17}Ne Nucleus", [T.Oishi](#), K.Hagino, H.Sagawa, Japan Physical Society 2011 Autumn Meeting, on 16-19th September 2011, at Hirosaki Univ., Hirosaki, Japan
5. "Effect of proton-proton Coulomb repulsion on the ground state and soft dipole excitations of light proton-rich nuclei", [T.Oishi](#), K.Hagino, H.Sagawa, CNS Summer School 2011, 26th September - 1st October, 2011 at Center for Nuclear Study, Univ. of Tokyo, Wako, Japan
6. "Properties of proton-rich unstable nuclei and two-proton radioactivity", [T.Oishi](#), K.Hagino, T.Maruyama, H.Sagawa, Symposium on "Recent topics on nuclear physics and radioactivity", 9-10th March, 2012 at Univ. of Aizu, Aizu-Wakamatsu, Japan
7. "Time-dependent approach to two-proton decay in 1-dimensional 3-body model", T.Maruyama, [T.Oishi](#), K.Hagino, H.Sagawa, Japan Physical Society 2011 Annual Meeting, on 24-27th March 2012, at Kwansei Gakuin Univ., Nishinomiya, Japan

No.10

Name	Yutaka Oya
Department	Physics
Position	D2
Research Title	RA: Deformation of Amphiphilic Membrane Containing Polymers

I. Summary of Research

Vesicles, which have a closed bilayer structure, transport some materials like proteins across the cell by forming an endoplasmic reticulum. The aim of our study is to simulate this phenomenon numerically and to clarify its physical origin.

In this study it is important to describe topological changes such as fusion or fission of membranes induced by the enclosed polymers. In order to realize this in our numerical calculation we use field

theoretical approach to describe the topological changes of bio membranes by avoiding any discontinuities in the calculation. In particular we use phase field theory to calculate shapes of vesicles and self consistent field theory to take into account conformation entropy of polymers. We will simulate behaviors of vesicles in a fluid by coupling the polymer-membrane system with a flow field which obeys Navier-Stokes equation. In this year for the first step toward the above goal we simulate polymer containing vesicles and investigate stability of these system by evaluating free energy.

As candidates of the stable shapes for vesicle, there are following three types of shapes with the same surface-area and volume, i.e. prolate shape, oblate shape and 2 separated spheres. Prolate shape is an uniaxially elongated sphere and oblate shape is a biaxially elongated sphere. As a result of containing polymers inside these shapes of vesicles, we find following stability changes contrary to the cases without polymers. When the confinement for polymers inside the vesicle is strengthened by an increase in the chain length of polymers or by a reduction of volume inside the vesicles, prolate shape of vesicle becomes more stable than the oblate shape. We found out that the origin of this stability change is the change in the conformation entropy of polymers. This phenomenon can be explained by an analytical calculation in which prolate and oblate shapes of vesicles are approximated as cylinders with the same surface area and volume.

Next, we found that in the case of phase separating polymers and solvents inside vesicles, prolate shape is more stable than 2 separated sphere due to repulsive interaction between polymers and the solvent.

[1] K. Nakaya, et al, *Europhys. Lett.*, **71** (2005) 494

II. Publications

1. "Deformation of the equilibrium shape of a vesicle induced by enclosed flexible Polymers", Y. Oya, K. Sato, T. Kawakatsu, *Europhys. Lett.*, **94**, 68004, (2011)

III. Presentations

1. "Deformation of Vesicle interacted with Polymer and Flow Field" (in Japanese), Yutaka Oya and Toshihiro Kawakatsu, Japan Physical Society 2011 Autumn Meeting (September 21-24, Toyama University, Toyama, Japan)
2. "Equilibrium States of Polymer-Containing Micells", Yutaka Oya and Toshihiro Kawakatsu, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)
3. "A Field Theoretical Approach for Deformation of Amphiphilic Membrane Having Spontaneous Curvature "(in Japanese), Yutaka Oya and Toshihiro Kawakatsu, Japan Physical Society 2012 Spring Meeting (March 24-27, Kwansei Gakuin University, Hyogo, Japan)

No.11

Name	Yuma Okazaki
Department	Physics
Position	D2
Research Title	RA: Electron correlations in semiconductor mesoscopic structures

I. Summary of Research

1. We fabricate a small quantum dot, where electron correlations are well developed. This structure allowed the detailed analysis of the electron correlation effects.
2. We investigate the shot noise properties in cotunneling regimes, where higher-order tunneling events carry a current flow. The measured shot noise in an elastic regime shows the Poissonian noise, while that in an inelastic regime shows super-Poissonian noise. This result demonstrates that shot noise measurements reveal microscopic mechanisms involved in cotunneling transport.
3. We investigate the shot noise measurements in the Kondo regime, where theory predicts an enhancement of shot noise. The measured shot noise shows super-Poissonian Fano factor, which agrees with the theoretical prediction.

II. Publications

1. "Spin-orbital Kondo effect in a parallel double quantum dot", Yuma Okazaki, Satoshi Sasaki, and Koji Muraki, Phys. Rev. B 84, 161305(R) (2011).

III. Presentations

1. "Shot noise measurements for a Kondo-correlated quantum dot in the unitary limit", Yuma. Okazaki, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

No.12

Name	Daisuke Kawama
Department	Physics
Position	D3
Research Title	RA: The analysis of Lambda hypernuclear spectroscopic experiment via the $(e,e'K^+)$ reaction at JLab Hall-C

I. Summary of Research

The main purpose of the research is the analysis of the experimental data taken in 2009 at Jefferson Lab, US. In particular I took care of the optics tuning of the magnetic spectrometers used in the experiment.

Firstly, I tuned the magnetic field map. I made some precise models for the magnets and calculate 3D magnetic field map with finite element method. After that, I tuned the field map based on the real data.

After optimizing the magnetic field map, I optimized directly the reconstruction function. The masses of Lambda hyperon and Sigma0 hyperon are well-known and these masses were used for the mass scale calibration. In addition, the peak of ground states of $^{12}_{\Lambda}\text{B}$ is also used for it. So far some parts of the tuning procedure have been done manually, but I automatized this procedure.

As a result of these analysis, I obtained the width of the Lambda peak about 1.5 MeV (FWHM). In addition, the momentum resolutions of the kaon spectrometer and electron spectrometer were estimated from this value as 4×10^{-4} and 6×10^{-4} , respectively. Though these values are almost double of the design value, they can be improved by the tuning of acceptance edge events.

From these results, it can be said that basic analysis method of the experimental system was established and the hypernuclear spectra will be obtained after the fine tune of the optics..

II. Publications

III. Presentations

1. "The Third Generation (e,e'K⁺) Hypernuclear Spectroscopic Experiment at JLab Hall-C", D. Kawama, PANIC11 (July 24-29, 2011, Massachusetts Institute of Technology, Cambridge, MA, USA)
2. "Analysis of the third generation Lambda hypernuclear spectroscopic experiment at JLab Hall-C", D. Kawama, ECT* 2011 meeting (September 26-30, 2011, Trento, Italy)
3. "Analysis status of the third generation Lambda hypernuclear spectroscopic experiment via the (e,e'K⁺) reaction at JLab-HallC", D. Kawama, Japan Physical Society 2011 Autumn Meeting (September 16-19, 2011, Hirosaki University, Hirosaki, Aomori, Japan)
4. "Analysis status of the third generation Lambda hypernuclear spectroscopic experiment via the (e,e'K⁺) reaction at JLab-HallC", D.Kawama, Japan Physical Society 2012 Spring Meeting (March 24-27, 2012, Kwansai Gakuin University, Nishinomiya, Hyogo, Japan)

No.13

Name	Chigusa Kimura
Department	Physics
Position	D2
Research Title	RA: The double pion photoproduction on the deuteron

I. Summary of Research

1. In this year, I have analyzed experimental data which our group took at the ELPH in 2010. The method of calibration for counters has been established and I repeat calibration and analysis. In the

result, the resolution of the particle identification is improved and background events are rejected clearly.

2. Alongside of analysis of data, I have proceeded some simulation. Using simulation result, I have checked detector behaviors and decide some cut condition for data.
3. The preparing to analysis of other data is almost ready, I can improve statistic and expand photon energy region.

II. Publications

III. Presentations

1. "Coherent double pion photoproduction on the deuteron", C. Kimura, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

No.14

Name	Toshiyuki Gogami
Department	Physics
Position	D2
Research Title	RA/Initiative A: Medium heavy Λ hypernuclear spectroscopic experiment by the $(e,e'K^+)$ reaction

I. Summary of Research

We have been performing Λ hypernuclear spectroscopic experiment by the $(e,e'K^+)$ reaction at JLab Hall-C since 2000. We performed $(e,e'K^+)$ experiment in 2000 and 2005, and measured up to $A=28$ Λ hypernuclei. In 2009, we performed the 3rd generation experiment E05-115, and successfully took data of Λ hypernuclei which are from $A=7$ to $A=52$. This is the first attempt to investigate $A=52$ Λ hypernuclei by the $(e,e'K^+)$ reaction in the world.

Experimentally, it is getting harder for the experiment as the target proton number Z is larger because backgrounds which are from electromagnetic processes are proportional to $\sim Z^2$. To overcome this difficulty, we newly constructed a spectrometer (HES) and optimized the setup concerning the S/N and the yield.

The rate and multiplicity of detectors are quite high with larger Z target such like ^{52}Cr . I found that a conventional tracking code which have been used in JLab Hall-C cannot handle the high multiplicity data efficiently. Therefore, a new tracking code for these high multiplicity data needs to be developed. I developed the new tracking code which can select hit-wires of tracking chambers effectively concerning the spectrometer's optics. By introducing the new tracking code, the number of kaons are increased more than 2 times for high multiplicity data. It would play important role for the future Λ hypernuclear spectroscopic experiment with larger mass number.

II. Publications**III. Presentations**

1. "Λ hypernuclear spectroscopic experiment via (e,e'K⁺) at JLab", T. Gogami, Casual talking conference of hypernuclear physics(June 21, 2011, GSI, Wixhausen, Germany)
2. "Study of light Λ hypernuclei by the (e,e'K⁺) reaction", T. Gogami, The fifth Asia-Pacific conference on Few-Body Problems in Physics 2011(August 22-26, 2011, SungKungwan University, Seoul, South Korea)
3. "Development of tracking code for high multiplicity data of medium heavy hypernuclear spectroscopic experiment with electron beam", T.Gogami, JPS annual meeting (September 16-19 , 2011 , Hirosaki University, Hirosaki, Japan)
4. "Tracking Procedure for high multiplicity data of hypernuclear spectroscopic experiment at JLab Hall-C", T. Gogami, Strange Hadronic Matter (September 26-30, 2011, ECT*, Trento, Italy)
5. "Tracking for high multiplicity event (E05-115) & E01-011 GEANT4 simulation", T.Gogami, HES-HKS international collaboration meeting (December 13-15, 2011, JLab, Newport News , VA, USA)
6. "Λ hypernuclear spectroscopic experiment by the (e,e'K⁺) reaction at Jefferson Lab", T. Gogami, First International School for Strangeness Nuclear Physics (February 12-18, 2012, J-PARC & Tohoku University , Tokai & Sendai, Japan)
7. "Lambda hypernuclear spectroscopic experiment with the high quality electron beam at JLab", T. Gogami, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

No.15

Name	Shogo Koshiya
Department	Physics
Position	D3
Research Title	RA/Initiative A: EELS and SXES studies of electronic structures of quasicrystals and related alloys

I. Summary of Research

After the discovery of quasicrystals, great effort has been spent for understanding the presence of quasiperiodic structured materials. In recent years, Hume-Rothery mechanism, which predicts an existence of a pseudogap around the Fermi level E_F , is accepted as a major reason for the stabilization of quasicrystals. The presences of pseudogap in quasicrystals were confirmed by X-ray photoemission spectroscopy and electron energy-loss spectroscopy (EELS). EELS experiments also pointed out characteristic chemical shifts in Al L-shell excitation spectra of Al-based quasicrystals, which suggested a

decrease of valence electron charge at Al sites. Recently, a covalent bonding nature in approximant crystal, which is related to quasicrystal, was reported by MEM/Rietveld analysis. Thus, it is interesting to investigate the relation between a chemical shift and bonding nature of the quasicrystals. Therefore, in this study, the chemical shift of Al-Si-Mn alloys and Zn-Mg-Zr alloys were investigated by using EELS and soft-X-ray emission spectroscopy (SXES). Those results of the amount of chemical shifts are compared with those of pure materials or their oxides.

In last year, it is clear that Al-based and Zn-Mg-Zr quasicrystalline alloys show an apparent chemical shifts, which imply the decrease of valence electron charge at all atomic sites.

In this year, the amounts of chemical shifts of quasicrystalline alloys are examined. As a result, the amounts of chemical shifts are comparable to metal oxides. Furthermore, there are no atomic sites that increase the valence charge. The amounts of decreased charge are calculated by theoretical calculation (WIEN2k code) and Bader analysis. It is concluded that about 1 electron decreased at Zn site of Zn-Mg-Zr quasicrystals.

From this result, a chemical shift to the larger binding energy side (decrease of valence charges on atomic sites) can be a common characteristic in quasicrystalline states and it strongly suggest that an increase of covalency in quasicrystalline states.

II. Publications

1. "Characteristic chemical shift of quasicrystalline alloy $\text{Al}_{53}\text{Si}_{27}\text{Mn}_{20}$ studied by EELS and SXES", S. Koshiya, M. Terauchi and A.P. Tsai, *Phil. Mag.* **91** (2011) p.2309.
2. "High Energy-Resolution EELS and SXES Studies on Characteristic Chemical Shifts and Charge Transfer in Al-Si-Mn and Zn-Mg-Zr Alloys", S. Koshiya, M. Terauchi, S. Ohhashi and A.P. Tsai, *Microsc. Microanal.* **17** (Suppl 2) (2011) p.1884.

III. Presentations

1. "Chemical shifts and charge transfer estimation of Zn-Mg-Zr by EELS and SXES", S. Koshiya, M. Terauchi, S. Ohhashi and A. P. Tsai, *The Japanese Society of Microscopy 2011*, P-I-8, (May 2011, Fukuoka, Japan).
2. "High energy-resolution EELS and SXES studies on characteristic chemical shifts and charge transfer in Al-Si-Mn and Zn-Mg-Zr alloys", S. Koshiya, M. Terauchi, S. Ohhashi and A. P. Tsai, *Microscopy & Microanalysis 2011*, 299, (August 2011, Nashville, Tennessee, USA).
3. "Characteristic chemical shifts and charge transfer estimation of Zn-Mg-Zr alloys by using EELS and SXES II", S. Koshiya, M. Terauchi, S. Ohhashi and A. P. Tsai, *Japan Physical Society 2011 Autumn Meeting*, 22pGD-6, (September 2011, University of Toyama, Toyama, Japan).
4. "Characteristic chemical shifts and charge transfer in Al-Si-Mn and Zn-Mg-Zr quasicrystalline alloys by using EELS and SXES" S. Koshiya, M. Terauchi, S. Ohhashi and A. P. Tsai, "International Conference of New Science Created by Materials with Nano Spaces: From

Fundamentals to Applications", PB-11, (November 2011, Sendai, Japan.).

5. "High energy-resolution EELS and SXES studies on characteristic chemical shifts and charge transfer in Al-Si-Mn and Zn-Mg-Zr alloys", S. Koshiya, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", P-40, (February 2012, Tohoku University, Sendai, Japan).

IV. Prizes (Awards)

1. IMRAM Research Award for the study on "EELS/SXES studies on characteristic electronic structure of Quasicrystalline phase alloys", Hatano Foundation, (December 2011).

No.16

Name	Shuhei Sasa
Department	Physics
Position	D1
Research Title	RA/Initiative A: New geometric interpretation of D-brane and DBI action

I. Summary of Research

Dirac-Born-Infeld (DBI) action gives the low-energy effective theory of a D-brane. It can be derived by calculating scattering amplitudes in string theory. However it is not obvious why DBI action. If some mechanisms characterize the effective theory of the D-brane and explain the reason why DBI action gives the effective theory, we may decide higher order corrections to DBI action without higher-order computation. As one such method, it is known that DBI action is invariant under the non-linearly realized Lorentz symmetry, which is broken by putting the D-brane on the target space. There, the scalar fields describing transverse displacements of the D-brane become NG bosons for broken translational symmetries.

We propose a new evidence for why DBI action by considering D-branes in the framework of generalized geometry proposed by Hitchin. In this framework, we show that the scalar fields and a gauge field on a D-brane can be treated in an equal footing and the argument about the non-linear realization of the spontaneously broken symmetries can be extended to include the gauge field and the NS-NS B-field.

II. Publications

III. Presentations

1. "New geometric interpretation of D-brane and DBI action", S. Sasa, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

2. "New geometric interpretation of D-brane and DBI action", S. Sasa, KEK Theory Meeting 2012 (March 5-7, 2012, KEK, Tsukuba, Ibaraki, Japan)
3. "New geometric interpretation of D-brane and DBI action", S. Sasa, Japan Physical Society 2012 Spring Meeting (March 24-27, 2012, Kwansai Gakuin University, Nishinomiya, Hyogo, Japan)

No.17**Name** Zenmei Suzuki**Department** Physics**Position** D2**Research Title** RA: Measurement of CP-violating angle ϕ_3 at Belle experiment**I. Summary**

The measurement of CP-violating angle f_3 is very important in terms of the verification of the Standard Model and search for new physics. However, the f_3 accuracy is not so good, because $B \rightarrow DK$ (D : D^0 or \bar{D}^0) decay that is used for ϕ_3 measurement is rare decay. This study is aimed for measurement of f_3 using $B^\pm \rightarrow DK^\pm$, $D \rightarrow K_S K^\pm \pi^\mp$. There is not yet an effective result using this decay.

In the last fiscal year, I understood that there are many resonances in the $D \rightarrow K_S K^\pm \pi^\mp$ decays. Thus it is need to study $D \rightarrow K_S K^\pm \pi^\mp$ Dalitz distribution. However, the fitting of $B^\pm \rightarrow DK^\pm$, $D \rightarrow K_S K^\pm \pi^\mp$ Dalitz distribution is very difficult because this decay has small statistics and cannot be distinguished between D^0 and \bar{D}^0 . Therefore, in this fiscal year, I studied $D^{*\pm} \rightarrow D\pi^\pm$, $D \rightarrow K_S K^\pm \pi^\mp$ to model the Dalitz distribution of $D \rightarrow K_S K^\pm \pi^\mp$. This decay has high statistics and can identify D flavor by the charge of D^* . I have confirmed whether the fitting of Dalitz distribution is consistent using the Monte Carlo simulation. Then I studied the background events of this mode because of characteristic behavior. As a result, the fitting method has been confirmed already. I will give the result in this fiscal year. In the next fiscal year, I will extract f_3 from $B^\pm \rightarrow DK^\pm$, $D \rightarrow K_S K^\pm \pi^\mp$ using the result.

II. Publications**III. Presentations**

1. "Study of $B \rightarrow DK$, $D \rightarrow K_S \pi$ for the measurement of CP-violating angle ϕ_3 ", Zenmei Suzuki, High energy physics Spring school (May 13-14, 2011, Hikone, Iga, Japan)
2. "Dalitz plot analysis of $B \rightarrow DK$, $D \rightarrow K_S K\pi$ for the measurement of the CP-violating angle ϕ_3 ", Zenmei Suzuki and Belle collaboration, Japan Physical Society 2011 Autumn Meeting (September 16-19, 2011, Hirosaki University, Hirosaki, Aomori, Japan)
3. "Study of $D^0 \rightarrow K_S K\pi$ for the measurement of ϕ_3 ", Zenmei Suzuki, B workshop 2011, (December 5-8, 2011, Bandaiaatami, Fukushima, Japan)
4. "Study of $B \rightarrow DK$, $D \rightarrow K_S K\pi$ for the measurement of CP-violating angle ϕ_3 , and $D^{*\pm} \rightarrow D\pi$, $D \rightarrow K_S K\pi$ for the modeling of $D \rightarrow K_S K\pi$ Dalitz plane", Zenmei Suzuki, The 4th International GCOE

symposium on “Weaving Science Web beyond Particle-Matter Hierarchy”, (February 20-22, 2012, Tohoku University, Sendai, Japan)

5. “Dalitz plot analysis of $D^* \rightarrow D\pi$, $D \rightarrow K_S K\pi$ for the measurement of the CP-violating angle ϕ_3 using $B \rightarrow DK$, $D \rightarrow K_S K\pi$ ”, Zenmei Suzuki and Belle collaboration, Japan Physical Society 2012 Spring Meeting (March 24-27, 2012, Kwansai Gakuin University, Nishinomiya, Hyogo, Japan)

No.18

Name	Yusuke Tanimura
Department	Physics
Position	D1
Research Title	RA/Initiative A: Approach by variational principle for a relativistic point coupling model

I. Summary of Research

In my work I aim to perform a relativistic mean field calculation for normal and hyper nuclei in 3 dimensional coordinate space. As a preparation for future calculations, in this fiscal year, we have extended a zero-range relativistic nucleon-nucleon interaction, which is called “relativistic point coupling model”, to a nucleon- Λ interaction. Since the model is a contact type interaction it is numerically easy to handle and has various advantages compared to the meson exchange models which have been widely used in relativistic mean field calculations. Our new model successfully reproduces the experimental data of single- Λ hypernuclei. By considering a tensor coupling between nucleon and Λ , which is usually ignored in nucleon-nucleon interaction, we have confirmed that the values of the coupling constants in the N- Λ sector are consistent with a quark model prediction. We have published the result in Physical Review C and presented it at the JPS meeting in September 2011 and at The First International School for Strangeness Nuclear Physics (SNP School 2012).

In addition we have performed three-body model calculations for ^{18}F and $^{19}_{\Lambda}F$, for which a gamma-ray spectroscopy experiment is planned at J-PARC. We investigated changes in the excitation spectrum and the electromagnetic transition probability caused by adding a Λ particle to the sd-shell nucleus ^{18}F . I presented this result at the JPS meeting in March 2012.

II. Publications

1. “Description of single-Lambda hypernuclei with a relativistic point-coupling model”,
Y. Tanimura, K. Hagino, Physical Review C85, 014306 (2012).

III. Presentations

1. "A method of solving Dirac equation by variational principle", Tanimura, Summer school of "Genshikaku-Sansha-Wakate" 2011 (August 16-21, 2011, Shiramaha-so, Takashima, Shiga, Japan).
2. "Description of Λ hypernuclei by Relativistic point coupling model", Tanimura, K. Hagino, Japan Physical Society 2011 Autumn Meeting (September 16-19, 2011, Hirosaki University, Hirosaki, Aomori, Japan).
3. "A novel method for solving a Dirac equation based on a variational principle", Y. Tanimura, YIPQS international workshop "Dynamics and Correlations in Exotic Nuclei 2011 (DCEN2011)", (October, 2011, Yukawa Institute for Theoretical Physics, Kyoto University, Kyoto, Japan).
4. "Description of single-Lambda hypernuclei with a relativistic point-coupling model", Y. Tanimura, "First International School for Strangeness Nuclear Physics (SNP School 2012)", (February 12-18, 2012, J-PARC, Ibaraki, Japan and Tohoku University, Sendai, Japan).
5. "Description of single-Lambda hypernuclei with a relativistic point-coupling model", Y. Tanimura, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan).
6. "Towards a 3-D RMF calculation in the coordinate space", Y. Tanimura, "Recent topics on Nuclear Physics and radioactivity", (March 9-10, 2012, University of Aizu, Fukushima, Japan).
7. "Impurity effect of Λ in $^{19}_{\Lambda}F$ ", Y. Tanimura, K. Hagino, Japan Physical Society 2012 Spring Meeting (March 24-27, 2012, Kwansai Gakuin University, Nishinomiya, Hyogo, Japan).

No.19

Name	Yoshiro Teshima
Department	Physics
Position	D2
Research Title	RA: Boundary state analysis on the equivalence of T-duality and Nahm transformation in superstring theory

I. Summary of Research

I investigated the equivalence of the T-duality for a bound state of D2 and D0-branes with the Nahm transformation of the corresponding gauge theory on a 2-dimensional torus, using the boundary state analysis in superstring theory. In contrast to the case of a 4-dimensional torus, it changes a sign in a topological charge, which seems puzzling when regarded as a D-brane charge. Nevertheless, it is shown that it agrees with the T-duality of the boundary state, including a minus sign. We reformulated boundary states in the RR-sector using a new representation of zero-modes, and show that the RR-coupling is invariant under the T-duality. Finally, the T-duality invariance at the level of the Chern-Simon coupling is shown by deriving the Buscher rule for the RR-potentials, known as the 'Hori formula', including the

correct sign.

II. Publications

1. "Boundary state analysis on the equivalence of T-duality and Nahm transformation in superstring theory", T. Asakawa, Y. Teshima, U. Carow-Watamura and S. Watamura, arXiv:1201.0125v2 [hep-th] (17 Jan 2012)

III. Presentations

1. "Boundary state analysis on the equivalence of T-duality and Nahm transformation in superstring theory", Yoshiro Teshima. The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

No.20

Name	Masatoshi Toda
Department	Physics
Position	D3
Research Title	RA: Rheological Study of Wormlike Micellar Systems Based on Particle-Field Hybrid Approach

I. Summary of Research

Surfactant solutions above the critical micellar concentration self-assemble into long and flexible micelles in the presence of certain salts. Such micelles are usually called "*wormlike micelles*." As the salt concentration increases, the micellar chains become elongated more and more and eventually entangle with each other. Such entangled micellar solutions show pronounced viscoelastic properties, *e.g.*, Maxwellian behavior and shear banding, due to the relaxation of intermicellar entanglements [1]. These properties are qualitatively very different from those of the entangled polymeric systems, because the micellar chains can break and recombine reversibly, while the polymer chains cannot.

In order to clarify the microscopic origin of both structural and rheological properties of the wormlike micellar systems, we develop a particle-field hybrid model with coupled Langevin equations proposed by Oono and Freed [2]. This model treats micellar chains as discrete particles and the solvent part as a continuous field. This model can reduce the computational complexity drastically compared with those of the conventional particle-based methods with the same characteristic scale, which will enable us to simulate large scale systems much more efficiently. In addition, in order to reduce the number of artificial model parameters, we derive coarse-grained potentials for the micellar parts based on Helfrich's bending elastic energy [3]. Here, the Helfrich's elastic energy is defined by a surface integral taken over the whole micellar surface in the system and is expressed with two elastic moduli, namely the cylindrical bending modulus and

the saddle splay modulus, and the spontaneous curvature, which reflects the shape properties of constituent molecules.

In this study, we have clarified the following points for the micellar systems:

1. The relationship between the static phase behavior and three material parameters of Helfrich's model, namely two elastic moduli and the spontaneous curvature (Fig.1).
2. The topological properties of the network structure, for example, the possibility of the network structures with many holes (Fig.1(c)).
3. The microscopic origin of the overshoot phenomena of the mechanical quantities observed in the micellar system.
4. The significant role of the micellar network structure for the mechanical instability that leads to a shear banding.

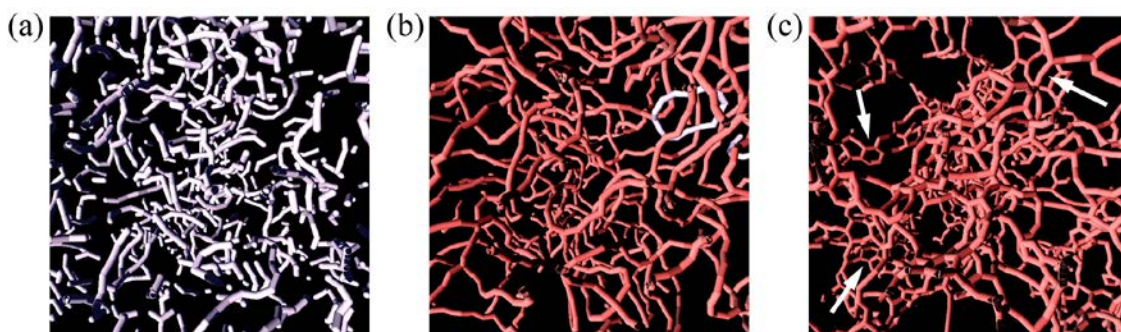


Fig. 1: Typical snapshots of characteristic structures in wormlike micellar systems.

(a) Sol phase, (b) gel phase with few holes, and (c) gel phase with many holes (indicated by white arrows).

References.

- [1] H. Rehage and H. Hoffmann, *Mol. Phys.*, **74**, 933 (1991).
- [2] Y. Oono and K. F. Freed, *J. Chem. Phys.*, **75**, 1009 (1981).
- [3] W. Helfrich, *Z. Naturforsch.*, **28c**, 693 (1973).

II. Publications

III. Presentations

1. "Effect of Spontaneous and Gaussian Curvatures on Structures and Dynamics of Wormlike Micelles", M. Toda and T. Kawakatsu, The JPS 2011 Autumn Meeting (September 21—24, 2011, Toyama University, Toyama, Japan)
2. "Statics and Dynamics of Wormlike Micellar Systems", M. Toda, The 4th GCOE International Symposium on "Weaving Science Web beyond Particle-Matter Hierarchy," (February 20—22, 2012, Tohoku University, Sendai, Japan)
3. "Statics and Dynamics of Wormlike Micellar Systems", M. Toda and T. Kawakatsu, The 5th

Discussion Meeting on Glass Transition, (February 27— March 1, 2012, Tohoku University, Sendai, Japan)

4. "Inner Structures and Dynamics of Soap Solutions", M. Toda and T. Kawakatsu, The Faculty of Science, Tohoku University, 100th Anniversary Open Symposium (March 15, 2012, Sendai Mediatheque, Sendai, Japan)
5. "Effect of Spontaneous and Gaussian Curvatures on Structures and Dynamics of Wormlike Micelles II", M. Toda and T. Kawakatsu, The 67th JPS Annual Meeting (March 24—27, 2012, Kwansei Gakuin University, Hyogo, Japan)

No.21

Name Yoji Nakagawa

Department Physics

Position D3

Research Title RA: Study of light hypernuclei with the Stochastic Variational Method

I. Summary of Research

An ordinary nucleus consists of protons and neutrons, which further consists of up and down quarks. It is known that a nucleus with a hyperon(s) containing a strange quark(s), which is called a hypernucleus, can have some different properties from ones of the core nucleus. Especially, properties of light nuclei may be drastically changed. Furthermore, one of the current topics in modern nuclear physics is concerned about neutron-rich nuclei with different properties from ones of stable nuclei.

The first observation of the neutron-rich hypernucleus, $^{10}_{\Lambda}\text{Li}$, was recently achieved, and the evidence for the extremely neutron-rich nucleus, $^6_{\Lambda}\text{H}$, was also reported. In near future, neutron-rich Λ hypernuclei, $^6_{\Lambda}\text{H}$ and $^9_{\Lambda}\text{He}$, will be produced in the J-PARC experiment. Therefore, it is timely to study the properties of neutron-rich hypernuclei theoretically.

So I have extended the trial function in order to study properties of light neutron-rich hypernuclei by using the Stochastic Variational Method, which is one of the accurate calculation method to solve few-body bound state problems. The trial function is composed of the Correlated Gaussian and the Global Vector. We may achieve an enough model space to treat the state of neutron-rich hypernuclei by extending the Global Vector.

I Calculated $^6_{\Lambda}\text{H}$ with the interaction which reproduces the Λ separation energies of s-shell hypernuclei ($^3_{\Lambda}\text{H}$, $^4_{\Lambda}\text{H}$, $^4_{\Lambda}\text{He}$). As a result, there was no bound state. Because the Σ particle degrees of freedom, which plays an important role in s-shell hypernuclei, was not explicitly treated in this calculation, I will answer this problem with the calculation taking into account the Σ degrees of freedom explicitly.

II. Publications**III. Presentations**

1. "Study of light hypernuclei with the Stochastic Variational Method", Y. Nakagawa, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

No.22**Name** Kenato Negishi**Department** Physics**Position** D1**Research Title** RA/Initiative A: Study of the decay $B^0 \rightarrow DK^{*0}$ for ϕ_3 measurement**I. Summary of Research**

In this year, I studied the decay $B^0 \rightarrow DK^+\pi^-$ followed by $D \rightarrow K^-\pi^+$, where D indicates D^0 or anti- D^0 . We reconstruct the $DK^+\pi^-$ state in a phase space corresponding to $DK^*(892)^0$. The CP violating angle ϕ_3 affects its decay rate via the interference between $b \rightarrow u$ and $b \rightarrow c$ transitions. The result is obtained from a 711 fb^{-1} data sample that contains 772×10^6 B anti-B pairs collected near the $Y(4S)$ resonance with the Belle detector at the KEKB e^+e^- collider. We measure the ratio $R_{\{DK^{*0}\}} \equiv \Gamma(B^0 \rightarrow [K^-\pi^+]_D K^+\pi^-) / \Gamma(B^0 \rightarrow [K^+\pi^-]_D K^+\pi^-)$ to be $(4.1 \text{ } (+5.6 - 5.0)(\text{stat.}) \text{ } (+2.8 - 1.8)(\text{syst.})) \times 10^{-2}$. We set an upper limit of $R_{\{DK^{*0}\}} < 0.16$ at the 95% confidence level.

II. Publications**III. Presentations**

1. "Study of the decay $B^0 \rightarrow DK^{*0}(892)$ followed by $D \rightarrow K^+\pi^-$ and $K^-\pi^+$ at Belle", Kentaro Negishi and other Belle collaboration, JPS2011Autumn, 2011 Sep., Hirosaki, Japan.
2. "Study of the decay $B^0 \rightarrow DK^{*0}(892)$ followed by $D \rightarrow K^+\pi^-$ and $K^-\pi^+$ at Belle", Kentaro Negishi, The 4th GCOE International Symposium on "Weaving Science Web beyond Particle-Matter Hierarchy," (February 20-22, 2012, Tohoku University, Sendai, Japan)

No.23**Name** Tatsuya Higashi**Department** Physics**Position** D3**Research Title** RA: Numerical studies of quantum Hall systems

I. Summary of Research

Graphene is a two-dimensional carbon material with a honeycomb lattice and has massless Dirac-type low-energy spectrum. The relativistic nature of the low-energy dispersion relation of electrons in graphene strongly modifies the Coulomb interaction between electrons under magnetic field. In this year, the ground state of the interacting massless Dirac fermions in a high Landau level (index $N=2$) is examined by the exact diagonalization (ED) method and the density matrix renormalization group (DMRG) method, which is a real space renormalization group method combined with the ED method. The DMRG method provides the low-energy eigenvalues and corresponding eigenvectors of the Hamiltonian within a restricted number of basis states. The ground state energy, excitation gap, and pair correlation functions are systematically calculated at various fillings from $\nu=1/9$ to $1/2$. We also compute the ground state wave function overlap between the exact few-particle wave function obtained by the ED method and the candidate variational wave function (i.e., Laughlin for $\nu=1/5$ and Moore-Read Pfaffian for $\nu=1/2$) for the incompressible fractional quantum Hall state. The obtained results for systems with up to 24 electrons confirm the existence of various electronic states. It is shown that the ground state phase diagram consists of incompressible quantum liquid exhibiting the fractional quantum Hall effect, compressible liquid, and various types of charge density waves called stripes, bubbles, Wigner crystal and so on.

II. Publications**III. Presentations**

1. "DMRG study of the ground state phase diagram of interacting massless Dirac fermions in graphene under magnetic field", Tatsuya Higashi, The 4th GCOE International symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

No.24

Name	Hiraku Fukushima
Department	Physics
Position	D1
Research Title	RA/ Initiative A: On the Supersymmetry breaking and the early Universe

I. Summary of Research

In this year I studied cosmological issues in a gauge mediated supersymmetry breaking model. In particular, I focused on the evolutions of the supersymmetry breaking scalar field (pseudo-moduli-field) and the messenger fields, and the gravitino relic density. Gravitino is a superpartner of the graviton and, in gauge mediation, a natural dark matter candidate. It is found that the relic density of gravitino highly

depends on the cosmological evolution of the pseudo-moduli field. This is partly because gravitinos are produced non-thermally by the decay process of the pseudo-moduli. Also, for thermal production, the gravitino production rate is affected by the nature of the pseudo-moduli field. If the pseudo-moduli field was standing at the origin of its field space in the early Universe, the gravitino production is highly suppressed. Taking into account these facts, a novel cosmological scenario is found that dark matter relic density is explained by the gravitino. This scenario is consistent with thermal leptogenesis, which is a natural mechanism to produce the baryon asymmetry of the Universe.

II. Publications

III. Presentations

1. "Cosmologically viable gauge mediation", Hiraku Fukushima, The 4th International GCOE symposium, (February 20-22, 2012, Tohoku University, Sendai, Japan)
2. "Cosmologically viable gauge mediation", Hiraku Fukushima, KEK Theory Meeting on Particle Physics Phenomenology (KEK-PH2012), (February 27-March 1, KEK, Tsukuba, Japan)
3. "Cosmologically viable gauge mediation", Hiraku Fukushima, Japan Physical Society 2012 Spring Meeting (March 24-27, 2012, Kansai Gakuin University, Nishinomiya, Hyogo, Japan)

No.25

Name	Takao Fujii
Department	Physics
Position	D2
Research Title	RA: Research of Kaon photoproduction process in the threshold region

I. Summary of Research

The purpose of our research is to calculate the total cross section of $n(\gamma, K^0)\Lambda$ and $p(\gamma, K^+)\Lambda$ reactions in the threshold energy region. In this year, I performed the analysis about the Λ particle before the calculation of the cross section. The experiment of K^+ / K^0 and Λ photoproduction with Neutral Kaon Spectrometer 2 (NKS2) has been performed in 2010 using liquid Hydrogen and Deuterium target. Before the analysis of experimental data, the calibrations of hodoscopes and drift chambers were carried out. In the current analysis status, the calibration of hodoscopes is finished only for the forward region of NKS2 (about $\pm 60^\circ$ from the photon beam direction) and undergoing for the side and backward region. After the calibration, I analyzed data and showed the particle identification using the momentums and the velocities of charged particles. And I also showed that the Λ particle was detected as the peak around $1.115 \text{ GeV}/c^2$ in the $p\pi^-$ invariant mass spectrum both of H_2 and D_2 target data. The number of detected Λ particles was about 600 (for D_2 data). It will increase by the analysis including side and backward region and VDC data.

II. Publications

III. Presentations

1. "Study of Λ photoproduction with Neutral Kaon Spectrometer 2",
T. Fujii, The 4th GCOE International Symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (Feb. 20-22, 2011, Tohoku University, Sendai, Japan)
2. "Study of Λ photoproduction on the proton and deuteron target with NKS2", T. Fujii, Japan Physical Society 2012 Annual Meeting, (March 24-27, 2012, Kwansei Gakuin University, Kobe, Japan)

No.26

Name Sho Furuhashi
Department Physics
Position D3
Research Title RA: Analysis of human behavior by complex network approaches

I. Summary of Research

In this year, we studied the regularities of human writing by analyzing written language. We used Aozora bunko, Balanced Corpus of Contemporary Written Japanese (BCCWJ) as Japanese corpus and British National Corpus (BNC) as English corpus. Our two main themes are as follows.

1. Mechanism of writing a sentence

We analyzed sentence structures from the viewpoint of sentence length. In Japanese, sentence structure can be represented as tree based on the dependency relations between segments. In addition, previous studies reported the distribution of sentence length follows lognormal distribution or gamma distribution. We focused on the facts that random variables made by multiplicative process follow lognormal distribution and the sum of random variables independently distributed exponential distribution follows gamma distribution. We investigated whether these processes appear in sentence structures or not.

We checked whether modification processes are multiplicative or not by using Fig. 1. As a result, this process is not multiplicative. We submitted a paper about this result and have already been accepted by Journal of the Physical Society of Japan. Furthermore, we made the distribution of the number of segments consisting of clauses such as subject clause and modification clause. This distribution is exponential distribution. This result indicates that writing a sentence consists of Bernoulli processes.

As well as Japanese, we did a same analysis in English by using BNC and obtained the same result.

2. Mechanism of lining up sentences in making texts

We investigated the features of the alignments of sentences in texts. We represented the adjacency relation of sentences as networks and examined the features of these networks. In this examination, sentences are characterized by their sequences of part of speeches. These networks have scale-free property. This result

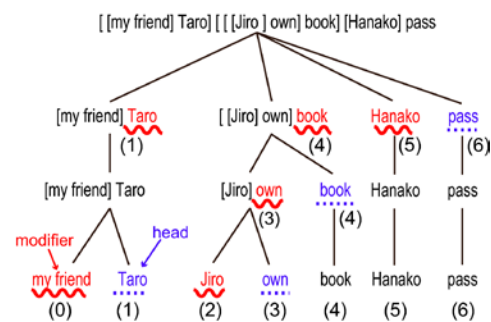


Fig. 1: Dependency tree. Leaves are segments and the root is a sentence.

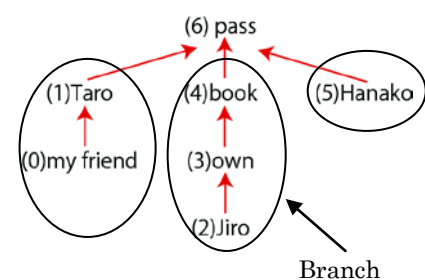


Fig. 2: Dependency tree.

Branches correspond to clauses such as subject clause and modification clause.

was obtained in last year. We used only Aozora bunko in last year, but, in this year, we used BCCWJ and BNC. Consequently, we confirmed the scale-free property of the networks in Japanese and English.

II. Publications

1. "Lognormality of the Distribution of Japanese Sentence Lengths", S. Furuhashi and Y. Hayakawa, Journal of the Physical Society of Japan, 81 (2012) 034004.

III. Presentations

1. "Text Structure Analysis in the Framework of Complex Networks", S. Furuhashi and Y. Hayakawa, European Conference on Complex Systems (September 12-16, 2011, University of Vienna, Vienna, Austria)
2. "Text Structure Analysis in the Framework of Complex Network", S. Furuhashi, International Symposium on Complex Systems 2011 (December 1-2, 2011, Tokyo University, Bunkyo-ku, Tokyo, Japan)
3. "Statistical analysis of human written language", S. Furuhashi, The 4th GCOE international symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)
4. "Lognormality of the distribution of sentence lengths", S. Furuhashi, The 1st JCL Workshop (March 5-6, 2012, National Institute for Japanese Language and Linguistics, Tachikawa, Tokyo, Japan)

No.27

Name	Kenji Hosomi
Department	Physics
Position	D3
Research Title	RA: Development of a new Ge detector array Hyperball-J for hypernuclear gamma-ray spectroscopy experiments.

I. Summary of Research

For a hypernuclear gamma-ray spectroscopy experiment at the J-PARC K1.8 beam line, a new Ge detector array (Hyperball-J) is under construction. Hyperball-J consists of Ge detectors and PWO counters. PWO counters are placed to surround a Ge crystal for anti-Compton suppression. In this year, I constructed PWO detectors. I tested effectiveness of optical grease between 2 combined crystals and found that we can consider 2 combined PWO crystals as a one bigger crystal.

I modified a drift chamber which is installed in front of the SKS magnet. A strong grounding with a copper plate was added for noise reduction. A mounting frame for the drift chamber was also made.

I analyzed experimental data of hypernuclear gamma-ray spectroscopy at KEK-PS. Missing mass

resolution was improved by tuning parameters of the drift chambers and modifying energy loss correction in target. These results were reported in the GCOE symposium and the JSPS meeting.

II. Publications

III. Presentations

1. "Analysis of the hypernuclear γ -ray spectroscopy of $^{12}_{\Lambda}\text{C}$ and $^{11}_{\Lambda}\text{B}$ via the (π^+, K^+) reaction", K. Hosomi for the E566 collaboration, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan), poster
2. "Hypernuclear gamma-ray spectroscopy on ^{12}C target", K. Hosomi, M. Ukai, T. Koike, A. Sasaki, K. Shirotori, K. Sugihara, H. Tamura, N. Chiga, F. Hiruma, R. Honda, Y. Matsumoto, K. Miwa, T.O. Yamamoto for the KEK-E566 Collaboration, Japan Physical Society 2012 Spring Meeting (March 24-27, 2012, Kwansai Gakuin University, Nishinomiya, Hyogo, Japan)

No.28

Name Daisuke Morikawa

Department Physics

Position D3

Research Title RA/Initiative A: The electrostatic potential and crystal structure analysis of the strongly correlated materials using convergent-beam electron diffraction

I. Summary of Research

1. In A-site disordered system, there are some charge fluctuation, local structure and defect. On the other hands, A-site ordered systems have no difficulty of analysis for relations between crystal structure and physical properties. A-site ordered perovskite type $\text{SmBaMn}_2\text{O}_6$ shows unusual charge and orbital ordered phase. And at low temperature, this materials show phase transformation related with the change of charge and orbital ordering. The different charge and orbital ordered models for room and low temperature phases were reported. From the determined space group by CBED method, the charge and orbital ordered models at room and low temperature phases were determined. From the coexistence of noncentrosymmetric symmetry and charge ordering at low temperature phase, electronic ferroelectricity is expected.
2. Hexagonal YMnO_3 is a ferroelectric material at room temperature. It is reported that this material shows clover leaf type domain structure. Electrostatic potential analysis using CBED was applied for determination of crystal structure and anisotropy of electrostatic potential. It is revealed that there is strong anisotropy around Y sites

II. Publications**III. Presentations**

1. "Structure analysis of charge-orbital ordered phases in A-site ordered $\text{SmBaMn}_2\text{O}_6$ using CBED", D. Morikawa, K. Tsuda, S. Yamada and T. Arima, XXII Congress of the International Union of Crystallography (August 22-30, 2011, Madrid, Spain)
2. "Electrostatic potential analysis of ferroelectric phase of hexagonal YMnO_3 using convergent-beam electron diffraction", D. Morikawa, K. Tsuda, N. Abe and T. Arima, Japan Physical Society 2011 Autumn Meeting (September, Toyama University, Toyama, Japan)
3. "Electrostatic potential analysis of ferroelectric phase of hexagonal YMnO_3 using convergent-beam electron diffraction", D. Morikawa, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

No.29

Name	Yuki Yamaki
Department	Physics
Position	D2
Research Title	RA: Impurity effect on charge/orbital/spin order in a layered manganite $\text{La}_{0.5}\text{Sr}_{1.5}\text{MnO}_4$

I. Summary of Research

In this year, I have investigated the impurity effect on charge-orbital ordered state in a layered manganites $\text{La}_{0.5}\text{Sr}_{1.5}\text{Mn}_{1-x}\text{Fe}_x\text{O}_4$. The layered manganite $\text{La}_{0.5}\text{Sr}_{1.5}\text{MnO}_4$ shows charge-orbital order below $T_{\text{COO}} = 240$ K. In Fe-doped compound, it has revealed that not only transition temperature ($T_{\text{COO}} = 140$ K) and order parameter of charge-orbital order decrease but also charge-orbital ordered state is strongly suppressed by x-ray irradiation at low temperature. In fact an intensity which reflects lattice distortion accompanied with charge-orbital order decreases by x-ray irradiation at 10 K. This measurement was performed with cooling from 200 K to 10 K without x-ray irradiation. On the other hand, the intensity increases at 70 K in the same measurement condition. So these results indicate that charge-orbital ordered state is suppressed at 10 K and enhanced at 70 K by x-ray exposure.

II. Publications**III. Presentations**

1. "Dopant-dependence on charge/orbital ordering in $\text{La}_{0.5}\text{Sr}_{1.5}\text{MnO}_4$ ", Y. Yamaki, H. Nakao, Y. Yamasaki, Y. Murakami, Y. Kaneko, and Y. Tokura, Japan Physical Society 2011 Autumn Meeting (September 20-24, 2011, Toyama University, Toyama, Japan)

2. "X-ray induced phase transition in impurity-doped manganite", Y. Yamaki, Y. Yamasaki, H. Nakao, Y. Murakami, Y. Kaneko, and Y. Tokura, Japan Physical Society 2012 Spring Meeting (March 24-27, 2012, Kansai Gakuin University, Nishinomiya, Hyogo, Japan)
3. "Dopant-dependence on charge/orbital ordering in layered manganite $\text{La}_{0.5}\text{Sr}_{1.5}\text{MnO}_4$ ", Y. Yamaki, H. Nakao, Y. Yamasaki, Y. Murakami, Y. Kaneko, and Y. Tokura, Low Temperature 26 (August 10-17, 2011, Beijing International Convention Center, Beijing, China)
4. "Dopant dependence on charge/orbital ordering in $\text{La}_{0.5}\text{Sr}_{1.5}\text{MnO}_4$ observed by resonant x-ray scattering", Y. Yamaki, H. Nakao, Y. Yamasaki, Y. Murakami, Y. Kaneko, and Y. Tokura, The 28th PF Symposium (July 12-13, 2011, Tsukuba International Congress Center(EPOCHAL Tsukuba), Tsukuba, Japan)
5. "Dopant-dependence on charge/orbital ordering in layered manganite $\text{La}_{0.5}\text{Sr}_{1.5}\text{MnO}_4$ ", Y. Yamaki, H. Nakao, Y. Yamasaki, Y. Murakami, Y. Kaneko, and Y. Tokura, IMSS Symposium 2011 (December 6-7, 2011, Tsukuba International Congress Center(EPOCHAL Tsukuba), Tsukuba, Japan)
6. "Dopant dependence of impurity effect on charge/orbital order in $\text{La}_{0.5}\text{Sr}_{1.5}\text{MnO}_4$ ", Y. Yamaki, H. Nakao, Y. Yamasaki, Y. Murakami, Y. Kaneko, and Y. Tokura, The 25th JSSRR Symposium, (January 5-9, 2012, Civic Cultural Hall Community Center, Tosu, Saga)
7. "X-ray exposure effect on charge-orbital order in Fe-doped layered manganite $\text{La}_{0.5}\text{Sr}_{1.5}\text{Mn}_{1-x}\text{Fe}_x\text{O}_4$ ", Y. Yamaki, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

No.30**Name** Satashi Yamazaki**Department** Physics**Position** D1**Research Title** RA: Study of Superconductivity and Magnetism in Fullerenes
Initiative A: Superconductivity Mechanism in Organic compounds**I. Summary of Research**

Alkali metal doped fulleride (A_3C_{60}) forms very interesting class of the materials as a high transition temperature (T_c) superconductor. Furthermore, A_3C_{60} is a strongly correlated system. In this year, we study the superconducting (SC) state in A_3C_{60} by the Coulomb repulsive interaction model.

In order to investigate the SC instability near T_c toward the SC state in A_3C_{60} , we introduce the effective tight binding Hamiltonian which reflects the orbitally degenerate t_{1u} levels of the isolated molecule, three dimensional crystal structure (bcc, fcc). To consider the effect of the Coulomb repulsive interaction, we use the effective interaction derived by the 2nd order perturbation theory. Our approach is valid in the weak

coupling limit.

As the result, the SC state has T_g symmetry in bcc model, while it has E_g symmetry in fcc model. These SC states have three or two fold degeneracy, respectively at T_c . This degeneracy is due to the crystal structure of A_3C_{60} . Generally, this degeneracy is resolved below T_c . We can classify the possible SC state with respect to their symmetry. One possibility is that the SC state becomes a chiral state which breaks time reversal symmetry. This state is consistent with nuclear magnetic resonance experimental result in A_3C_{60} , because this state causes a small coherence peak in spin relaxation rate.

II. Publications

III. Presentations

Oral presentation

1. "Theory of Superconductivity in fullerides by the repulsive interaction model", Satoshi Yamazaki, Yoshio Kuramoto, Japan Physical Society 2011 Autumn Meeting (September 21-24, 2011, Toyama University, Toyama, Japan)

Poster presentation

2. "Theory of Superconductivity in fullerides by the repulsive interaction model", Satoshi Yamazaki, Yoshio Kuramoto, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

No.31

Name	Fumiya Yamamoto
Department	Physics
Position	D1
Research Title	RA: Improvement of detector systems for Neutral Kaon Spectrometer 2

I. Summary of Research

I am studying contribution of the non-quasi free process in 2π photoproduction. In order to obtain better accurate data, I studied the following things.

1. Development of a computer simulator for upgraded Neutral Kaon Spectrometer 2 (NKS2).
We installed a new internal detector: Vertex Drift Chamber (VDC) in 2009. I developed a simulation code for upgraded NKS2. The simulated data enabled the development of the analysis code with a new tracking algorithm and the estimation of the detection efficiency of particle for upgrade NKS2.
2. Evaluation of the performance of lead-glass Cherenkov counters.
In 2010, we set four lead-glass Cherenkov counters, at 3 m downstream of NKS2. By reducing the QED background, mainly electrons and positrons, at trigger level with this detector, DAQ efficiency

and beam intensity were improved by 14 % and 25 %, respectively. From ADC information on this counter, we found that 50 % - 80 % of electron or positron hitting on this counter can be reduced. Loss of π was estimated to be 13% at the maximum.

3. Development of new photon tagging systems.

I carried out the experiment to test a prototype of a tagging counter with MPPC in January 2012 at NewSUBARU, University of Hyogo. A gamma ray beam by the laser Compton scattering is provided at NewSUBARU BL1. The relative timing of the hits on the tagging counters and their detection efficiencies were measured by using the electrons or positrons emitted by irradiating the gamma ray on a lead plate. I am analyzing this data.

II. Publications

III. Presentations

1. "Improvement of the detector systems for Neutral Kaon Spectrometer 2", F. Yamamoto, The 4th GCOE International Symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (Feb. 20-22, 2011, Tohoku University, Sendai, Japan)

No.32

Name	Shusaku Yusa
Department	Physics
Position	D2
Research Title	RA/Initiative A: Role of non-collective excitations in low energy heavy-ion reaction

I. Summary of Research

In this year, we investigated the role of non-collective excitations in heavy-ion reaction at energies around the Coulomb barrier. In the previous study, we had investigated the role of non-collective excitations by using a schematic one-dimensional potential penetration model. In that model, we had shown that the non-collective excitations smear the higher energy part of the barrier distribution. In order to investigate how the non-collective excitations affect the barrier distribution for realistic systems, we applied the coupled-channels calculation to $^{16}\text{O} + ^{208}\text{Pb}$ reaction. In addition to the fact that there have been experimental data for cross sections for fusion reaction as well as quasi-elastic scattering of this system around the Coulomb barrier, almost all the excited states up to 7.5 MeV with spin and parity have been identified for the ^{208}Pb nucleus by high resolution proton inelastic scattering measurements. We included those excited states in ^{208}Pb in coupled-channels calculations and showed that the non-collective excitations smear the higher energy part of the fusion and the quasi-elastic barrier distributions. However, the improvement of the agreement with the experimental data was not obtained. We also investigated the effect

of anharmonicity of the vibrational excitations of ^{208}Pb and found that the effect on the barrier distribution is minor and this does not improve the agreement with data, either.

For the quasi-elastic scattering, we also calculated the energy dependence of the Q-value distribution. The calculated results indicate that the contribution from the non-collective excitations becomes more and more important as the incident energy increases. This result is consistent with the experimental data.

We also studied the projectile mass number dependence of the effect of non-collective excitations. For this purpose, we performed the coupled-channels calculation for $^{32}\text{S} + ^{208}\text{Pb}$ and $^{40}\text{Ca} + ^{208}\text{Pb}$ systems in addition to the $^{16}\text{O} + ^{208}\text{Pb}$ system. We showed that the smearing effect of the non-collective excitations becomes stronger for heavier system.

We presented these results in JPS meetings and workshops, and are presently preparing for submitting a paper.

II. Publications

1. "Role of non-collective excitations in nuclear fusion reaction and quasi-elastic scattering around Coulomb barrier", S. Yusa, K. Hagino, and N. Rowley, *Soryushi-Kenkyu* Vol. 10, No.2 (2011)
2. "Role of non-collective excitations in subbarrier fusion reactions", K. Hagino, S. Yusa and N. Rowley, *EPJ Web of Conferences*, Volume 17, 2011, 5th International Conference FUSION11

III. Presentations

1. "Role of non-collective excitations in nuclear fusion reaction and quasi-elastic scattering around Coulomb barrier", S. Yusa, Kiken meeting on "Physics based on microscopic nuclear reaction theory", (August, 1-3, 2011, Yukawa Institute for Theoretical Physics, Kyoto, Japan)
2. "Role of non-collective excitations in heavy-ion fusion and quasi-elastic scattering around Coulomb barrier energies", S. Yusa, K. Hagino, Japan Physical Society 2011 autumn Meeting, (September, 16-19, 2011, Hirosaki University, Hirosaki, Aomori, Japan)
3. "Role of non-collective excitations in heavy-ion reaction around the Coulomb barrier", S. Yusa, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy" (February, 20-22, 2011, Tohoku University, Sendai, Japan)
4. "Role of non-collective excitations in heavy-ion reaction around the Coulomb barrier", S. Yusa, "Nuclear Physics and radioactivity", (March, 9-10, 2012, University of Aizu, Aizu-Wakamatsu, Fukushima, Japan)
5. Role of non-collective excitations in ^{208}Pb for the reaction $^{16}\text{O} + ^{208}\text{Pb}$ and $^{40}\text{Ca} + ^{208}\text{Pb}$ around Coulomb barrier, S. Yusa, K. Hagino, N. Rowley, Japan Physical Society 2012 Spring Meeting, (March, 24-27, 2012, Kwansei Gakuin University, Hyogo, Japan)

No.33

Name	Takayuki Watanabe
Department	Physics
Position	D2
Research Title	RA: Study about optical response of GaAs micromechanical cantilever

I. Summary of Research

I have got mainly two results in this fiscal year.

RESULT1: I have demonstrated a scheme that mechanical characterization of optical absorption at exciton states of GaAs via GaAs/AlGaAs heterostructure based cantilever.

RESULT2: I have succeeded in cavity-free laser cooling of mechanical mode at exciton states of GaAs.

Our samples are GaAs/AlGaAs heterostructure based cantilever. Our samples can be controlled and the resonance amplitude increases by back action force which comes from irradiation laser at 10 K in vacuum when the wavelength of irradiation laser corresponds to the bandgap of GaAs [1]. This process occurs because GaAs layer absorbs the laser. If we think about this process in reverse direction, we can evaluate the optical absorption spectrum of GaAs by monitoring the irradiation laser wavelength dependence of cantilevers amplitude. On the basis of this idea, I measured the wavelength dependence of cantilever amplitude and strong relations between cantilever response and GaAs optical absorption were obtained. Interestingly, this scheme shows very high resolution that is enough to observe several exciton related peaks. This new scheme helps to know the new optical property.

From result1, I can conclude that my samples have higher coupling efficiency compared to samples used in ref. 1. In ref. 1, they could not cool the samples' mechanical mode due to its low coupling efficiency. Wherein, I tried to cool my samples' mechanical mode with similar scheme. I optimized the best condition to cool the resonator based on the result1, the cooling effect was observed. At the best cooling efficiency, 50 % reduction of mechanical mode temperature was observed. The cooling efficiency is low, but the cooling way is completely new. The interaction between light and mechanical resonator in this measurement have never been reported.

These are my results in this fiscal year.

[1] H. Okamoto *et al*, Phys. Rev. B **84**, 014305 (2011)

II. Publications**III. Presentations**

International conference:

1. "Micromechanical Characterization of Optical Absorption in a GaAs/AlGaAs Heterostructure", T. Watanabe, Solid State Devices and Materials 1012 (September 25-27, 2012, Kyoto International Conference Center, Kyoto, Japan) Oral
2. "Mechanical Characterization of Excitonic Absorption with a GaAs/AlGaAs Cantilever", T.

Watanabe, Gordon Research Conferences (March 4-9, 2012, Hotel Galvez, Galveston, TX, United States) Poster

Workshop:

3. "Strong Laser-Wavelength Dependence of the Thermo-Mechanical Vibration of a GaAs/AlGaAs Heterostructured Cantilever", T. Watanabe, Quantum Nanostructure and Nanoelectronics 2011 (October 3-4, 2011, Tokyo University, Japan) Poster

Symposium:

4. "Laser cooling of a GaAs/AlGaAs cantilever by exciton-related optical absorption", T. Watanabe, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan) Poster

National congress:

5. "Carrier-induced opt-mechanical coupling in GaAs/AlGaAs heterostructure cantilevers" T. Watanabe, JSAP autumn meeting 2011 (August 29-September 2, 2011, Yamagata University) Poster
6. "Vibration mode cooling of a GaAs cantilever using excitonic absorption" T. Watanabe, JSAP Spring meeting 2012 (March 15-18, 2012, Waseda University) Oral

No.34

Name	Masanori Watahiki
Department	Physics
Position	D2
Research Title	RA/Initiative A: Coupled spin and orbital degrees of freedom in geometrical frustration compounds investigated by neutron scattering and radiation beam

I. Summary of Research

1. In last year, we have performed powder neutron diffraction experiment on NdPd₃S₄, which shows an antiferromagnetic (AFM) transition at 1.82 K. The experimental diffraction pattern at 1.56 K was fitted by considering the AFM structure $\mathbf{k} = [100]$. In this year, I presented these experimental data at Strongly Correlated Electron Systems (SCES) 2011. I have submitted the paper as a proceeding of SCES 2011.
2. We studied a valence number of doped Te ions was estimated by X-ray fluorescence (XRF) analysis method by using polycrystalline samples La_{1-x}Te_xCoO₃ ($x = 0.01, 0.05$). Magnetization measurements were also performed. From the XRF results, it is considered that the valence number of doped Te ion is six. This means that each Te ion introduces three electrons, and magnetization value per one electron is consistent with the Kanamori theory. This result suggests that a huge magnetic moment does not realize in the lightly Te-doped LaCoO₃. I will present these experimental

results at Japan Physical Society 2012 Spring Meeting.

II. Publications

1. "Crystalline electric field study in the pyrochlore $\text{Nd}_2\text{Ir}_2\text{O}_7$ with metal-insulator transition", M. Watahiki, K. Tomiyasu, K. Matsuhira, K. Iwasa, M. Yokoyama, S. Takagi, M. Wakeshima, and Y. Hinatsu, J. Phys.: Conf. Ser. **320** (2011) 012080.
2. "Emergence of magnetic long-range order in frustrated pyrochlore $\text{Nd}_2\text{Ir}_2\text{O}_7$ with metal-insulator transition", K. Tomiyasu, K. Matsuhira, K. Iwasa, M. Watahiki, S. Takagi, M. Wakeshima, Y. Hinatsu, M. Yokoyama, K. Ohoyama, and K. Yamada, J. Phys. Soc. Jpn. **81** (2012) 034709.
3. "Resonant X-ray diffraction study of multipole ordering in the ferromagnetic compound CePd_3S_4 ", S. Michimura, T. Inami, E. Matsuoka, M. Watahiki, K. Tanigaki, and H. Onodera, J. Phys. Soc. Jpn. (accepted).

III. Presentations

1. "Successive phase transitions induced by magnetic fields in a cubic system NdPd_3S_4 ", M. Watahiki *et al.*, Strongly Correlated Electron systems 2011, (August 29 – September 3, 2011, University of Cambridge, Cambridge, United Kingdom)
2. "Magnetic properties of lightly electron doped LaCoO_3 ", M. Watahiki *et al.*, The 4th GCOE International Symposium, (February 20-22, 2012, Tohoku University, Sendai, Japan)
3. "Magnetic and transport properties of lightly electron doped LaCoO_3 ", M. Watahiki *et al.*, Japan Physical Society 2012 Spring Meeting (March 24-27, 2012, Kansai Gakuin University, Kobe, Japan)

No.35

Name	Masahiro Yoshida
Department	Physics
Position	D3
Research Title	Initiative A: Study of the charge structures in two-leg ladder cuprate using resonant inelastic x-ray scattering

I. Summary of Research

1. I have tried to apply resonant inelastic x-ray scattering (RIXS) method to high-pressure experiments. In the last fiscal year, I had succeeded obtaining Q-resolved RIXS spectra under high pressure for the first time. However, the spectra had been affected by scattering from diamond. In order to suppress the effect from diamond, I introduced a pinhole after the sample position. As the result, the effect was suppressed to zero level.

2. After the introduction of a pinhole, I carried out RIXS experiments at about 3 GPa for $\text{Sr}_{2.5}\text{Ca}_{11.5}\text{Cu}_{24}\text{O}_{41}$. Comparing RIXS spectrum to the data obtained at ambient pressure, I observed a change due to pressure. I consider that this change is caused by the increase of the number of holes in the ladder layers. In order to understand a nature of the change, I have to measure the pressure dependence of RIXS spectra.
3. I made two oral presentations in Japan Physical Society 2011 Autumn Meeting and Japan Physical Society 2011 Autumn Meeting.
4. I made two poster presentations in the 1st Asia-Oceania Conference on Neutron Scattering and the 4th GCOE International Symposium. Especially in the former, I won poster award.
5. I summed up my findings as a doctoral thesis.

II. Publications

1. "Momentum dependence of electronic excitations in the Mott insulator Sr_2IrO_4 studied by resonant inelastic x-ray scattering", K. Ishii, I. Jarrige, M. Yoshida, K. Ikeuchi, J. Mizuki, K. Ohashi, J. Matsuno, and H. Takagi, Phys. Rev. B, **83**, 115121 (2011).
2. "Polarization-analyzed resonant inelastic x-ray scattering of the orbital excitations in KCuF_3 ", K. Ishii, S. Ishihara, Y. Murakami, K. Ikeuchi, K. Kuzushita, T. Inami, K. Ohwada, M. Yoshida, I. Jarrige, N. Tatami, S. Niioka, D. Bizen, Y. Ando, J. Mizuki, S. Maekawa, and Y. Endoh, Phys. Rev. B, **83**, 241101(R) (2011).

III. Presentations

1. "Charge excitations under high-pressure in $(\text{Sr}, \text{Ca})_{14}\text{Cu}_{24}\text{O}_{41}$ studied by resonant inelastic x-ray scattering", M. Yoshida, K. Ishii, I. Jarrige, T. Watanuki, J. Mizuki, Y. Murakami, N. Hiraoka, H. Ishii, K. D. Tsuei, K. Tsutsui, T. Tohyama, S. Maekawa, K. Kudo, Y. Koike, K. Kumagai and Y. Endoh, Japan Physical Society 2011 Autumn Meeting (September 21-24, 2011, Toyama University, Toyama, Toyama, Japan) Oral
2. "Observation of the electronic states under high pressure in $\text{Sr}_{14-x}\text{Ca}_x\text{Cu}_{24}\text{O}_{41}$ by resonant inelastic x-ray scattering", M. Yoshida, K. Ishii, I. Jarrige, T. Watanuki, J. Mizuki, Y. Murakami, N. Hiraoka, H. Ishii, K. D. Tsuei, K. Kudo, Y. Koike, K. Kumagai and Y. Endoh, The 52nd high pressure conference of Japan (November 9-11, 2011, Okinawa Christian University, Tyuto, Okinawa, Japan) Oral
3. "Study of the Charge Dynamics in $\text{Sr}_{14-x}\text{Ca}_x\text{Cu}_{24}\text{O}_{41}$ by Resonant Inelastic X-ray Scattering", M. Yoshida, K. Ishii, K. Ikeuchi, I. Jarrige, Y. Murakami, J. Mizuki, J.H. Kim, M. Upton, K. Tsutsui, T. Tohyama, S. Maekawa, K. Kudo, Y. Koike, Y. Endoh, 1st Asia-Oceania Conference on Neutron Scattering (November 20-24, 2011, Tsukuba International Congress Center EPOCHAL TSUKUBA, Tsukuba, Ibaraki, Japan) Poster
4. "On the development of resonant inelastic x-ray scattering for high-pressure experiments", M.

Yoshida, The 4th GCOE International Symposium on "Weaving Science Web beyond Particle-Matter Hierarchy" (February 20-22, 2012, Tohoku University, Sendai, Miyagi, Japan)
Poster

IV. Prizes (Awards)

1. Poster award for the study on "Study of the Charge Dynamics in $\text{Sr}_{14-x}\text{Ca}_x\text{Cu}_{24}\text{O}_{41}$ by Resonant Inelastic X-ray Scattering", 1st Asia-Oceania Conference on Neutron Scattering (Nov. 24, 2011)

No.36

Name	Koji Uematsu
Department	Physics
Position	D3
Research Title	Initiative A: Terahertz beam control via laser induced gas plasma

I. Summary of Research

Femtosecond pulse shaping techniques which exist in wavelength range from visible to mid-infrared have been developed for coherent control of matter and chemical reactions. The use of intense sub-picosecond THz pulses provides tools in non-linear and time-domain THz spectroscopy combined with femtosecond laser pulse. However, no efficient way for THz pulse shaping exists. In this research, it is designed to control THz temporal waveforms. Complex and precise control techniques of THz temporal waveforms are desirable for various applications, such as control of coherent phonons, intermolecular vibrations and molecular orientation.

In this fiscal year, I have proposed and demonstrated a novel method of arbitrary THz pulse shaping. It is based on spectral phase transfer to THz pulses via a difference-frequency generation process. I confirmed that the phase profile of a shaped pulse in the near-infrared can be transferred to THz pulses. Moreover, two and third order dispersion of the shaped NIR pulse could be transferred to THz pulses. This result will allow controlling to the tailored waveform for several applications by manipulating the high-order dispersion of NIR pulse.

II. Publications

III. Presentations

1. "Terahertz beam control using femtosecond pulse shaping", Koji Uematsu, K.Maki, C.Otani, The 12th Extreme Photonics Symposium (June 30, 2011, RIKEN, Saitama, Japan)
2. "Intense terahertz radiation source", Koji Uematsu, JST industry co-creating basic infrastructure Start-up meeting (August 4-5, 2011, Akiu Grand Hotel, Sendai, Japan)
3. "Terahertz beam steering using femtosecond laser interference technique", Koji Uematsu, K.Maki,

C.Otani, 36th International Conference on Infrared, Millimeter, and Terahertz (October 2-7, 2011, Hyatt Regency Houston, Houston, USA)

4. "Terahertz beam steering using femtosecond laser interference technique", Koji Uemastu, K.Maki, C.Otani, Joint Conference of International Symposium. on Terahertz Nanoscience Workshop of International Terahertz Research Network (Nov. 24-29, 2011, Osaka University Nakanoshima Center, Osaka, Japan)
5. "Terahertz pulse shaping via difference frequency mixing of shaped optical pulses", Koji Uematsu, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (Feb. 20-22, 2012, Tohoku University, Sendai,

No.37

Name	Mitsutoshi Nakamura
Department	Physics
Position	D2
Research Title	Initiative A: Theoretical study and phenomenology in Supersymmetry Breaking Models

I. Summary of Research

We apply technique of sum rule to general supersymmetry breaking models and derive sum rules.

II. Publications

III. Presentations

1. "Spectral-function sum rules in supersymmetry breaking models", M. Nakamura, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)
2. "Spectral-function sum rules in supersymmetry breaking models", M. Nakamura, R. Kitano, M. Kurachi, and N. Yokoi, Japan Physical Society 2012 Spring Meeting (March 24-27, 2012, Kwansai Gakuin University, Nishinomiya, Hyogo, Japan)

No.38

Name	Nobuhiko Mitoma
Department	Physics
Position	D2
Research Title	Initiative A: Electronic state tuning of graphene using metallic particles

I. Summary of Research

1. We found that water molecules exhibit nonnegligible photochemical reactivity with graphene under strong light irradiation.
2. The resistivity of obtained graphene derivative was higher than that of pristine graphene. This implies that adsorbed hydrogen atoms acted as electron scatterers.

II. Publications

III. Presentations

1. "Laser Raman Spectroscopy and the D Band of Graphene",
Nobuhiko Mitoma, Ryo Nouchi, Katsumi Tanigaki
The Japan Society of Applied Physics 2011 Fall Meeting (Aug. 29 - Sep. 2, Yamagata University, Yamagata, Japan)
2. "Laser Raman Spectroscopy and the D Band of Graphene",
Nobuhiko Mitoma, Ryo Nouchi, Katsumi Tanigaki,
The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (Feb. 20-22, 2011, Tohoku University, Sendai, Japan)
3. "Laser Raman Spectroscopy and the D Band of Graphene"
Nobuhiko Mitoma, Ryo Nouchi, Katsumi Tanigaki,
The 2012 WPI-AIMR Annual Workshop, (2/20-23, 2012, Sendai International Center, Sendai, Japan)
4. "Laser Raman Spectroscopy and the D Band of Graphene II",
Nobuhiko Mitoma, Ryo Nouchi, Katsumi Tanigaki
The Japan Society of Applied Physics 2012 Spring Meeting (Mar. 15-18, Waseda University, Tokyo, Japan)

No.39

Name	Ahmad Ridwan Tresna NUGRAHA
Department	Physics
Position	D2
Research Title	Initiative A: Research of the elementary particle models that provide neutrino masses

I. Summary of Research1. Development of coherent phonon program within electronic ETB picture

We finished developing coherent phonon simulation program for carbon nanotube system, originally created by G. D. Sanders (Phys. Rev. B 79, 205434, 2009), by including geometry optimization and curvature effects in the framework of extended tight-binding model. The ultrafast dynamics of laser-induced coherent phonons in single wall carbon nanotubes (SWNTs) of different chiralities with diameter of 0.7 – 1.0 nm are calculated using the program. In particular, we examined coherent radial breathing mode (RBM) amplitudes in semiconducting SWNTs by changing excitation energies within 0.5 to 4.0 eV resonant to their optical transition energies. The calculation results are published in Phys. Rev. B 84, 174302 (2011).

2. Extension of the program for graphene nanoribbon system

The calculation is further extended for the graphene nanoribbon system. Similar behavior of coherent phonon amplitude is found, namely the coherent radial breathing like mode (RBLM). The calculation results have been submitted to Phys. Rev. B (2012), arXiv:1201.5339.

3. Coherent states within excitonic picture

A big target of this project is to describe the coherent phonon phenomena in terms for exciton picture. Preliminary calculations are done using a simple gaussian model to simulate both spatial and time evolution of the coherent states. This calculation is still an ongoing problem.

4. Recent results of the research

- **Behavior of coherent phonon amplitudes**

We found that the coherent phonon amplitudes are very sensitive to the change in excitation energies and that the resonant condition for each SWNT or graphene nanoribbon is strongly type dependent. From this simulation, we can also predict how the SWNT diameter or nanoribbon width changes as a response to femtosecond laser excitation, especially to understand whether the material will initially increase or decrease.

- **Same origin of electron-phonon interactions in SWNTs and graphene nanoribbons**

We can analyze two main constituents of the oscillation amplitude, i.e., its magnitude and its phase. From our theory, we predict that the magnitude of oscillations should be roughly proportional to the product of the electron-phonon and electron-photon matrix elements, while initial phase would only be determined by the sign of electron-phonon matrix elements.

Interestingly, we found a same origin of the electron phonon interactions in SWNTs and graphene nanoribbons. The type dependence of electron-phonon matrix element originates from the so-called *cutting line* concept in the one-dimensional Brillouin zone of the two materials. This finding gives a universal picture for the electron-phonon interaction in 1D carbon materials.

II. Publications

1. "Vibrational and NMR properties of polyynes", M.M. Haque, L.C. Yin, A.R.T. Nugraha, and R. Saito, Carbon **49**, 3340-3345 (2011)
2. "Excitation energy and chirality dependence of coherent phonon amplitudes in single wall carbon nanotubes", A.R.T. Nugraha, G.D. Sanders, K. Sato, C.J. Stanton, M.S. Dresselhaus, and R. Saito, Phys. Rev. B **84**, 174302 (2011)
3. "Luminescence properties of individual empty and water-filled single-walled carbon nanotubes", S. Cambre, S. Santos, W. Wenseleers, A.R.T. Nugraha, R. Saito, L. Cognet, and B. Lounis, ACS Nano, <http://dx.doi.org/10.1021/nn300035y>, accepted (2012)
4. "Coherent radial breathing like phonons in graphene nanoribbons", G. D. Sanders, A.R. T. Nugraha, R. Saito, and C.J. Stanton, arXiv:1201.5339 (2012)

III. Presentations

1. "Coherent phonon spectroscopy of RBM and RBLM phonons in carbon nanotubes and graphene nanoribbons", A.R.T. Nugraha, K. Sato, and R. Saito, The 42nd Fullerene-Nanotubes-Graphene General Symposium (March 6-8, 2012, University of Tokyo, Japan)
2. "Theory of coherent phonon oscillations in carbon nanotubes and graphene nanoribbons", A.R.T. Nugraha and R. Saito, The 4th GCOE International Symposium (February 20-22, 2012, Tohoku University Aobayama Campus, Sendai, Japan)
3. "Excitation and chirality dependence of coherent phonons in carbon nanotubes", A.R.T. Nugraha, K. Sato, and R. Saito, A3 Symposium of Emerging Materials (October 13-15, 2011, Royal International Hotel, Urumqi, China)
4. "Chirality-dependent coherent phonon amplitudes in single wall carbon nanotubes", A.R.T. Nugraha, K. Sato, and R. Saito, The 41st Fullerene-Nanotubes-Graphene General Symposium (September 5-7, 2011, Tokyo Metropolitan University, Tokyo, Japan)
5. "Coherent phonon amplitudes of single wall carbon nanotubes", A.R.T. Nugraha and R. Saito, ATI 2011 Nano-Carbon Meeting and Zao11 Meeting (August 2-3, 2011, Yamagata-Zao, Japan)
6. "Chirality dependence of coherent phonon amplitudes in carbon nanotubes", A.R.T. Nugraha and R. Saito, Postgraduate Workshop on Nanoscience and Nanotechnology 2011 (June 15-17, 2011, Hong Kong)

No.40

Name	Md. Mahbubul Haque
Department	Physics
Position	D2
Research Title	Initiative A: TEM/EELS study of polyynes inside single wall carbon nanotube

I. Summary of Research

We have obtained the images of polyynes inside single-walled carbon nanotube (polyynes@SWCNT) using high resolution transmission electron microscope (HRTEM). From HRTEM images of polyynes@SWCNT the following different aspects are visible:

1. Encapsulation of polyynes by single-walled carbon nanotube has been confirmed.
2. Orientation of polyynes is not always parallel with the nanotube axis rather, in the case of large diameter (~2 nm) nanotube, making large angle with the axis.
3. Yield of polyynes inside nanotube is not uniform that is some nanotube has high yield of polyynes inside them but some other has low yield.
4. It can also be noticed that some polyynes are not perfectly straight rather in slightly bending condition.

EELS of polyynes@SWCNT: Electron energy loss spectra (EELS) of different specimens (polyynes@SWCNT) have been obtained. EELS of both the empty region of nanotube and the nanotube region including polyynes were studied. Both the eels spectra, corresponding to empty and polyyne-included region of SWCNT respectively, show similar nature which makes it difficult to identify the energy loss peak due to polyyne, however, an increased intensity from 2 eV to 7 eV, i.e. around π -plasmon energy region in spectrum of polyynes-included region should be due to the inclusion of polyynes that is due to an increase of volume. The inter-band transitional energies E_{ii} , (where $i=1,2,3\dots$) specially E_{11} and E_{22} , are quite prominent which makes it easy to index the nanotube chirality with the help of Kataura plot.

II. Publications

1. "Vibrational and NMR properties of polyynes.", Md. Mahbubul Haque, Lichang Yin, Ahmad R.T. Nugraha, Riichiro Saito, CARBON 49, 3340 – 3345 (2011).

III. Presentations

1. "Calculation for Vibrational and NMR properties of Polyynes And Microscopic studies of Polyynes@SWNT", Md. Mahbubul Haque, The 40th Commemorative Fullerene Nanotubes General Symposium (March 8-10, 2011, Meijo University, Nagoya)

2. "TEM/EELS studies of polyynes inside SWCNT", Md. Mahbubul Haque, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)
3. "TEM/EELS studies of polyynes inside SWCNT", Md. Mahbubul Haque, Workshop on Carbon Nanotube in Commemoration of the 20th Anniversary of its Discovery ("2011-CNT20") (December 12-13, 2011, Tokyo International House, Tokyo)

No.41

Name	Thiago Junqueira de Castro Bezerra
Department	Physics
Position	D2
Research Title	Initiative A: Double Chooz: A Search for the Neutrino Mixing Angle θ_{13}

I. Summary of Research

1. Performed calculations concerning uncertainties related to the nuclear reactors, for the Double Chooz experiment, in order to get these values interference on the neutrino rate and spectrum estimation.
2. Study the possibility of extract the Δm^2_{13} neutrino parameter, combining the 3 current reactor experiment (Double Chooz, Daya Bay and Reno) result. Therefore, the result obtained from accelerator experiments can be cross checked.
3. Analyzed the data from the Double Chooz far detector, checking the rate temporal evolution, looking for photomultiplier tubes (PMT) that are producing light from electrical discharges of its base, known as "Glower PMT".
4. Developed macros to blind and check the nuclear reactor thermal power data, provided by the EdF (Électricité de France), company that runs the two Chooz nuclear reactors.
5. Tested and prepare the flanges of the Double Chooz near detector. The PMTs cables, fibers and monitoring devices cables, will pass through these flanges, that were manufactured at Tohoku University.
6. Tested the PMTs that will be used in the Double Chooz near detector. The tests were performed at Max-Planck Institute for Nuclear Physics in Heidelberg, Germany.
7. Did on-site monitoring and data taking shift during two weeks at the Double Chooz experiment site, in Chooz, France.

II. Publications**III. Presentations**

1. "Status of Sensitivity and Reactor Group Activities", Thiago J. C. Bezerra, Double Chooz Japan

Group Collaboration Meeting (July 08-10, 2011, Hiroshima Institute of Technology, Hiroshima, Japan)

2. "Preparation of Near Detector Flanges", Thiago J. C. Bezerra and Hiroshi Tabata, Double Chooz Japan Group Collaboration Meeting (July 08-10, 2011, Hiroshima Institute of Technology, Hiroshima, Japan)
3. "Status of R&D for Reactor Monitor at Tohoku University", Thiago J. C. Bezerra on Behalf of Tohoku University Group, Applied Antineutrino Physics (September 15-16, 2011, Vienna University of Technology, Vienna, Austria)
4. "The Reactor Values and Uncertainties for the Shape Fitting", Thiago J. C. Bezerra, Double Chooz Japan Group Collaboration Meeting (January 08-09, 2012, Niigata University, Niigata, Japan)
5. "Near Detector's PMT Light Noise Test at MPIK Heidelberg, Germany", Thiago J. C. Bezerra, Double Chooz Japan Group Collaboration Meeting (January 08-09, 2012, Niigata University, Niigata, Japan)
6. "Reactor Complementary Study", Thiago J. C. Bezerra, Internal Communication (January 17, 2012, Tokyo Institute of Technology, Tokyo, Japan)
7. "Light Noise Status", Thiago J. C. Bezerra and Hisataka Furuta, Double Chooz Collaboration Meeting (February 08-13, 2012, Tohoku University, Sendai, Japan)

No.42

Name	Huynh Kim Khuong
Department	Physics
Position	D1
Research Title	Initiative A: Investigation of the Impurity Effects on the Dirac Cone States of (122) Materials AE(Fe_{1-x}M_xAs)₂ (AE = Ba, Sr, Ca; M = Co, Ni, Cu)

I. Summary of Research

1. Optimized crystal growth conditions for (122) single crystals. Obtained very high quality crystals with desirable thickness.
2. Optimized annealing process to improve conductivity of the (122) single crystals.
3. Measured transport properties of the single crystals under magnetic fields up to 50 T. Analyzing data. The results will be presented in the M2S and JPS conferences.

II. Publications

1. "Both electron and hole Dirac cone states in Ba(FeAs)₂ confirmed by magnetoresistance", K. K. Huynh, Y. Tanabe, K. Tanigaki, Physical Review Letters, 106, 217004, (2011).

2. "Coexistence of Dirac-cone states and superconductivity in iron pnictide $\text{Ba}(\text{Fe}_{1-x}\text{Ru}_x\text{As})_2$ ", Y. Tanabe, K. Huynh, S. Heguri, G. Mu, T. Urata, J. Xu, R. Nouchi, N. Mitoma, K. Tanigaki, Physical Review B, 84, 100508, (2011).

III. Presentations

1. "Evidences for Quantum Magnetotransport of Dirac cone states in $\text{Ba}(\text{FeAs})_2$ ", K. K. Huynh, Y. Tanabe, T. Urata, R. Nouchi, N. Mitoma, S. Heguri, J. Xu, G. Mu, H. Nojiri, K. Tanigaki, 26th International Conference on Low Temperature Physics (August 10-17, 2011, Beijing, China)
2. "Co-doping effects on Dirac cone of $\text{Ba}(\text{FeAs})_2$ ", K. K. Huynh, Y. Tanabe, T. Urata, S. Heguri, J. Xu, G. Mu, K. Tanigaki, H. Nojiri, Japan Physical Society 2011 Autumn Meeting (September 20-24, 2011, Toyama University, Toyama, Japan)
3. "Evidences for Quantum Magnetotransport of Dirac cone states in $\text{Ba}(\text{FeAs})_2$ ", K. K. Huynh, Y. Tanabe, T. Urata, R. Nouchi, N. Mitoma, S. Heguri, J. Xu, G. Mu, H. Nojiri, K. Tanigaki, GCOE Symposium (February 20-22, 2011, Tohoku University, Tohoku, Japan)

No.43

Name Kenta Takahashi

Department Physics

Position D1

Research Title Initiative A: Research of Transmission-line STJ Detector for Terahertz Band

I. Summary of Research

1. We have proposed and demonstrated a new type detector for THz Band. We improved the performance of the superconducting tunnel junction.
2. We have detected THz waves by the detector and analyzed the data, and presented the results at conferences.

II. Publications

III. Presentations

1. "Study of Transmission-line STJ Detector", Kenta Takahashi, The 12nd RIKEN-IMS joint symposium on Extreme Photonics (2011.6.30, RIKEN, Wako, Japan)
2. "Study of Transmission-line Detector", Kenta Takahashi, The Symposium 2011 on "Physics of origin of universe ~ From inflation to dark matter ~", (2011.7.11-12, JAXA, Sagami-hara, Japan)
3. "Research of superconducting micro-stripline detectors for terahertz waves", Kenta Takahashi, Seiichiro Ariyoshi, Takashi Noguchi, Masahiko Kurakado, Kensuke Koga, Noboru Furukawa, Chiko Otani, 24th International Symposium on Superconductivity (ISS

2011)(2011.10.24-26,Tokyo,Japan)

4. "Micro-stripline superconducting tunnel junction detectors for terahertz waves", Kenta Takahashi, Seiichiro Ariyoshi, Takashi Noguchi ,Masahiko Kurakado ,Kensuke Koga, Noboru Furukawa, Chiko Otani, The 6th East Asian Symposium on Superconducting Electronics (EASSE 2011)(2011.10.27-29,Yamagata University, Yonezawa,Japan)
5. "Research of Transmission-line STJ Detector for Terahertz Band", Kenta Takahashi, Seiichiro Ariyoshi, Takashi Noguchi ,Masahiko Kurakado ,Kensuke Koga, Noboru Furukawa, Chiko Otani, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)
6. "Development of Transmission-line STJ Detector for Terahertz Band", KentaTakahashi, Seichiro Ariyoshi, Taku Noguti, Masahiko Kurakado, Noboru Furukawa, Tomoyuki Oya, JSAP Spring meeting 2012 (March 15-18, 2012, Waseda University, Tokyo, Japan)

No.44

Name	Brian O'Neil Beckford
Department	Physics
Position	D3
Research Title	RA /Initiative A: Study of the strangeness photoproduction process in the threshold energy region

I. Summary of Research

In the course of the current semester I have explored the production of strangeness by the electromagnetic interaction. I have successfully obtained the invariant mass, momentum and angular event distributions and have calculated the preliminary excitation function. I was able to present some of my preliminary results at the JPS fall meeting, the 1st International school of Nuclear Physics and the 4th GCOE symposium. Lastly, I was able to establish a working collaboration with a theorist at the Gent University in Belgium and have compared preliminary results to the predictions.

II. Publications

1. "Report on strangeness photoproduction experiments performed with the Neutral Kaon Spectrometer 2", B.Beckford, et al. arXiv:1202.2748 (2012)
2. "Report on strangeness photoproduction experiments performed with the Neutral Kaon Spectrometer 2", B.Beckford, et al Research report of the Research center for Electron Photon Science, Tohoku University **Vol 44** (2011).

III. Presentations

1. "Investigation of the photoinduced production of strangeness in the threshold region" B.Beckford, 1st International School of Strangeness Nuclear Physics, (February 12-18, 2012, Tohoku University, Tokai-Sendai, Japan)
2. "Investigation of the photoinduced production of strangeness in the threshold region" B.Beckford, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)
3. "Photoproduction of Λ Hyperons and Neutral Kaons on the deuteron in the energy range of 0.8 - 1.1 GeV", B. Beckford, Japan Physical Society 2011 Autumn Meeting (September 16-19, 2011, Hirosaki University, Hirosaki, Aomori, Japan)

No.45

Name Shinobu Sekine

Department Physics

Position D1

Research Title Initiative A: Theoretical research for the property change in the propagation of crack tip in polymer material.

I. Summary of Research

1. To expand Yamaguchi's simple block model, we propose a simple mechanical model describing viscoelasticity and cavitation during the crack propagation process in pressure-sensitive adhesive.
2. We extend our block model to describe hydrogen dissolution process into polymer material and defect generation phenomena.

II. Publications

III. Presentations

1. "Simple model for rupture process of pressure-sensitive adhesives", S.Sekine, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)
2. "Simple block model for dissolution process of hydrogen into polymer material", S.Sekine and T.Kawakatsu, AEARUEEW 2012, The 4th Energy and Environmental workshop, (March 29-30, 2012, National Taiwan University, Taipei, Taiwan)

No.46

Name	Kenji Tsutsumi
Department	Physics
Position	D1
Research Title	RA/Initiative A: Research of magnetic excitation for high- Tc cuprates of widely electron doped system

I. Summary of Research

In this year, I studied magnetic excitation of Bi2201 for inelastic neutron scattering. In this result, it is found that its magnetic excitation is different from another high-Tc cuprates like LSCO. Bi2201 has more broadened spectrum of high energy region than LSCO –spin wave like -. It may be explain that magnetic excitation and Tc has very strong correlation.

II. Publications**III. Presentations**

1. "Crystal growth of new target systems for high-energy neutron-scattering measurements at J-PARC", K. Tsutsumi¹, M. Enoki¹, K. Soto¹, Y. Ai¹ M. Matsuura², K. Yamada³, and M. Fujita², AOCNS (November 22-24, 2011, Tsukuba, Ibaraki, Japan)
2. "Crystal growth of new target systems for high-energy neutron-scattering measurements at J-PARC", K. Tsutsumi¹, M. Enoki¹, K. Sato¹, Y. Ai¹ M. Matsuura², K. Yamada³, and M. Fujita², The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)
3. "Research for Magnetic Excitation of Bi2201-System of Dilution Doped by Pulse Neutron Scattering", K. Tsutsumi, M. Fujita, M. Enoki, M. Matsuura, K. Sato, K. Yamada., Japan Physical Society 2012 Spring Meeting (March 24-27, 2012, Kansai Gakuin University, Nishinomiya, Hyogo, Japan)

No.47

Name	Shinsuke Fukaya
Department	Physics
Position	D1
Research Title	RA: Creation of a spontaneous movement vesicle and elucidation of structural change dynamics in the vesicle

I. Summary of Research

A living body system uses an amphipathic molecule etc. as a fundamental component. They are merely material. But they have such a feature of life by self-assembly. The reason is seldom known. This biological system which cannot be dealt with in the present thermodynamics, linear non-equilibrium statistical physics and equilibrium statistical physics has a very interesting phenomenon. However, since there is no clear experiment models in this biological system, this field is not yet developed. In this year, I studied membrane shape changes in vesicles caused by chemical environment which is one of the biological systems. I was added dropwise to NaOH solution into the vesicles. NaOH solution was made to transform the vesicles' shape to 'strange' shapes (ex. small tubes grew) from spheres.

II. Publications**III. Presentations**

1. "A structural change of the vesicles in a nonequilibrium system including a chemically reacting system", The 4th GCOE International Symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (Feb. 20-22, 2011, Tohoku University, Sendai, Japan)

No.48

Name	HE Qinghua
Department	Physics
Position	D1
Research Title	RA: A Test for Uniformity of BGO Crystals to be Used For an EM Calorimeter

I. Summary of Research

From October in 2011 to March in 2012, I joined the work of constructing a 4π BGO electromagnetic (EM) calorimeter named BGOegg. It consists of 1320 BGO crystals, which are shaped as tapered blocks to make up an egg-shaped EM calorimeter. The scintillation lights of each BGO crystal will be read out through the back surface with a photomultiplier tube (PMT). If the light collection from every point along the path of interacting particles is not uniform, the whole crystal will give different responses depending

not only on the energy deposit but also on the position of the light release. In other words, the amount of scintillation lights reaching PMT is affected by the shape of BGO crystal. In general, the position dependence of light output could be attributed to the optical properties of tapered crystals and reflectors with which the crystals are wrapped. The surface treatment by an etching method can make an improvement on the uniformity. In the present time, we are measuring the effect on the uniformity due to different surface treatments and wrapping reflectors for BGO crystals. Three different surface treatments and three kind of wrapping reflectors have been tested. In the 4th International GCOE symposium I presented the results of longitudinal uniformity for each combination of surface treatment and reflector for BGO crystals.

II. Publications

III. Presentations

1. "A Test for Uniformity of BGO Crystals to be Used For an EM Calorimeter", A. Name, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

No.49

Name	Phan Thi Nhu Quynh
Department	Physics
Position	D1
Research Title	Initiative A: Electronic state of potassium doped polyacene

I. Summary of Research

1. I have synthesized intercalation compounds between polyacene and potassium.
2. Both static and dynamic magnetic susceptibility of K-intercalated samples were investigated. The experimental data have been analyzed and reported in conferences.

II. Publications

III. Presentations

1. "Synthesis and magnetic properties of potassium doped organic semiconductor: anthracene, tetracene, pentacene", Quynh Phan, Satoshi Heguri, Junichi Ikeda, Yoichi Tanabe, and Katsumi Tanigaki, Japan Physical Society 2010 Autumn Meeting, (September 20-24, 2011, Toyama University, Toyama, Japan).
2. "Magnetic properties of potassium doped organic semiconductor: anthracene, tetracene, pentacene", Quynh Phan, Satoshi Heguri, Junichi Ikeda, Yoichi Tanabe, and Katsumi Tanigaki,, The 4th GCOE International Symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (Feb.

20-22, 2011, Tohoku University, Sendai, Japan).

3. "ESR study on potassium doped anthracene", Quynh Phan, Satoshi Heguri, Junichi Ikeda, Yoichi Tanabe, and Katsumi Tanigaki, Japan Physical Society 2012 Spring Meeting, (March 24-27, 2012, Kwansei Gakuin University, Hyogo, Japan), submitted.

No.50

Name	XU, Benda
Department	Physics
Position	D1
Research Title	Initiative A: Observation of ^7Be Solar Neutrinos with KamLAND

I. Summary of Research

1. 4pi calibration analysis is carried out by the author. Please refer to the research plan for the background of this analysis. The discrepancy of 4pi output vertex and PMT vertex has been resolved by shifting the center of mass and by introducing buoyancy with catenary of the cable. The vertex and energy bias and resolution will be inferred from the analysis. This result will be reported at KamLAND collaboration meeting held on March 15-17 at Matsushima, and finally integrated into the result of ^7Be solar neutrino flux.
2. The plan of using and improving KLG4sim to simulate KamLAND low energy behavior has not been carried out yet. The author will initiate the work from KamLAND collaboration meeting after discussions with colleagues.
3. The author has finished a proof-of-concept project of porting Linux to MoGURA FPGA as SoC. Full operating system can be run on MoGURA to aid the process of data in hardware. The experiment result has been published in poster session at GCOE international symposium 2012. Applications of this experiment are Ethernet read of MoGURA waveform data, smart trigger logic and on chip data compression. An attempt of hardware and software co-design will bring these applications into reality. The snapshot of project progress will be reported at KamLAND collaboration meeting held on March 15-17 at Matsushima.

II. Publications

1. "Search for extraterrestrial antineutrino sources with the KamKAND detector", , A. Gando et al. ApJ 745 193 (2012) doi:10.1088/0004-637X/745/2/193

III. Presentations

1. "Porting Linux to MoGURA Frontend Electronics", Benda XU, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012,

Tohoku University, Sendai, Japan)

No.51

Name Amin Vakhshouri

Department Physics

Position D1

Research Title Initiative A: Real-Space Observation of Electronic Structure of Low-Dimensional Systems in High Magnetic Field.

I. Summary of Research

1. Performed scanning tunneling microscopy (STM) on bulk molybdenum disulphide (MoS_2) and visualized the step structure of MoS_2 .
2. The density of state (DOS) of bulk MoS_2 was studied in ambient condition and the indirect bandgap was observed.
3. Exfoliation of single layer MoS_2 from the bulk sample has been started to study the layer dependency of the DOS.
4. Modification of the design of the low temperature STM was done.

II. Publications

1. "Electrical transport properties in a single-walled carbon nanotube network", K. Snoussi, A. Vakhshouri, H. Okimoto, T. Takenobu, Y. Iwasa, S. Maruyama, K. Hashimoto and Y. Hirayama, Phys. Status Solidi C 9, 183 (2012)
2. "Magnetoresistance hysteresis due to a capacitive effect in a single-walled carbon nanotube network", K. Snoussi, A. Vakhshouri, H. Okimoto, T. Takenobu, Y. Iwasa, S. Maruyama, K. Hashimoto and Y. Hirayama, To be submitted.

III. Presentations

1. "Scanning tunneling microscopy of electronic properties of bulk and layered MoS_2 ", A. Vakhshouri, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

No.52

Name	Rihei Endo
Department	Physics
Position	D3
Research Title	RA/Initiative A: Optical response of photonic crystal with self-similar structure

I. Summary of Research

The transient time of an optical pulse in multi-layered photonic crystal is discussed as a function of the length L of the crystal and the wave vector of the incident light. In a periodic photonic crystal, the transient time τ for the wave vector close to photonic band gap is proportional to L^3 while τ for the wave vector at the center of photonic band is proportional to L . In a non-periodic Fibonacci lattice, τ becomes proportional to $L^{3.127}$ and $L^{1.287}$ for the wave vector close to photonic band gap and at the center of photonic band, respectively. The power for L^β in Fibonacci (periodic) photonic crystal can (not) be changed by refraction indices of consequent layers.

II. Publications

1. R. Endo, R. Saito, "Tunneling time of optical pulse in photonic band gap", Journal of the Optical Society of America B Vol. 28, No. 10 (in press).

III. Presentations

1. "Light pulse delay in Fibonacci photonic crystal" Rihei Endo, Japan Physical Society 2011 Autumn Meeting (September 21-24, Toyama University, Toyama, Japan)