

**No.53**

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| <b>Name</b>           | <b>Nami Uchikata</b>                            |
| <b>Department</b>     | <b>Astronomy</b>                                |
| <b>Position</b>       | <b>D2</b>                                       |
| <b>Research Title</b> | <b>RA: Quasinormal modes of AdS Black holes</b> |

**I. Summary of Research**

1. It is important to study the properties of AdS black holes due to the AdS/CFT correspondence. One of the important properties of black holes is the stability and we have investigated the stability of the charged AdS black holes by calculating their quasinormal modes. Although we have calculated the quasinormal modes of the charged AdS black holes last year, the results are only valid for the black holes whose radii are sufficiently smaller than the AdS scale because of the numerical problem. This year we have tried the calculation by another approach using the same numerical program as last year to obtain the boundary of stability and instability for black holes having arbitrary radii.
2. We have also tried to construct the new numerical program to calculate the quasinormal modes for the charged AdS black holes with their radii having arbitrary value. In both way (1 and 2), we have succeed to get the converge data, however, the results do not coincide with those we have obtained in the last year in the same parameter range. Since we have checked the convergence and mistakes, the reasons might be that we do not have sufficient accuracy or that these numerical approaches are not suitable to our work. We are now under consideration to solve these problems.

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

1. "Quasinormal modes of charged AdS black holes", N. Uchikata, Japan Physical Society 2011 Autumn Meeting (September 16-19, 2011, Hirosaki University, Hirosaki, Aomori, Japan)
2. "Quasinormal modes of charged anti-de Sitter black holes", N. Uchikata, The 4<sup>th</sup> International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy" (February 20-22, 2012, Tohoku University, Sendai, Japan)

**No.54**

|                       |   |
|-----------------------|---|
| <b>Name</b>           | <b>Mariko Kubo</b>  |
| <b>Department</b>     | <b>Astronomy</b>  |
| <b>Position</b>       | <b>D1</b>   |
| <b>Research Title</b> | <b>RA/Initiative A: The galaxy formation in the high density region of the galaxies at redshift 3.1</b> |

**I. Summary of Research**

In this year, we proceed the analysis of the SSA22 protocluster at  $z=3.09$  and submission of the proposals of the observation to obtain further data.

First of all, in this year, I worked to complete the analysis of the previous year. We have selected the candidates of the protocluster galaxies by using MOIRCS (Multi Objects IR camera and spectrograph) and analysed these by using Spitzer IRAC MIPS photometories. We have revealed the density excess of the K-selected galaxies, furthermore, the higher density excess of the dusty starburst galaxies, passively evolving galaxies are detected. These are very important result to understand the formation of the cluster of the galaxies but also the formation of the massive ellipticals which dominates the center of the cluster of the galaxies. In this year I precisely examined these findings to complete as the article.

On the other hand, we submitted the observational proposals to Subaru telescope and Hubble Space Telescope (HST). We submitted the proposal of multi objects NIR spectroscopy using MOIRCS on Subaru telescope to confirm the redshift of the K-selected galaxies (S12A at 2011/9/12, S12B at 2012/3/9). Unfortunately, affected by the accident on Subaru telescope, S12A proposal was rejected, however, our proposal was very appreciated as same as accepted proposals. We also submitted the NIR imaging observation proposal for HST (Cycle 20, 2012/2/24 submitted). We project the morphological analysis with this.

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

1. "The star formation in the SSA22 protocluster",  
M. Kubo, Subaru Users Meeting, (Feb.28-Mar.1, 2012, NAOJ Mitaka campus, Tokyo, Japan),  
Poster presentation
2. "The star formation in the SSA22 protocluster" M. Kubo, The 4th GCOE International Symposium  
on "Weaving Science Web beyond Particle-Matter Hierarchy", (Feb. 20-22, 2012, Tohoku  
University, Sendai, Japan, Poster presentation
3. "The star formation in the SSA22 protocluster", M. Kubo, Japan Astronomical Society 2012 Spring  
Meeting, (March 19-22, 2012, Kyoto Ryukoku University, Kyoto, Japan)

**No.55**

**Name** Naonori Sugiyama  
**Department** Astronomy  
**Position** D2  
**Research Title** RA/Initiative A: Theoretical Test of Inflation Scenario

**I. Summary of Research**

1. We investigated two non-linear parameters charactering Non-Gaussianity of CMB temperature fluctuations. We found a useful and brief relation between these parameters. This result will constrain a wide class of inflationary models all at once.

**II. Publications**

1. "Non-Gaussianity Consistency Relation for Multi-field Modles", Naonori S.Sugiyama, Eiichiro Komatsu, Toshifumi Futamase, Physical Review Letter, 106, 251301, (2011)

**III. Presentations**

1. "Non-Gaussianity Consistency Relation", Naonori Sugiyama, Japan Physical Society 2011 Autumn Meeting (September 16-19, 2011, Hirosaki University, Hirosaki, Aomori, Japan)
2. "Consistency Relation for Multi Field Inflation Scenario", N. Sugiyama, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

**No.56**

**Name** Kazuya Fujio  
**Department** Astronomy  
**Position** D2  
**Research Title** RA: Path integral Analysis of Bianchi type I spacetime in Loop Quantum Cosmology

**I. Summary of Research**

1. Loop quantum cosmology

Loop quantum cosmology is cosmology based on Loop quantum gravity. In loop quantum cosmology, the quantum effect causes the repulsive force to avoid the initial singularity ( Big Bang Singularity ). This is very interesting framework. However, the Hamiltonian constraint equation is difficult to solve analytically or numerically. Therefore we need some approximation. The path integral approach is useful approximation. By following Feynman's original approach, we can construct the effective action

( Hamiltonian ). From this Hamiltonian, we can obtain first order approximation equation which include the quantum correction.

We investigate the brief behavior of Bianchi type I spacetime which is homogeneous but not isotropic model by using path integral analysis.

The result is as follows:

- We construct the effective action ( Hamiltonian ) of Bianchi type I spacetime.

As we expected, this Hamiltonian reproduces the isotropic Hamiltonian if we choose anisotropic parameter = 0.

- The effective Hamiltonian gives the first order approximation equations.

We solved these equations numerically. These equations show that the anisotropy in LQC has upper limit.

Fig.1 shows that the quantum effect causes repulsive force in small scale to avoid the initial singularity even if anisotropy existed. In large scale, the classical general relativity becomes good approximation.

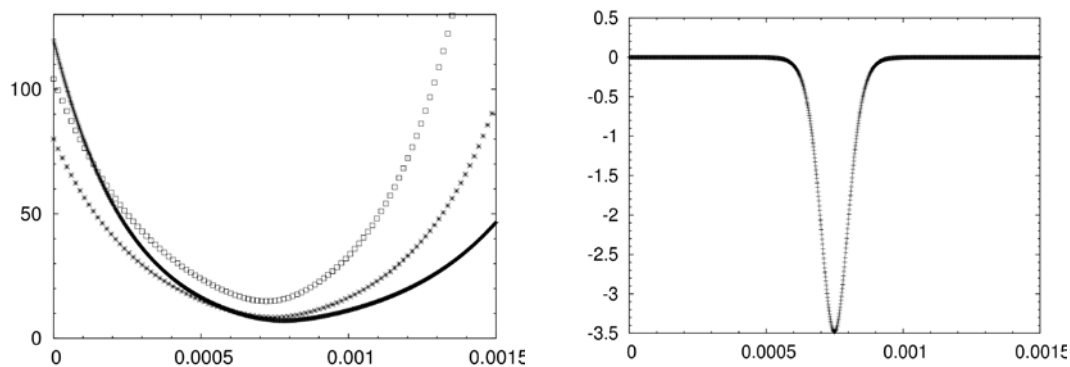


Fig.1 The directional scale factors (left) & the quantum effect (right).

'Quantum effect' is defined as the departure from classical general relativity. As figure shown, the quantum effect causes the repulsive force in small scale to avoid the singularity. In large scale, the quantum effect vanishes, therefore the general relativity becomes good approximation.

- The behavior of anisotropy is little complex ( see Fig.2 )

Case A. If the scale factor does not become so small, the LQC anisotropy is larger than classical one.

Case B. If the scale factor becomes so small. The LQC anisotropy is smaller than classical one. This is because that the LQC anisotropy has upper limit.

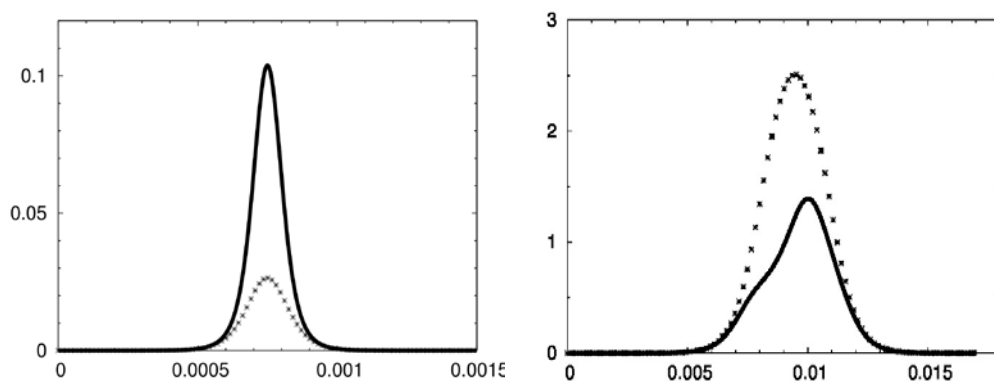


Fig.2 The anisotropy in case A ( left ) and case B (right )

The real line denotes LQC anisotropy and dashed line denotes classical anisotropy. In caseA, the LQC anisotropy is larger than classical one in small scale. On the other hand, In caseB, the LQC anisotropy is smaller than classical one. In caseB, the scale factor becomes so small that classical anisotropy (which proportional to  $\text{scale}^{-6}$ ) is larger than upper limit of LQC anisotropy  $\sim 1.85$ . The scale's behavior is strongly depending on the matter property.

## 2. The estimation of probability of anisotropy

We can construct the 'probability' by considering the relative volume occupied by the trajectories which has relevant physical property in phase space. This estimation needs only the Hamiltonian constraint, therefore we can use the effective Hamiltonian constructed by path integral approach. I'm trying to estimate the 'probability' of anisotropy. But there are some difficulty. We can construct the volume form on phase space. However, the range of variables are not clear. This is because the relevant variables ( anisotropic parameter, volume etc ) are in trigonometric function in Hamiltonian. And the definition of 'bounce surface' is not clear.

## II. Publications

## III. Presentations

1. "Path integral analysis of Bianchi type I spacetime in Loop quantum cosmology", Kazuya Fujio, The 4<sup>th</sup> International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan) (Poster)

**No.57**

|                       |  |
|-----------------------|--|
| <b>Name</b>           | <b>Takayuki Maebayashi</b>   |
| <b>Department</b>     | <b>Astronomy</b>   |
| <b>Position</b>       | <b>D1</b>  |
| <b>Research Title</b> | <b>RA/ Initiative A: The origin of low-luminosity AGN/AGN-like activity in massive early-type galaxies</b> |

**I. Summary of Research**

1. In this year, I examined some observational properties of early-type galaxies (ETGs) to constraint the physical nature of low-luminosity active galactic nuclei (AGN) and/or AGN-like activity in ETGs. From these analyses, I found that (I) the emission-line ratios concentrate into the typical values of 'LINER' class galaxies (which defined by the emission-line diagnostics) as host galaxy color becomes red, and because a correlation between host stellar mass and color (so called 'red sequence') this concentration is also seen in the galaxies with large stellar mass, (II) even in red ETGs, the galaxies with broad 'equivalent width (astronomical quantification of the contrast of emission-line flux to continuum flux)' show the typical emission-line ratio distribution seen in high-luminosity AGNs, which is different from the concentrated distribution.
2. As far as I can research, the ionizing mechanisms of LINER class galaxies proposed so far fall roughly into four categories: (a) photoionization from low-luminosity AGN, (b) shock excitation, (c) photoionization from old stars, (d) photoionization from hot ( $T \approx 10^7$  K) inter-stellar medium. From these models and my analyses, I think that in a large number of LINER class objects seen in red ETGs with narrow equivalent width, the possible ionizing mechanism is model (c) because red host color means old stellar populations dominate in its host galaxy. And I also think that many previous works which discussed the origin of low-luminosity AGNs based on the properties of LINER class galaxies seems to be misleading.
3. I made presentations on these results in the following scientific meeting. And I am in the process of writing a paper on this theme.

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

1. "The origin of low-luminosity AGN/AGN-like activity in massive early-type galaxies", T. Maebayashi, AGN Workshop in Matsuyama (September 28-29, 2011, Ehime University, Matsuyama, Ehime, Japan)
2. "The origin of low-luminosity AGN/AGN-like activity in red early-type galaxies", T. Maebayashi, Science in Subaru Wide-Field AGN Survey with HSC, (November 16-18, 2012, Kyoto University, Kyoto, Kyoto, Japan)
3. "The origin of low-luminosity AGN/AGN-like activity in red early-type galaxies", T. Maebayashi,

The 4<sup>th</sup> International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

4. "The origin of low-luminosity AGN/AGN-like activity in red early-type galaxies", T. Maebayashi, Japan Astronomical Society 2012 Spring Meeting (March 19-22, 2012, Ryukoku University, Kyoto, Kyoto, Japan)

## No.58

**Name** Satoshi Ueki

**Department** Mathematics

**Position** D1

**Research Title** RA/Initiative A: Lagrangian intersections and leaf-wise intersections

### I. Summary of Research

This research is about the existence of leaf-wise intersections. The leaf-wise intersection is a generalization of the Lagrangian intersection and the fixed point of Hamiltonian diffeomorphism. We define the leaf-wise intersection for a coisotropic submanifold  $M$  of a symplectic manifold  $P$  and for a Hamiltonian diffeomorphism  $f$  on  $P$ . We can apply this existence theory for the research on periodic orbits of Hamiltonian systems.

1. I proved the next theorem about the existence of leaf-wise intersections. This theorem is based on A. Weinstein's theorem about the existence of Lagrangian intersections.

**Thm1.** If a Hamiltonian diffeomorphism  $f$  is  $C^1$ -close to the identity map, then there is one to one correspondence between the leaf-wise intersections of  $f$  and the zero points of some closed 1-form on  $M$ . Moreover, if  $M$  is compact and the first de Rham cohomology  $H^1(M)$  vanishes, then  $f$  has at least  $\text{cat}(M)$  leaf-wise intersections. Here,  $\text{cat}(M)$  is the Lusternik-Schnirelmann category of  $M$ .

Actually, J. Moser, who introduced the leaf-wise intersection, proved the same conclusion under the conditions that  $M$  is compact and  $P$  is simply connected.

2. I constructed the examples for which we can apply the Thm1 or Moser's theorem and for which the conclusion doesn't hold. By these example, we can see that the conclusion doesn't hold without assuming the compactness of  $M$ . I also tried to construct an example for which  $M$  is compact,  $P$  is not simply connected,  $H^1(M) \neq 0$  and the conclusion doesn't hold, but I couldn't.

These are the summary of research in 2011 fiscal year. Finally, the paper about this theory is submitted to KODAI MATHEMATICAL JOURNAL.

### II. Publications

### III. Presentations

1. "Research on Lagrange intersections and leaf-wise intersections", S. Ueki, Differential Geometry of

Submanifolds (June 27-29, 2011, Kyoto University, Kyoto, Japan)

2. "Research on Lagrange intersections and leaf-wise intersections", S. Ueki, Geometry workshop in Aso (August 21-24, 2011, National Park Resort Minamiaso, Aso, Kumamoto, Japan)
3. "Research on Lagrange intersections and leaf-wise intersections", S. Ueki, The 58th geometry symposium in Japan (August 27-30, 2011, Yamaguchi University, Yamaguchi, Japan)
4. "Leaf-wise intersections in coisotropic submanifolds", S. Ueki, The 10th Pacific Rim Geometry Conference 2011 Osaka-Fukuoka (December 1-5 / 7-9, 2011, Osaka City University, Osaka, Japan / Kyushu University, Fukuoka, Japan)
5. "Leaf-wise intersections in coisotropic submanifolds", S. Ueki, The 4<sup>th</sup> International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)
6. "Leaf-wise intersections in coisotropic submanifolds", S. Ueki, The Mathematical Society of Japan Spring Meeting 2012 (March 26-29, 2012, Tokyo University of Science, Shinjuku-ku, Tokyo, Japan)

## No.59

**Name** Kouta Uriya

**Department** Mathematics

**Position** D1

**Research Title** RA/Initiative A: Asymptotic behavior of a solution to the nonlinear Schrödinger system

### I. Summary of Research

In this year, I studied the asymptotic behavior of a solution to the nonlinear Schrödinger system. Especially, I considered a quadratic nonlinear Schrödinger system which has conservation law of energy. For the nonlinear Schrödinger system, mass of the particle may be effective to the asymptotic behavior of a solution. This phenomenon occurs due to the difference between the frequency of a free solution and that of nonlinear terms, and we call this phenomenon "mass resonance". It is known that the modified wave operator can be constructed under special assumptions on the two scattering states with mass resonance condition. I showed the existence of the modified wave operator for the quadratic nonlinear Schrödinger system under weaker assumption. More precisely, I removed the assumption on the argument of two scattering states.

### II. Publications

### III. Presentations

1. "Modified wave operator for the quadratic nonlinear Schrödinger system in two space dimensions",



K. Uriya, The 13th Northeastern Symposium on Mathematical Analysis, Hokkaido University, February 17, 2012, poster presentation.

2. "Modified wave operator for the 2d nonlinear Schrödinger system with mass resonance", K. Uriya, The 4th GCOE International Symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", Tohoku University, February 21, 2012, poster presentation.
3. "Modified wave operator for the quadratic nonlinear Schrödinger system in two space dimensions", Joint workshop on nonlinear PDE's, University of Tohoku and University of Sydney, University of Sydney, March 9, 2012, poster presentation.

## No.60

|                       |   |
|-----------------------|---|
| <b>Name</b>           | <b>Emi Osuka</b>  |
| <b>Department</b>     | <b>Mathematics</b>  |
| <b>Position</b>       | <b>D1</b>   |
| <b>Research Title</b> | <b>RA/Initiative A: A stochastic analysis for G-Brownian motion and its application to nonlinear heat equations</b> |

## I. Summary of Research

The purpose of this study is the analysis of G-Brownian motion introduced by Peng. G-Brownian motion can be regarded as a Brownian motion whose variance is uncertain. One peculiarity is that, while the classical Brownian motion is defined on a probability space, G-Brownian motion is defined on a sublinear expectation space. G-Brownian motion is realized on the sublinear expectation space called G-expectation space. It is known that any sublinear expectation has a representation as a supremum of linear expectations, referred as an upper expectation. Recently, Denis—Hu—Peng gave a specific upper expectation representation for G-expectation. Through their representation, capacities  $V$  and  $v$  are defined naturally, and these make us possible to analyze G-Brownian paths.

From its construction, G-Brownian motion has a direct relation with viscosity solutions of nonlinear heat equations. Through the nonlinear Feynman-Kac Formula, it is thought to be possible to analyze viscosity solutions of nonlinear heat equations by using G-Brownian motion. I have thus far studied to analyze viscosity solutions of nonlinear heat equations by using G-Brownian motion. As a basic study for it, we need to see whether properties of Brownian motion and formulas known in the classical stochastic analysis still holds in the case of the G-expectation space. I focused on the law of the iterated logarithm (LIL) for G-Brownian motion in current year. LIL for G-Brownian motion is already obtained in the last fiscal year, and its proof was based on the upper expectation representation of Denis—Hu—Peng and on the time-change formula due to Dambis, Dubins—Schwarz. In this year, we gave another proof of this result. LIL for classical

Brownian motion can be proved as follows: we show Strassen's LIL by using Schilder's large deviation principle, and then derive LIL for Brownian motion from Strassen's LIL. In the case of G-Brownian motion, we could prove LIL by similar procedure. From that proof, the following is inferred: when we analyze G-Brownian motion, it is important to deal with capacities as a pair  $(V, \nu)$ .

## II. Publications

## III. Presentations

1. "Girsanov's Formula for G-Brownian Motion and G-Novikov's Condition", E. Osuka, Tohoku Probability Seminar (July 1, 2011, Tohoku University, Sendai Japan).
2. "Girsanov's Formula for G-Brownian Motion and G-Novikov's Condition", E. Osuka, Okayama Analysis and Probability Seminar (July 19, 2011, Okayama University, Okayama, Japan).
3. "Girsanov's Formula for G-Brownian Motion", E. Osuka, Probability Yang Summer Seminar (August 1—5, 2011, Itako Hotel, Itako, Japan).
4. "Girsanov's Formula for G-Brownian Motion", E. Osuka, Probability Summer School 2011 (August 8—11, 2011, Shinshu University, Shinshu).
5. "Another Proof of the Law of the Iterated Logarithm for G-Brownian Motion", E. Osuka, Mathematical Finance and Related Topics (January 28—29, 2012, Tohoku University, Sendai, Japan).
6. "The Law of the Iterated Logarithm for G-Brownian Motion", E. Osuka, The 4<sup>th</sup> International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)
7. "The Law of the Iterated Logarithm for G-Brownian Motion", E. Osuka, The 100th Anniversary Open Symposium of Tohoku University's Faculty of Science (March 15, 2012, Sendai Mediatheque, Sendai, Japan)

## No.61

|                       |  |
|-----------------------|--|
| <b>Name</b>           | <b>Mriko Ohara</b>   |
| <b>Department</b>     | <b>Mathematics</b>   |
| <b>Position</b>       | <b>D1</b>  |
| <b>Research Title</b> | <b>RA/Initiative A: On elliptic surfaces related to Beilinson's Tate conjecture.</b> |

## I. Summary of Research

In this year, I present examples of a rational elliptic surface over a field such that the complement of all fibers of split type I satisfies Beilinson's Tate conjecture for the second K-group but the boundary map arising from the localization sequence is not surjective. I consider the case that the base field is positive

characteristic and transcendental over its prime subfield and find the examples for the case of the characteristic = 2 and 3.

## II. Publications

1. "Rational elliptic surfaces related to Beilinson's Tate conjecture", Mariko Ohara, preprint, (2011)

## III. Presentations

1. "Rational elliptic surfaces related to Beilinson's Tate conjecture", Mariko Ohara, Waseda number theory seminar (June 17, 2011, Waseda University, Tokyo, Japan)
2. "Rational elliptic surfaces related to Beilinson's Tate conjecture", Mariko Ohara, Hiroshima-Sendai number theory conference (July 19-22, 2012, Hiroshima University, Hiroshima, Japan)
3. "On elliptic surfaces related to Beilinson's Tate conjecture", Mariko Ohara, The 4<sup>th</sup> International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

## No.62

**Name** Toru Kajigaya

**Department** Mathematics

**Position** D1

**Research Title** RA/Initiative A: Research of submanifolds in symplectic manifolds and contact manifolds.

## I. Summary of Research

In this year, I researched L-minimal Legendrian submanifolds in Sasakian manifolds.

1. I researched the construction of L-minimal Legendrian minimal submanifolds in Sasakian manifolds. For example, I proved the next result: "Let  $L^n$  be an Legendrian submanifold in  $R^{2n+1}(-3)$ . Assume that  $L^n$  lies in the cylinder, and has parallel mean curvature in the cylinder. Then  $L^n$  is L-minimal in  $R^{2n+1}(-3)$ ".
2. I researched some relations between H-minimal Lagrangian submanifolds in Kahler manifolds and L-minimal Legendrian submanifolds in Sasakian manifolds. For example, I checked that "Under the canonical fibration  $\pi : M^{2n+1} \rightarrow M^{2n}$ , the lift of H-minimal Lagrangian submanifolds in M is L-minimal, and conversely hold."
3. I researched the L-stability of L-minimal Legendrian submanifolds in Sasakian manifolds. I constructed the examples of closed L-stable L-minimal Legendrian curves in  $SL(2, R)$ . On the other hand, I prove the next result: "There are no compact L-stable L-minimal Legendrian immersion into the unit sphere".

**II. Publications**

1. "Second variation formula of Legendrian minimal submanifolds in Sasakian manifolds", T. Kajigaya, submitted.

**III. Presentations**

1. "Legendrian minimal submanifolds in Sasakian manifolds, and its stability", T., Kajigaya, RIMS Workshop, "Differential geometry of submanifolds" (June 27-29, 2011, Kyoto University, Kyoto, Japan)
2. "Legendrian minimal submanifolds in Sasakian manifolds", T.Kajigaya, Aso geometry Workshop, (August 24, 2011, Aso Kyukamura, Aso, Kumamoto, Japan)
3. "Legendrian minimal submanifolds in Sasakian manifolds", T.Kajigaya, The 58<sup>th</sup> geometry symposium in Japan, (August 27-30, 2011, Yamaguchi University, Yamaguchi, Japan)
4. "On H-minimal Lagrangian submanifolds and L-minimal Legendrian submanifolds", T.Kajigaya, Geometry Seminar, Tohoku University, (November 8, 2011, Sendai, Japan)
5. "On Legendrian minimal submanifolds in Sasakian manifolds, and its stability" T. Kajigaya, The 10<sup>th</sup> Pacific Rim Geometry Conference 2011, (December 1-5, Osaka City University, Osaka, Japan)
6. "On Legendrian minimal submanifolds in Sasakian manifolds", T. Kajigaya, The 4<sup>th</sup> GCOE International symposium, (February 20, 2012, Tohoku University, Sendai, Japan)
7. "On Legendrian minimal submanifolds in Sasakian manifolds", T.Kajigaya, 100<sup>th</sup> Anniversary Symposium, (March 15, 2012, Sendai Mediatheque, Sendai, Japan)

**No.63**

|                       |  |
|-----------------------|--|
| <b>Name</b>           | <b>Kotaro Kawai</b>  |
| <b>Department</b>     | <b>Mathematics</b>   |
| <b>Position</b>       | <b>D1</b>  |
| <b>Research Title</b> | <b>RA/Initiative A: The study of calibrations and G-structures</b> |

**I. Summary of Research**

In this year, I mainly studied calibrated submanifolds. In general, it is known by the Wirtinger inequality that the complex submanifold in a Kähler manifold minimize its volume in its homology class. Generalizing this property, calibrated submanifolds are defined. As examples, there are complex submanifolds in Kähler manifolds, special Lagrangian submanifolds in Calabi-Yau manifolds, (co)associative submanifolds in G2 manifolds, and so on.

I constructed special Lagrangian submanifolds explicitly using moment maps last year. I submitted the paper and have already been published by Kodai Mathematical Journal. In this year, using the generalized

notion of moment maps, I characterized (co)associative submanifolds as pseudo holomorphic curves in the reduced space.

From this result, we also confirm that there are several relationships between calibrated submanifolds and we can construct many examples

## II. Publications

1. "Torus invariant special Lagrangian submanifolds in the canonical bundle of toric positive Kahler Einstein manifolds", K. Kawai, Kodai Math. J. 34, no. 3, 519–535. (2011)

## III. Presentations

1. "Construction of special Lagrangian submanifolds", K. Kawai, Geometry Seminar in Tohoku University, (July 26, 2011, Tohoku University, Sendai, Miyagi, Japan)
2. "Construction of special Lagrangian submanifolds", K. Kawai, Geometry Conference in Aso, (August 21-24, 2011, Aso, Kumamoto, Japan)
3. "Torus invariant special Lagrangian submanifolds in the canonical bundle of toric positive Kahler-Einstein manifolds", K. Kawai, The 58th geometry symposium in Japan, (August 27-30, 2011, Yamaguchi University, Yamaguchi, Yamaguchi, Japan)
4. "Construction of special Lagrangian submanifolds", K. Kawai, The 17th International Symposium on Complex Geometry, (November 9-12, 2011, Sugadaira, Nagano, Japan)
5. "Construction of Calibrated submanifolds", K. Kawai, Submanifolds. Yuzawa 2011, (November 24-26, 2011, Yuzawa, Niigata, Japan)
6. "Construction of special Lagrangian submanifolds", K. Kawai, The 10th Pacific Rim Geometry Conference 2011, (December 7-9, 2011, Nishijin, Fukuoka, Japan)
7. "Construction of calibrated submanifolds", K. Kawai, The 7th Geometry Conference for the Friendship of Japan and China, (January 10-14, 2012, Tokyo institute of technology - Kawaguchiko, Tokyo - Yamanashi, Japan)
8. "Calibrated Submanifolds", K. Kawai, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Miyagi, Japan)

**No.64**

**Name** Kouichi Kimura  
**Department** Mathematics  
**Position** D1  
**Research Title** RA: Homogeneous Reinhardt domains of Stein in  $\mathbb{C}^n$

**I. Summary of Research**

The theme of my study in fiscal 2011 was the holomorphic equivalence problem for Reinhardt domains in  $\mathbb{C}^n$ . The classification of homogeneous Reinhardt domains of Stein in  $\mathbb{C}^n$  is conjectured to be as follows:

**Conjecture.** There exist integers  $n_1, \dots, n_k$  and non-negative integers  $l, m$  with  $n_1 + \dots + n_k + l + m = n$  such that

$$D \stackrel{\text{alg}}{\cong} B_{n_1} \times \dots \times B_{n_k} \times \mathbb{C}^l \times (\mathbb{C}^*)^m,$$

where  $B_{n_i}$  is the complex  $n_i$ -unit ball.

I showed a next partial solution of this problem and announced it in Several Complex Variables Winter Seminar 2011 at Hiroshima.

**Theorem.** If a Reinhardt domain  $D$  in  $(\mathbb{C}^*)^n$  is homogeneous and Stein, then the domain  $D$  is identified with  $(\mathbb{C}^*)^n$ .

Now I study the conjecture under the opposite condition to the Theorem's, i.e. assume a domain  $D$  contains the origin. In addition, for the sake of simplicity, let the space dimension be 3. It seems that the notion of Liouville foliation would play a key role in a solution.

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

1. "Homogeneous Reinhardt domains in  $(\mathbb{C}^*)^n$ ", Kouichi Kimura, Several Complex Variables Winter Seminar (December 16-18, 2011, Hiroshima University, Hiroshima, Japan)
2. "Homogeneous Reinhardt domains of Stein in the complex n-space", Kouichi Kimura, The 4th International GCOE Symposium (February 20-22, 2012, Tohoku University, Sendai, Japan)

**No.65****Name** Rena Tateda**Department** Mathematics**Position** D1**Research Title** RA/Initiative A: Problems concerning the number of integral points in the theory of heights**I. Summary of Research**

Define the excess of a positive integer to be the difference between the total multiplicity and the number of distinct primes in the factorization. I studied the density of a set of positive integers of excess  $k$  and the applications to the algebraic geometry.

The set  $E_k$  of positive integers of excess  $k$  has a density  $d_k$  and that the sequence  $\{d_k\}$  has a generating function represented by the product extends over all primes. I derived that this result has an analogue for polynomials over a finite field. Moreover, I expect that this result can be extended naturally to the densities of ideals in the ring of integers of a function field over the finite field by using zeta functions.

Especially, I computed the density of a set of positive integers with excess 0. Given  $f, g$  are polynomials in  $n$  variables with integral coefficients, we could compute the density of  $x$  such that  $f(x)$  has excess  $k = 0$ , i.e.,  $f(x)$  is square-free, assuming the abc-conjecture. We could compute the density of  $x$  such that  $\gcd(f(x), g(x)) = 1$  unconditionally. In fact, analogues where square-free is replaced by  $l$ th power-free follow from the same arguments. I showed that these results also have the function field analogues.

Now, let  $\mathbb{Q}$  be the rational number field and  $f$  be a polynomial in one variable with integral coefficients. Write  $f(x) = cg(x)^2h(x)$ , where  $c$  is a constant and  $h(x)$  is a square-free whose coefficients have gcd 1. If  $\deg h \geq 4$ , assume the abc-conjecture. Then, I derived that the image of  $\{f(1), f(2), \dots, f(B)\}$  in  $(\mathbb{Q}^* / \mathbb{Q}^{*2}) \cup \{0\}$  has the size  $c_f B + o(B)$  for some constant  $c_f \in [0, 1]$  depending on  $f$ .

An application of these results is towards estimating, given a regular quasi-projective scheme  $X$  over the integral ring, what fraction of hypersurface sections of  $X$  are regular.

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

1. "On the density of some sequences of integers", Rena Tateda, The 4<sup>th</sup> International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

**No.66**

**Name** Tomonori Nakayama  
**Department** Mathematics  
**Position** D1  
**Research Title** RA: On the formal group and the cohomology

**I. Summary of Research**

In this year, I studied formal groups and the Jacobian varieties. In the study of curves, it is important to show the explicit constructions of the formal groups. The formal group of a hyperelliptic curve can be constructed in two ways. One way is to expand the addition formula of the Jacobian and the other method is to use the expansion of a holomorphic differential of the Jacobian. In last year, I studied the classical result on the formal groups of an elliptic curve by Honda which is proved in 1968. He proved two formal groups which are constructed in two ways are essentially the same. To generalise this result, we need Jacobians because the natural addition formula we have in the case of an elliptic curve which is cubic cannot be formed in general. In this year, I studied Jacobian varieties and examined the more general case like hyperelliptic curves.

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

1. "On the formal group of the Jacobian", T. Nakayama, The 4<sup>th</sup> International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

**No.67**

**Name** Keisuke Yoshii  
**Department** Mathematics  
**Position** D1  
**Research Title** RA/Initiative A: Determinacy of Games in Second Order Arithmetic

**I. Summary of Research**

The purpose of this research is to investigate the logical strength of weak determinacy of Gale-Stewart games from the stand point of reverse mathematics.

Gale-Stewart game is a simple 2-person perfect information game as follows: let  $C \subseteq \mathbb{N}^{\mathbb{N}}$  be a class of Baire space, and fix  $A \in C$ , a set of infinite sequences of natural numbers. Players I and II alternately choose natural numbers infinitely many times as I chooses  $n_0$ , and then II chooses  $n_1$ . Next, I chooses  $n_2$ , and II chooses  $n_3$ , and they keep going on. In their choosing natural numbers in this way, we will obtain an



infinite sequence of natural numbers  $n_0 n_1 n_2 \dots$ . Player I *wins* game  $G_A$  if  $n_0 n_1 n_2 \dots \in A$ . II wins otherwise.

In this game, if player I has a winning strategy, I can win this game without depending on the II's choices of numbers. Conversely, if II has a winning strategy, I can not win this game whatever I chooses numbers in his turns. The game  $G_A$  is *determined* if one of the players has a winning strategy in  $G_A$ .

In 1953, D. Gale and F. Stewart showed that open game (i.e.  $A \subseteq \mathbb{N}^{\mathbb{N}}$  is an open set or equivalently  $\Sigma_1^0$  set) is determined. That is, if A is open set, one of the players has a winning strategy in  $G_A$ . This determinacy is now called *open determinacy* or  $\Sigma_1^0$  *determinacy*, and denoted as  $\Sigma_1^0$ -Det. Two decades later, J. Steel showed that  $\Sigma_1^0$ -Det is equivalent to one of the subsystems (set of axioms) of second order arithmetic, ATR. Determinacy of the game is important research topic especially in Set Theory, and many interesting results are known. Intuitively, determinacy of games insists an existence of a real number with certain complexity, and, for example, if we assume that Borel game is determined, Borel determinacy, which says one of the players has a winning strategy in game  $G_A$  for any Borel set A, it is same as we are assuming tremendously large size of real numbers. Since each subsystem of second order arithmetic also insists an existence of real number, we can say that Steel's results shows that real numbers whose existence is guaranteed by  $\Sigma_1^0$ -Det is also guaranteed by the subsystem ATR, and vice versa.

Following this result, much of effort has been made to characterize the determinacy of the game classes above  $\Sigma_1^0$ -Det, for example,  $\Delta_2^0, \Sigma_2^0, \Delta_3^0, \dots \subseteq \mathbb{N}^{\mathbb{N}}$  by K. Tanaka, M. Medsalem, and so. In our research, we investigate the determinacy of the classes between  $\Sigma_2^0$  and  $\Delta_2^0$ . We define new subsystems of second order arithmetic  $[\Sigma_1^1]^k$ -IDTR and show that it is equivalent to  $\Delta(\Sigma_2^0)_{k+1}$ -Det. We are now submitting a paper to a conference "Computability in Europe 2012", celebrating centennial of the birthday of Alan Turing.

## II. Publications

1. "Infinite Games and Transfinite Recursion of Multiple Inductive Definitions", K.Yoshii, K.Tanaka, Computability in Europe 2012, submitting.

## III. Presentations

1. "Weak Determinacy of Infinite Games and Corresponding Hierarchy of Inductive Definitions", K. Yoshii, The 4<sup>th</sup> GCOE International Symposium (February 20-22, 2012 I, Tohoku University, Sendai, Miyagi, Japan)
2. "Infinite Games and Reverse Mathematics", K. Yoshii, K. Tanaka, Workshop on proof theory and computability theory (February 20 – 23, 2012, Harumi Grand Hotel, Tokyo, Japan)
3. "Transfinite Recursion Axiom of Inductive Definitions and Determinacy of Infinite Games in Second Order Arithmetic", K. Yoshii, K. Tanaka, The Mathematical Society of Japan Spring Meeting 2012 (March 26-29, Tokyo University of Science, Tokyo, Japan)

**No.68**

|                       |   |
|-----------------------|---|
| <b>Name</b>           | <b>Masaki Wada</b>  |
| <b>Department</b>     | <b>Mathematics</b>  |
| <b>Position</b>       | <b>D1</b>   |
| <b>Research Title</b> | <b>RA/Initiative A: On some properties for jump processes of variable order</b> |

**I. Summary of Research**

In this fiscal year, I researched perturbation of jump type Dirichlet form  $(\mathcal{E}, \mathcal{F})$  by the Green-tight positive measure  $\mu$  in Kato class. This is a bilinear form called Schrödinger form and is defined by  $\mathcal{E}^\mu(u, u) := \mathcal{E}(u, u) - \int u^2 d\mu$ . Since it is proved that the embedding  $\mathcal{F} \subset L^2(\mu)$  is compact by K. Tsuchida, M. Takeda et al, this form is well defined. Denote the generator corresponding to  $(\mathcal{E}, \mathcal{F})$  and  $(\mathcal{E}^\mu, \mathcal{F})$  by  $\mathcal{L}$  and  $\mathcal{L}^\mu$  respectively, and let  $p(t, x, y)$  be the fundamental solution of the partial differential equation  $\frac{\partial u}{\partial t} = \mathcal{L}u$ . Z.-Q. Chen, T. Kumagai et al proved that  $p(t, x, y)$  can be estimated as follows;

$$C_1 \phi(C_2 t, C_3 |x - y|) \leq p(t, x, y) \leq C_4 \phi(C_5 t, C_6 |x - y|),$$

where  $C_i$ 's are positive constants and  $\phi$  is an appropriate function. Combining their results with transformation of Dirichlet form by the  $\mathcal{L}^\mu$ -harmonic function given by M. Takeda et al, I gave the sufficient conditions under which the fundamental solution of  $\frac{\partial u}{\partial t} = \mathcal{L}^\mu u$  has the same two-sided estimates (i.e. upper and lower bounds) as  $p(t, x, y)$  except for the choice of positive constants. The precise statement is as follows:

Denote the fundamental solution of  $\frac{\partial u}{\partial t} = \mathcal{L}^\mu u$  by  $p^\mu(t, x, y)$ . If  $\mu$  is gaugeable and  $\iint G(x, y) \mu(dx) \mu(dy) < \infty$  is satisfied,  $p^\mu(t, x, y)$  has the same type two sided estimates as  $p(t, x, y)$ , where  $G(x, y) = \int_0^\infty p(t, x, y) dt$ .

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

1. "On some properties for jump processes of variable order", Masaki Wada, Tohoku probability seminar, (June 17, 2011, Tohoku University, Sendai, Japan)
2. "The range of sample paths for jump Markov processes of variable order", Masaki Wada, Young summer seminar on probability theory 2011, (August 1-5, 2011, Itako Hotel, Itako, Japan)
2. "On some properties for jump processes", Masaki Wada, Okayama Analysis and Probability Seminar, (October 21, 2011, Okayama University, Okayama, Japan)
3. "Heat kernel estimates for Markov processes associated with perturbed Dirichlet form s", Masaki Wada., Japatt Mathematic!! Conference -Tohoku Chapter-, (February 18, 2012, Iwate University,

Morioka, Japan)

4. "Heat kernel estimates for Markov processes associated with perturbed Dirichlet forms", Masaki Wada, The 4th International GCOE symposium -poster session-, (February 20-22, 2012, Tohoku University, Sendai, Japan)

## No.69

**Name** Hiroko Yamamoto

**Department** Mathematics

**Position** D1

**Research Title** RA/Initiative A: Point concentration phenomenon in a least-energy solution of Neumann problem for a semilinear elliptic equation with variable coefficients

### I. Summary of Research

1. I considered the existence of a concentration phenomenon appearing in a ground-state solution of Neumann problem for a semilinear elliptic equation with variable coefficients and influence coefficients on a location of concentration of a ground-state solution by variable  $\lambda$ . I already obtain a location of concentration if a basic production term is identical to 0. Here, I assume that the basic production term is non-negative valued and sufficiently small function of independent of a solution. In this research, I could obtain a necessary condition for a concentration point if the basic production term is NOT identical to 0. The necessary condition is that a concentration point need to be minimum points of a certain function formed by coefficients, similarly to the case of the basic production term 0. Furthermore, I obtained if coefficients are Lipschitz continuous and continuously differentiable, then the certain function is Lipschitz continuous and continuously differentiable, respectively.
2. In order to prove the existence of a concentration phenomenon, I need to consider four properties of a global solution of a semilinear elliptic equation, which is the existence, uniqueness, radial symmetry and exponential decay. Because shape of the ground-state solution just depends on shape of the global solution since I use the global solution as approximate solution of the ground-state solution. In the case of the basic production term 0, it is well-known that the global solution had the four properties by known results. In the case that the basic production term is NOT 0, since the equation is different from the case of the basic production term 0, I proved to hold newly that the global solution has the four properties. Here, on uniqueness of the global solution, I remark that a power of nonlinear term is restricted just a little by influence that the basic production term is NOT 0,

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

1. "Location of the concentration point in the ground-state solution of a reaction-diffusion equation with variable coefficients", H. Yamamoto, The 13<sup>th</sup> Northeastern Symposium on Mathematical Analysis, (February 17-18, 2012, Hokkaido University, Sapporo, Hokkaido, Japan)
2. "Location of the concentration point in the ground-state solution of a reaction-diffusion equation in a heterogeneous medium", H. Yamamoto, The 4<sup>th</sup> International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)
3. "Influence of heterogeneity on a point concentration pattern appearing in a reaction-diffusion equation", H. Yamamoto, The Mathematical Society of Japan Spring Meeting 2012, (March 26-29, 2012, Tokyo University of Science, Kagurazaka, Tokyo, Japan)

**No.70**

|                       |  |
|-----------------------|--|
| <b>Name</b>           | <b>Kazumasa Inaba</b>                                      |
| <b>Department</b>     | <b>Mathematics</b>   |
| <b>Position</b>       | <b>D2</b>  |
| <b>Research Title</b> | <b>RA: Topology of plane curve singularities and links</b> |

**I. Summary of Research**

Mixed polynomials are polynomials in complex variables and their conjugates. M. Oka showed that mixed polynomials have Milnor's fibrations under the strong non-degeneracy condition. We study the enhancements to the Milnor numbers defined by W. Neumann and L. Rudolph, which is an invariant of the homotopy classes of fibered links in the sphere and belongs to integers. We calculate the enhancements to the Milnor numbers of a certain class of strongly non-degenerate mixed polynomials and show that all integers are realized by such mixed polynomials.

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

1. "On the enhancements to the Milnor numbers of a class of mixed polynomials", Poster Session, The 6<sup>th</sup> Franco-Japanese Symposium on Singularities, (September 5-10, 2011, Kyushu University, Japan)
2. "On the enhancements to the Milnor numbers of a class of mixed polynomials", Musubime no Sugaku IV, (December 24-27, 2011, Tokyo Woman's Christian University, Japan)
3. "On the enhancements to the Milnor numbers of a class of mixed polynomials", Poster Session, The 4<sup>nd</sup> International GCOE symposium on "Weaving Science Web beyond Particle-Matter

Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

4. "On the enhancements to the Milnor numbers of a class of mixed polynomials", Topology of Singularities and Related Topics, III, (March 26-30, 2012, University of Dalat, Dalat, Vietnam)

**No.71**

|                       |  |
|-----------------------|--|
| <b>Name</b>           | <b>Kazuaki Tajima</b>  |
| <b>Department</b>     | <b>Mathematics</b>   |
| <b>Position</b>       | <b>D3</b>  |
| <b>Research Title</b> | <b>RA: On the pre homogenous vector spaces defined over local fields</b> |

**I. Summary of Research**

A prehomogenous vector space  $(G, V)$  is a representation space  $V$  of an algebraic group  $G$  which has an open orbit. In general, the orbit of a pre homogenous space is single orbit over an algebraic closed field. But  $V$  is not necessarily single orbit over an arbitrarily field, and it is difficult and interesting problem to describe the orbit space explicitly.

An arithmetical meaning of prehomogenous vector spaces is known as "Wright—Yukie theory". The main result of this theory state as the existence of the bijective correspondence between the set of separable extensions of defined field and the set of the orbit of the point satisfies some good condition. On the other hand, we also need the information of the orbit of "bad" points . In this year, I studied the methods to drive the information of the orbit space consists the orbit which corresponds bad points.

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

1. "On the orbit space of certain prehomogenous vector spaces", K. Tajima, The 4<sup>th</sup> International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

**No.72**

|                       |   |
|-----------------------|---|
| <b>Name</b>           | <b>Yas Yasuhito Nishimori</b>   |
| <b>Department</b>     | <b>Mathematics</b>  |
| <b>Position</b>       | <b>D2</b>   |
| <b>Research Title</b> | <b>RA/ Initiative A: Large deviations weighted by multiplicative functionals and its applications</b> |

**I. Summary of Research**

We consider a free energy of a polymer. The polymer is a path of a stochastic process controlled by a Gibbs measure including a parameter of the inverse temperature and the energy is like a local time on a set. It is said that the polymer is pinned when the energy has a growth as  $kt$ ,  $k$  is a some positive constant and  $t$  is a length of polymer, respectively.

Our claim is that, if the underlying process is transient then there exists a critical temperature  $\beta$  such that, for any  $0 < b < \beta$ , the pinning occurs but not for larger than  $\beta$ . On the other hand, the polymer is pinned in the recurrent case, whenever.

This fact derives from the large deviation for additive functionals under the stable process weighted by Feynman-Kac functionals and properties of a spectral function of the Schrodinger operator generated by the underlying process. In particular, the existence of the critical  $\beta > 0$  depends on the point of the spectral function standing up.

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

1. "A large deviation weighted Feynman-Kac functionals for additive functionals and its application for a pinned polymer", Yasuhito Nishimori, Markov processes and related topics, Nov. 4-6, 2011, KKR Kagoshima Keitenkaku, Kagoshima, Japan.
2. "The characterization of pinned polymer", Yasuhito Nishimori, The 4<sup>th</sup> GCOE international symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", Feb. 20-22, 2012, Tohoku Univ., Sendai Japan.

**No.73**

**Name** Masakuni Matsuura  
**Department** Mathematics  
**Position** D3  
**Research Title** RA: Some Aspects of Stochastic Analysis Beginning from Penalization Problems  
Initiative A: Asymptotic Behavior of Symmetric Markov Process

**I. Summary of Research**

1. We have studied asymptotic behavior of non-local Feynman-Kac semigroups. We have in particular solved Feynman-Kac penalization problem with jumping functions for symmetric stable processes on Euclidean space.
2. We find that asymptotic behavior of non-local Feynman-Kac semigroups is given by gaugeability and the ergodic theory. By using this, we further see the growth of  $L^p$  spectral bounds.

**II. Publications**

1. "Feynman-Kac Penalization Problem for Additive Functionals with Jumping Functions", M. Matsuura, in preparation.

**III. Presentations**

1. "Feynman-Kac penalization problem with jumping functions", M.Matsuura, Markov processes and related topics, (November 4-6, 2011, KKR Kagoshima Keitenkaku, Kagoshima, Japan)
2. "Feynman-Kac penalization problem with jumping functions", M.Matsuura, Stochastic analysis and related topics, (November 11-13, 2011, Saga University, Saga, Japan)
3. "Asymptotic Behavior of Non-local Feynman-Kac Semigroups", M.Matsuura, The 4<sup>th</sup> International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", poster session (February 20-22, 2012, Tohoku University, Sendai, Japan)

**No.74**

**Name** Ahmad Termimi Bin Ab Ghani  
**Department** Mathematics  
**Position** D3  
**Research Title** RA: Determinacy and Optimal Strategies of Network Games

**I. Summary of Research**

In 2011 fiscal year, we studied the determinacy of simultaneous-choice network games with imperfect

information. The study of the problem began at the situation for network games without synchronicity. The main question is the existence and effective computability of Nash equilibria for player's conflicting objectives. Then, we generalized our network game to an asynchronous game, where two players repeatedly executed simultaneous games. Although the asynchronous game is formally an infinite game, we show that it has an optimal strategy by reducing it to a finite game.

## II. Publications

1. "Network Games with Many Attackers and Defenders", Ahmad Termimi, A.G. and Tanaka, K. In: Proceedings of Research Institute for Mathematical Sciences (RIMS) K<sup>o</sup>kyu<sup>o</sup>roku, vol. 1729, pp. 146–151. Kyoto University (2011)
2. "Network Games with and without Synchronicity", Ahmad Termimi, A.G. and Tanaka, K. In: Baras J.S., Katz, J., Altman, E. (eds.) GAMESEC 2011. LNCS, vol. 7037, pp. 87-103. Springer, Heidelberg (2011)

## III. Presentations

1. "Asynchronous Games", Ahmad Termimi, A.G., Sendai Logic Seminar. (June 17, 2011, Tohoku University, Sendai, Japan)
2. "Network Games with and without Synchronicity", Ahmad Termimi, A.G., 2nd International Conference on Decision and Game Theory for Security (GameSec). (November 14-15, 2011, College Park, Maryland, USA)
3. "Network Games with and without Synchronicity (Poster)", Ahmad Termimi, A.G., The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)
4. "Determinacy and Optimal Strategies of Network Games", Ahmad Termimi, A.G., Workshop on Proof Theory and Computability Theory - Philosophical Frontiers in Reverse Mathematics (February 21-23, 2012, Tokyo, Japan)

## No.75

|                       |   |
|-----------------------|---|
| <b>Name</b>           | <b>Madoka Nakayama</b>  |
| <b>Department</b>     | <b>Mathematics</b>  |
| <b>Position</b>       | <b>D3</b>   |
| <b>Research Title</b> | <b>RA: Stationary solutions of a head regeneration model of hydra and its stability</b> |

## I. Summary of Research

We consider a model proposed by Marciniak-Czochra in 2006, which is based on the receptor-ligand



dynamics. The basic idea of this ODE-diffusion system is as follows: Each cell has receptors on its surface. A receptor functions as a switch of a chain of reactions that stimulates the formation of head. When diffusive ligands are bound to a receptor, the switch is turned on. Hence a head is formed at the place of higher receptor density. The model consists of the densities of free receptors, bound receptors, ligands and the production rate of ligands. The characteristic of this model lies in that the density of ligand is a only variable which diffuses. In 2010, I constructed stationary solutions with simply increasing and continuous of this model.

In this year, I showed following problems of the model:

- (1) existence and boundedness of solutions of the model.
- (2) conditions of initial functions when solutions converge to constant solutions.

conditions when a stationary solution is unique.

## II. Publications

1. "Mathematical analysis of a system of diffusive and non-diffusive species modeling pattern formation in hydra", M. Nakayama, Doctoral Thesis, Tohoku University, (2012)
2. "Behavior of solutions of a head regeneration model for hydra based on ligand-receptor", M. Nakayama, Lecture note, Applied mathematics seminar in Morioka,(submitted)

## III. Presentations

1. Construction of stationary solution of head regeneration model for hydra based on receptor-ligand, Applied mathematics seminar, Tohoku University, (July 20, 2011, Sendai, Japan)
2. Behavior of stationary solutions of head regeneration model for the hydra based on ligand-receptor, The mathematical society of Japan autumn meeting, (September 30,2011,Shinshu University,Nagano, Japan)
3. Behavior of solutions of head regeneration model for hydra based on ligand-receptor reaction, Applied mathematics symposium in Morioka, (November 12-13, 21010, Iwate University, Morioka, Japan)
4. Stationary solutions of a head regeneration model of hydra based on receptor-ligand reaction, Mathematical Models of Biological Phenomena and their Analysis, (November 21-24, Sendai International Center, Sendai, Japan), poster
5. Structure of the set of stationary solutions for an ODE-diffusion system modeling regeneration of Hydra, The 13th Northeastern Symposium on Mathematical Analysis, (February 17-18, 2012, Hokkaido University, Sapporo, Japan), poster
6. An ODE-diffusion system modeling regeneration of Hydra, The 4<sup>th</sup> International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan), poster

**No.76**

|                       |   |
|-----------------------|---|
| <b>Name</b>           | <b>Takanao Negishi</b>  |
| <b>Department</b>     | <b>Mathematics</b>  |
| <b>Position</b>       | <b>D3</b>   |
| <b>Research Title</b> | <b>RA: Study of periodic functions of several complex variables</b> |

**I. Summary of Research**

I have studied the periodic decomposition problem of entire or meromorphic functions.

I gave some additional investigations to the results on periodic decompositions of entire functions and obtained a necessary and sufficient condition for entire function to have a representation as a sum of periodic entire functions under the condition that the given periods are pairwise linearly independent over  $\mathbb{R}$  (the field of real numbers).

I also studied the periodic decompositions of functions holomorphic on domains containing convex polygons. I gave some results on the periodic decomposability of functions holomorphic on closed convex polygons or domains having more general shapes. What is more, I gave some results on the periodic decomposability of functions meromorphic on closed convex  $n$ -sided polygon for  $n=3,4,5,6$ . These results are extensions of Leont'ev's theorem that gives the periodic decomposability of functions holomorphic on convex polygons. I am studying the periodic decompositions of functions holomorphic on more general domains.

**II. Publications**

1. "On periodic decomposition of entire functions of several variables," T.Negishi, submitted

**III. Presentations**

1. "Periodic decomposition of functions holomorphic in domains containing convex polygons", T.Negishi, The 4<sup>th</sup> International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

**No.77**

|                       |  |
|-----------------------|--|
| <b>Name</b>           | <b>Tadahisa Nara</b>   |
| <b>Department</b>     | <b>Mathematics</b>   |
| <b>Position</b>       | <b>D3</b>  |
| <b>Research Title</b> | <b>RA: On estimates of the canonical height on elliptic curves and their rational points</b> |

**I. Summary of Research**

I continued a research of rational points of elliptic curves which are a part of basis of the Mordell—Weil group. As an earlier study there is the research of the elliptic curve of the form  $y^2=x^3-nx$  by Duquesne. He considered not only the independence of rational points but also whether the points can be a part of the basis of the Mordell—Weil group. We note that  $n$  in the equation is assumed to have a special form and so the elliptic curve has two rational points of the explicit form. Last fiscal year, in a joint study with Fujita we considered the elliptic curve of the form  $y^2=x^3+n$ , where  $n$  is a special form. This curve has three rational points of explicit form and we proved similar statement to Duquesne's for our curve. These results are about families consisting of quartic or sextic twists of elliptic curves. In this year we consider families consisting of quadratic twists. Though the strategy in the research is similar to that in earlier ones, we had a encounter with difficulty to have a uniform lower bound of the canonical height explicitly. Then using a identity between division polynomials of elliptic curves, we could compute the bound. As an application we showed that for a family consisting of quadratic twists with an explicit point, the point is always primitive under a condition. We submitted the manuscript about this study to a journal and the preprint is available online.

**II. Publications**

1. “On The Mordell—Weil Group Of The Elliptic Curve  $y^2=x^3+n$ ”, Y. Fujita and T. Nara, Journal of Number Theory, vol. 132, pp 448-466, 2012

**III. Presentations**

1. “On the Mordell-Weil groups of twists of elliptic curves”, T. Nara, Hiroshima-Sendai number theory seminar, (July 18-22, 2011, Hiroshima University, Hiroshima, Japan)
2. “On the Mordell—Weil group of the elliptic curve  $y^2=x^3+n$ ”, Y. Fujita, T. Nara, Japan Mathematical Society 2011 Autumn Meeting, (Sep. 28-Oct. 01, 2011, Shinshu University, Matsumoto, Japan)
3. “On the Mordell-Weil groups of twist families of elliptic curves”, T. Nara, RIMS “Algebraic Number Theory and Related Topics”, (Nov. 28-Dec. 2, 2011, Kyoto University, Kyoto, Japan)
4. “Lower bounds of the canonical heights on certain elliptic curves”, T. Nara, The 4th GCOE International Symposium on “Weaving Science Web beyond Particle-Matter Hierarchy”, (Feb.

20-22, 2012, Tohoku University, Sendai, Japan)

5. "On quadratic twists of elliptic curves and the canonical height", T. Nara, Japan Mathematical Society 2012 Meeting, (Mar. 26-29, 2012, Tokyo University Of Science, Tokyo, Japan)

## No.78

|                       |  |
|-----------------------|--|
| <b>Name</b>           | <b>NingNing Peng</b>   |
| <b>Department</b>     | <b>Mathematics</b>   |
| <b>Position</b>       | <b>D2</b>  |
| <b>Research Title</b> | <b>Initiative A: Study on Algorithmic Randomness and distributional complexity of Game trees</b> |

### I. Summary of Research

1. We study randomness notions between 1-randomness and 2-randomness. A best-known example of such notions is weak 2-randomness (Kurtz 1981). In (2) of Publications, we introduced the notion of L-randomness and we have shown that L-randomness lie strictly between 1-randomness and 2-randomness. In this year, we extend some results of this study. For instance, we prove that L-randomness is equivalent to 1-randomness relative to any 1-generic sets. We also show another characterization of L-randomness.
2. We study the relative randomness for 1-random sets. We show that weak n-randomness is strictly stronger than semi n-randomness. Moreover, we investigate the relationship between various definitions of randomness. This result already submitted to Computability in Europe 2012.
3. We also study the distributional complexity of game trees. In 2010, we proposed a new game tree which we call unbalanced game trees. And, we have shown the lower bound of distributional complexity for unbalanced game trees. In this year, we show the upper bound of distributional complexity for unbalanced game trees. In addition, we proof that the lower bound and upper bound are equivalent. This result will submit to the Journal of Information Processing Letters.

### II. Publications

1. "The notions between Martin-Löf randomness and 2-randomness" NingNing Peng, RIMS Kôkyûroku, No. 1729, PP: 117-122, (2011).
2. "Relative Randomness for Martin-Löf random sets" NingNing Peng, Kojiro Higuchi, Takeshi Yamazaki, Kazuyuki Tanaka, Submitted.
3. "Algorithmic Randomness and Lowness Notions" NingNing Peng, Takeshi Yamazaki, Kazuyuki Tanaka, Preprint.
4. "The distributional query complexity of unbalanced game trees" NingNing Peng, Takeshi Yamazaki, Kazuyuki Tanaka, Preprint.

**III. Presentations**

1. "Tight bounds for unbalanced game trees", NingNing Peng, Workshop on Proof Theory and Theory of Computing 2011, (Sep. 12-14, 2011, Tokyo Metropolitan University, Tokyo, Japan)
2. "Relative Randomness for Martin-Löf random sets", NingNing Peng, The 4<sup>th</sup> GCOE International Symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (Feb. 20-22, 2012, Tohoku University, Sendai, Japan)
3. "Relative Randomness for Martin-Löf random sets", NingNing Peng, Workshop on Proof Theory and Computability Theory 2012, (Feb. 20-23, 2012, Tokyo, Japan)

**No.79**

|                       |  |
|-----------------------|--|
| <b>Name</b>           | <b>Nobuaki Naganuma</b>  |
| <b>Department</b>     | <b>Mathematics</b>   |
| <b>Position</b>       | <b>D1</b>  |
| <b>Research Title</b> | <b>RA/Initiative A: Smoothness of densities of generalized locally non-degenerate Wiener functionals</b> |

**I. Summary of Research**

One of aim in this year was to obtain an example of generalized locally non-degenerate Wiener functionals which have smooth densities. I achieved this aim by showing solutions of stochastic differential equations without Lipschitz continuity of their coefficients.

In the case where the coefficients have Lipschitz continuity and smoothness, a lot of studies have been done and many results about smoothness of densities of the solutions were obtained in Malliavin calculus. On the other hand, the smoothness of densities have not been studied without assumption of Lipschitz continuity. Because we cannot expect

1. Solutions themselves have higher order H-derivative,
2. Determinants of the Malliavin covariance matrices have higher order negative moments.

To overcome these difficulties, I tried to prove existence of smooth densities using the notion of generalized local non-degeneracy.

In this year, I showed that 1-dimensional stochastic differential equations are locally non-degenerate and have continuous densities under the condition that drift coefficients are Lipschitz continuous and continuously twice differentiable and dispersion one are  $2\sqrt{x}$ . Furthermore I obtained a clue to prove of existence of smooth densities in the case where dispersion coefficients had  $\alpha$ -Hölder continuity for  $1/2 < \alpha < 1$ .

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

**No.80**

**Name** Abdullah Kizilay  
**Department** Mathematics  
**Position** D1  
**Research Title** RA/Initiative A: Viscosity solutions on a Riemannian manifold

**I. Summary of Research**

My research area is theory of viscosity solutions. The theory was first introduced in the first order case by Lions and Crandall to solve optimal control problems involving Hamilton-Jacobi equations. It was studied for second-order equations by Chen, Giga and Goto [1], and Evans and Spruck [2]. These authors were the first to introduce the notion of geometric evolutions.

The content of my research is about viscosity solutions to second order parabolic partial differential equations on a Riemannian manifold. In particular Cauchy-Dirichlet problem on a Riemannian manifold, the general goal is to obtain uniqueness, existence and stability of viscosity solutions to Cauchy-Dirichlet problem under some assumptions. The Cauchy-Dirichlet problem we consider is of the form;

$$\begin{aligned} u_t + F(t, x, u, Du, D^2u) &= 0, \quad (t, x) \in (0, T) \times \Omega, \\ u(t, x) &= h(t, x), \quad (t, x) \in [0, T) \times \partial\Omega, \\ u(0, x) &= \psi(x), \quad x \in \bar{\Omega}, \end{aligned}$$

without giving definitions of each words, our main result is;

**Main Result.** *If  $M$  is complete Riemannian manifold with nonnegative curvature, and if*

$$F : [0, T) \times \Omega \times \mathbb{R} \times \mathbb{R}^N \times \mathcal{S}^N \rightarrow \mathbb{R}$$

*is intrinsically uniformly continuous and proper, then the comparison principle holds for*

*the Cauchy-Dirichlet problem.*

The key idea for the extension of the theory of viscosity solutions in the Euclidean space to Riemannian manifold is a use of special charts, namely the normal coordinate using exponential maps. The proof of the existence and uniqueness of a viscosity solution is a consequence of the comparison principle (uniqueness part). Existence part can be proven by the method of sub and supersolutions known as Perron's method.

The necessity to introduce viscosity solutions is that in general, classical solutions of geometric evolution equations do not exist. In this case, it is natural to introduce a weak notion of solutions that it is more easy to prove existence and uniqueness.

My interest is about curve shortening flow of the form; given a one parameter family of closed curves,

$$\gamma_t : [0, 1] \rightarrow \mathbb{R}^2$$

such that  $\gamma_t(0) = \gamma_t(1)$ . Let  $\nu$  be the unit normal vector,  $\tau$  is the unit tangent vector and  $\kappa$  is the curvature. The evolution law

$$d(\gamma_t(s))/dt = -\kappa_t(s)\nu_t(s)$$

is called curve shortening flow. We focus on fruitful attempt that is level set approach, for which the notion of solutions is the one of viscosity solutions. The idea in general, if  $u$  is solution of an evolution equation, its zero level sets define a moving curve. The level set approach was popularized by Osher and Sethian [3], and a rigorous analysis of the motion by mean curvature flow was first performed by Evans and Spruck [2], and independently by Chen, Giga and Goto [1] for geometric motion with function of curvature tensor. Both used the theory of viscosity solutions.

#### References:

- [1] Y.-G. Chen, Y. Giga and S. Goto, Uniqueness and existence of viscosity solutions of generalized mean curvature flow equations, Proc. Japan Acad. Ser. A. Math. Sci., 65(1989), 207-210.
- [2] L.C. Evans and J. Spruck. Motion of level sets by mean curvature. I. J. of Differential Geometry, 33:635-681, 1991.
- [3] S. Osher and J.A. Sethian. Fronts propagating with curvature dependent speed: Algorithms based on Hamilton-Jacobi formulation. J. of Computational Physics, 79:12-49, 1988.

## II. Publications

## III. Presentations

1. "Surface evolution equation on a Riemannian manifold", A. Kizilay, Geometry Seminar (July 26, 2011, Tohoku University, Sendai, Japan).
2. "Viscosity solutions on a Riemannian manifold", A.Kizilay, The 10th Rim. Geometry Conference 2011 Osaka-Fukuoka (December 7-9, 2011, Kyushu University Nishijin Plaza, Fukuoka, Japan).
3. "Viscosity solutions on a Riemannian manifold", A.Kizilay, The 4th International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy" (February 20-22, 2012, Tohoku University, Sendai, Japan)

**No.81**

|                       |   |
|-----------------------|---|
| <b>Name</b>           | <b>Kensaku Kinjo</b>  |
| <b>Department</b>     | <b>Mathematics</b>  |
| <b>Position</b>       | <b>D3</b>   |
| <b>Research Title</b> | <b>RA: Hypergeometric series over complete local fields</b> |

**I. Summary of Research**

Dwork proved that the Gaussian hypergeometric function on  $p$ -adic numbers can be extended to a function which takes values of the unit roots of ordinary elliptic curves over a finite field of characteristic  $p \geq 3$ . In this year, I studied an analogous theory in the case  $p = 2$  with Yuken Miyasaka. As an application, we give a relation between the canonical lift and the unit root of an elliptic curve over a finite field of characteristic 2 by using the 2-adic arithmetic-geometric mean.

The proof of a 2-adic analogue of Dwork's result is based on the Gauss-Manin connection of the cohomology of a 2-adic family of the ordinary elliptic curves defined by some equations. By replacing the equations, I obtain the differential equation which has the Huen's confluent hypergeometric function as solutions. I will research special values of the confluent hypergeometric series.

**II. Publications**

1. "Hypergeometric series and arithmetic-geometric mean over 2-adic fields", Kensaku Kinjo, Yuken Miyasaka, to appear in International Journal of Number Theory.

**III. Presentations**

1. "Hypergeometric series and arithmetic-geometric mean over 2-adic fields", Kensaku Kinjo, Number Theory Seminar (May 23, Tohoku University, Sendai, Japan).
2. "Hypergeometric series and arithmetic-geometric mean over 2-adic fields", Kensaku Kinjo, Yuken Miyasaka, The 10<sup>th</sup> conference of Hiroshima-Sendai number theory, (Jul. 19-22, Hiroshima University, Hiroshima, Japan).
3. "Hypergeometric series and arithmetic-geometric mean over 2-adic fields", Kensaku Kinjo, Yuken Miyasaka, Annual Meeting of Mathematical Society of Japan (September 29, Shinshu University, Matsumoto, Japan).
4. "Hypergeometric series and arithmetic-geometric mean over 2-adic fields", Kensaku Kinjo, Workshop on arithmetic geometry 2011, (October 12, Okinawa Syogaku High School, Naha, Japan).
5. "Hypergeometric series and arithmetic-geometric mean over 2-adic fields", Kensaku Kinjo, Algebraic Number Theory and Related Topics 2011(November 29, Research Institute for Mathematical Sciences, Kyoto, Japan).



**No.82**

|                       |   |
|-----------------------|---|
| <b>Name</b>           | <b>Yoshihiro Horihata</b>   |
| <b>Department</b>     | <b>Mathematics</b>  |
| <b>Position</b>       | <b>D3</b>   |
| <b>Research Title</b> | <b>RA: Complex analysis and number theory within weak second order arithmetic</b> |

**I. Summary of Research**

1. *Complex analysis in weak second order arithmetic* (joint work with Dr. Keita Yokoyama).

In 2010, we proved in RCA<sub>0</sub> "weak Riemann's mapping theorem (WRMT)", that is, Riemann's mapping theorem for polygonal region. In this year, we proved that the Riemann mapping obtained from WRMT is uniformly continuous. But we do not know whether we can expand the above mapping to a homeomorphism on the boundary of the domain within RCA<sub>0</sub>. We also considered identity theorem because this theorem makes it difficult to construct a holomorphic function with some intended properties in order to show reversals in the sense of reverse mathematics. Then, we proved that the theorem is provable in RCA<sub>0</sub> with the assumption; "Taylor expandability of holomorphic functions (TEXP)" which states that each holomorphic function has a Taylor expansion on any open ball whose is included in the domain. There are some theorems which have been known to be provable in WKL<sub>0</sub> but the reversals are still open. For the two theorems; the maximum modulus principle; and mean value principle, of them, we gave the following result: they are equivalent to TEXP over RCA<sub>0</sub>. Our results give an indication of the existence of the new class of second order arithmetic which lies between RCA<sub>0</sub> and WKL<sub>0</sub>.

2. *Variations of theories of concatenation and minimal essentially undecidable theories*

In 2010, I defined a theory WTC of concatenation, that is, a theory consists of the axioms for semiring with two irreducible alphabets plus editors axiom. Then I proved that WTC is mutually interpretable with Tarski's very weak arithmetic R, and hence WTC has been proved to be essentially undecidable. In this year, I defined some variations of WTC such as WTC without empty string, WTC with stronger axioms, and etc. Then I proved that they are mutually interpretable with WTC and thus they are essentially undecidable. Next, I consider the following question: "Which theories are minimal essentially undecidable ?" With Mr. Yoshida, we proved that WTC is not minimal, since WTC without the axiom for unit element, WTC-(WTC1), can interpret WTC. Although the minimality of WTC-(WTC1) is still open, with Dr. Higuchi, we proved that the theory WTC without empty string is minimal.

**II. Publications**

1. "Weak theories of concatenation and arithmetic", Y. Horihata, to appear in the Nortre Dame Journal of Formal Logic, Volume 53 Issue 2, May 2012

**III. Presentations**

1. "Picard's theorems and Schottky's theorem within second order arithmetic", Y. Horihata, Tohoku logic Seminar (May, 2011, Tohoku university, Miyagi, Japan)
2. "Weak subsystems of first and second order arithmetic", Y. Horihata, Tohoku logic Seminar", (July 2011, February, Tohoku university, Miyagi, Japan)
3. "Weak arithmetic and theories of concatenation", Y. Horihata, Mathematical logic seminar at Tokyo Institute of Technology (October 2011, Tokyo Institute of Technology, Tokyo, Japan)
4. "Reverse mathematics of complex analysis", Y. Horihata, Seminar Logic and Analysis (December 2011, Gent university, Gent, Belgium)
5. "Interpretation between weak theories of concatenation and arithmetic", Y. Horihata and O. Yoshida, Workshop on proof theory and computability theory (February 20 – 23, 2012, Harumi Grand Hotel, Tokyo, Japan )
6. "Weak theories of concatenation and their mutual interpretabilities", Y. Horihata and O. Yoshida, The Mathematical Society of Japan Spring Meeting 2012 (March 26-29, Tokyo University of Science, Tokyo, Japan)

**No.83**

|                       |   |
|-----------------------|---|
| <b>Name</b>           | <b>Harunori Monobe</b>  |
| <b>Department</b>     | <b>Mathematics</b>  |
| <b>Position</b>       | <b>D3</b>   |
| <b>Research Title</b> | <b>RA: On the stability of a free boundary problem with the curvature</b> |

**I. Summary of Research**

1. In this year, I studied a free boundary problem describing amoeba motion. The mathematical model is composed of unknown functions  $u(\mathbf{x}, t)$  and  $\Omega(t)$ , where  $\mathbf{x}$  is a point of  $\mathbf{R}^2$ . They represent the area density of F-actin in a cell and the shape of the cell, respectively. In last year, I showed the existence of global-in-time classical solutions in spherically symmetric initial data. I submitted the paper and have already been accepted by Differential and integral equations. In this year, I showed the existence of blow-up solutions for a free boundary problem. From this result, we also confirmed that, if the initial domain is sufficiently small, the domain  $\Omega(t)$  shrinks to a single point in a finite time.

**II. Publications**

1. "Behavior of solutions for a free boundary problem describing amoeba motion", H. Monobe, Differential and integral equations, accepted.

### III. Presentations

1. "On the behavior of solutions for a free boundary problem related to amoeba motion", H. Monobe, Applied mathematical seminar, (June 30, 2011, Tohoku University, Sendai, Japan)

#### No.84

**Name** Hirioshi Yoshikawa  
**Department** Mathematics  
**Position** D1  
**Research Title** RA:

*On a temporary leave of absence from the doctoral course.*

#### No.85

**Name** Yasuhiko Fujio  
**Department** Philosophy  
**Position** D3  
**Research Title** RA/Initiative A:  

1. Study of the Significance of the "Highest Good" in Kant's Practical Philosophy
2. Philosophical or ethical research of implications of the introduction of science-technology into the society

### I. Summary of Research

#### 1. Study of the Significance of the "Highest Good" in Kant's Practical Philosophy

This research revealed that we can only hope for happiness in the status named 'worthiness to be happy' and if we lost such humidity we would want happiness wrongfully.

Under the name of 'worthiness to be happy' we are asked to be modest: we must not look away from our evil in ourselves and ask for happiness despite lack of our efforts. It is moral happiness in the highest good that we search for with modesty. The idea of the highest good on Kant harmonizes the moral highest good with the political highest good in 'worthiness to be happy'.

#### 2. Philosophical or ethical research of implications of the introduction of science-technology into the society

This research examines the notion of "rationality" and the implications of "deliberative democracy" with regard to the better application of the precautionary principle.

We cannot obtain full knowledge of future events; thus, we must base our risk analysis and management on probabilistic or statistical approaches and assess the likelihood of an event's occurrence probabilistically or statistically.

However, there are some realms of science in which we cannot use such approaches due to a lack of sufficient scientific knowledge with regard to complex phenomena, such as global warming. We must, nonetheless, make decisions in circumstances in which insufficient knowledge of possible high risk events compromises the reliability of scientific analysis.

In order to cope with such uncertainty and evade catastrophic disasters, we need to introduce a "precautionary principle", requiring us to adopt approaches such as regulating or banning the use of certain chemical substances or technologies in order to protect human health and the environment despite a lack of sufficient scientific certainty.

Some doubt the applicability of the precautionary principle, claiming that it lacks a rational basis and may thus lead to irrational conclusions. This might suggest that we cannot make public policy decisions in by means of the precautionary principle alone. Accordingly, it is necessary to reconsider the precautionary principle from the viewpoint of "risk communication".

## **II. Publications**

## **III. Presentations**

1. "The rationality of the Precautionary principle: making the precautionary principle more applicable", Yasuhiko Fujio, The 4<sup>th</sup> International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)
2. "The Highest Good and Perpetual Peace - for the understanding of the idea of the highest good in Kant's practical philosophy", Yasuhiko Fujio, The 70<sup>th</sup> Conference of the Philosophical Association of Japan, (May 14-15, 2011, The University of Tokyo, Tokyo, Japan)
3. "Risk, uncertainty and the precautionary principle — ethical implication of the precautionary principle on the basis of the conception of hypothetical retrospection", Yasuhiko Fujio, The 62<sup>nd</sup> Conference of Japanese Society for Ethics (October 1-2, 2011, Toyama University, Toyama, Japan)
4. "The Lisbon earthquake and Kant—On humans in Nature", Yasuhiko Fujio, The 36<sup>th</sup> Conference of Kant Society of Japan (November 12, 2011, Tokyo Metropolitan University, Tokyo, Japan)

**No.86**

|                       |  |
|-----------------------|--|
| <b>Name</b>           | <b>Hiromichi Sugawara</b>  |
| <b>Department</b>     | <b>Philosophy</b>  |
| <b>Position</b>       | <b>D3</b>  |
| <b>Research Title</b> | <b>RA/Initiative A: Hume on Imagination in his Theory of Causation</b> |

**I. Summary of Research**

1. The main purpose of my researches is to locate the logic and the demonstration of 18<sup>th</sup> century philosopher David Hume in and after the tide of medieval and early-modern logic, and distinctly characterize them. As space is limited, I make a report of the research results, narrowing an argument down to my poster presentation, especially of Hume's logic, in the 4<sup>th</sup> international symposium of our program (his arguments of demonstration and all that will be omitted).
2. Scholastic logic or theology in medieval period inherited exclusively deductive arguments as a typical of syllogism, which Aristotle had argued in 'Analytica' in *Organon*. However, probable reasoning was rarely included in university curricula of that time. After that, when natural philosophy flourished, which was chiefly due to the adoption of experimental method, practitioners' way of thinking also changed to study a particular natural phenomenon; they employed inductive reasoning or reasoning from cause to effect. The establishment of useful method toward a new phenomenon had an effect naturally on philosophy. F. Bacon wrote *novum organum* as against Aristotle, and applied the experimental method to the problems of human mind.
3. Hume stated in his 'Abstract' that he has finished what regards logic in 'Of the understanding' of *Treatise*. But his logic is different from modern formal logic. The difference is revealed itself, when he criticizes existing or traditional logic teaching at that time, which divides acts of our understanding into conception, judgment, and reasoning, and gives definition one by one (cf. Arnauld & Nicole). Hume thought in opposition to them that acts of understanding were integrated into conception. I interpreted this disagreement to be originated in the location of division and their definitions within their inquiries. That is to say, existing logic enumerated presumably acts of understanding and gives definitions separately from an educational or arbitrary view, whereas, for Hume, the division and definitions themselves were aims of his inquiries concerning natural functions of human nature, through empirical inquiries with the experimental method of reasoning. This interpretation allows us to read consistently his 'Two definitions of cause' and 'General rules'.
4. For Hume, logic is a set of provisional and elaborate rules to deal with unexperienced particular object, with the method of inductive reasoning or reasoning from cause to effect, to be aimed for a higher level of assurance, which could be strengthened by the evidences of repeated experiences and general or historical confirmations. If this is ever appropriate understanding for Hume's argument of logic, he could be practically on a par with the claim that all the reasoning we employ would result in probable reasoning, without appealing to a certain exemplar model, including

proportions in number in philosophical relation. Historically speaking, he argued against the traditional scholastic doctrines of logic that had made unreflectingly or dogmatically represent *terminus* something ambiguous as materials of logic.

## II. Publications

1. "Hume on Demonstration in his Science of Man", Hiromichi Sugawara, 'Bunka', No.75, (Pages undecided), (2012).

## III. Presentations

1. "Hume on Logic and Demonstration", Hiromichi Sugawara, The 4<sup>th</sup> International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan).

## No.87

|                       |  |
|-----------------------|--|
| <b>Name</b>           | <b>Yusuke Minegishi</b>  |
| <b>Department</b>     | <b>Philosophy</b>  |
| <b>Position</b>       | <b>D2</b>  |
| <b>Research Title</b> | <b>RA/Initiative A: An inquiry about the "one's own" in Hegel's logic and Religionphilosophy</b> |

## I. Summary of Research

The treatment of the problem of subjectivity in the work of Hegel throws on the relation between individuality and universality from the viewpoint of modern German philosophy. That relation had been a topic of keen debate since medieval times. In one of his chief works, "Wissenschaft der Logik"; Hegel advances a motif quite peculiar to his thought: the "personality of the concept". This does not imply the rendering of philosophy into a form of anthropology. He intends to lay the foundation for the person-motif, which was formed as a philosophical motif by way of Christian theology (for example via Augustine's trinity theory), metaphysically rather than ethically or practically.

In my presentation, I make reference to the philosophy of Nicholas of Cusa (1401~64), especially one of his most important book "de non aliud", for the purpose of gaining a wider view of the metaphysical significance of the person motif. Nicholas tells us that the individual is, though limited as an individual, nonetheless unlimited as part of the totality. Bringing in his thought offers us a new perspective on one of the most important motifs in Hegel's philosophy: totality.

## II. Publications

1. "On self-generation and thesis of the concept in Hegel's logic", Yuusuke Minegishi, Journal of the

philosophical society of Tohoku, No.27, 2012 (accepted)

### III. Presentations

1. "On self-generation and thesis of the concept in Hegel's logic", Yuusuke Minegishi, the philosophical society of Tohoku, October 2011, Hirosaki, Japan
2. "The problem of the relationship between individuality and universality in Hegel's philosophy", Yuusuke Minegishi, The 4<sup>th</sup> International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan)

### No.88

**Name** Masatoshi Echigo

**Department** Philosophy

**Position** D1

**Research Title** RA/Initiative A: On the theory of science in Husserl's phenomenology

### I. Summary of Research

1. In last year, I studied Husserl's foundation theory in his *Logical Investigations*. In Investigation VI from *Logical Investigations*, it is not clear that what kind of relation categorial intuition has with sensuous intuition. I presented the possible model of foundation between both intuitions.
2. In this year, I studied the relationship of phenomenology to philosophy in Husserl's *First Philosophy*. This study is mainly literal survey.
3. Also, in this year I studied the position of Husserl's phenomenology to other philosophical positions, such as relativism. Husserl's position is different from a mere relativism and foundationalism. I surveyed the character of phenomenology from his 'Prolegomena' and *Crisis*.

### II. Publications

### III. Presentations

1. "What does it mean that categorial form is fulfilled?", Masatoshi Echigo, *Shisaku* Research Presentation Meeting (June 20, 2011, Tohoku University, Sendai, Japan)
2. " 'Prolegomena' Revisited", Masatoshi Echigo, The 4<sup>th</sup> International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy" (February 20-22, 2012, Tohoku University, Sendai, Japan)

**No.89**

**Name** Koki Tamura  
**Department** Philosophy  
**Position** D1  
**Research Title** RA: Scientific Knowledge in Bergson's Philosophy

**I. Summary of Research**

In the first half of this year, I tried to reexamine *Laughter* whom little attention has been given to. The Reconsideration of *Laughter*, in particular social philosophical aspects of Bergson's philosophy, contributed greatly to my study in the latter half of this year. Then, I studied *The Two Sources of Morality and Religion* which is Bergson's last book. Especially I clarified relations between philosophy, science, and religion, by means of the Myth-Making function which is technical term of Bergson's philosophy.

**II. Publications**

1. "Fabulation and Imagination", Koki Tamura, *Journal of the Philosophical Society of Tohoku*, 28 vols. (2012).

**III. Presentations**

1. "Laughter and Imagination in Bergson", Koki Tamura, The meeting of Sisaku (June, 27, 2011, Tohoku University, Sendai, Miyagi, Japan).
2. "Imagination and Religion", Koki Tamura, The meeting of the Philosophical Society of Tohoku (October 22, 2012, Hirosaki University, Hirosaki, Aomori, Japan).
3. "On the Myth-Making function in Bergson", Koki Tamura, The 4<sup>th</sup> International GCOE symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", (February 20-22, 2012, Tohoku University, Sendai, Japan).

**No.90**

**Name** Marika Hirama  
**Department** Philosophy  
**Position** D1  
**Research Title** RA: The formation of Heidegger's ontology: Life and speech in early Heidegger

**I. Summary of Research**

In this year, I studied about relationship between early Heidegger's thought and Dilthey's thought of life. In his early training time, Heidegger received many inspirations of thought from Dilthey.



Heidegger, on one hand, criticized Dilthey's presupposition of scientific objectification. But on the other hand, Dilthey's motif affected Heidegger's early formation of thought where Dilthey wasn't mentioned directly. For example, Dilthey's categories of life influenced Heidegger's existential categories of being of human.

Beyond that, time and history as structures of being of human life, which were accepted from Dilthey, developed Heidegger more profoundly. Although, there are also some motif of thought in Dilthey which were accepted but not developed sufficiently by Heidegger. For this example, I focused in this year on the problem of expression. Heidegger criticized Dilthey's thought of objective expression of life only through which life understand itself. According to Heidegger, human always and already express itself by acting in the world. Human needs not to objectify it's life to understand itself.

But this problem of expression faded out in Heidegger's thought with formation of ontology. I can grasp one aspect of Heidegger's source of motif and limit of his methodology by seeing his accept and reject of Dilthey's life philosophy.

## II. Publications

## III. Presentations

1. "The concept of objectification in life philosophy and natural science", Mariko Hiram, The 4<sup>th</sup> GCOE International Symposium on "Weaving Science Web beyond Particle-Matter Hierarchy", Poster Session, (Feb.20-22, 2011 Tohoku University Sendai, Japan)

## No.91

|                       |  |
|-----------------------|--|
| <b>Name</b>           | <b>Hiroyuki Akatsuka</b>   |
| <b>Department</b>     | <b>Philosophy</b>  |
| <b>Position</b>       | <b>D3</b>  |
| <b>Research Title</b> | <b>RA/Initiative A: The problem of history in Heidegger's latter philosophy and the application to practical world</b> |

## I. Summary of Research

1. I researched the problem of history of Heidegger's philosophy of his early Freiburg period. In "being and time" Heidegger tried to define the philosophy in relation to the history. It seems in the relation between a analysis of historicity and a deconstructing of the history of ontology in this book. He sort out the 'Geschichte' as ontological historicity from 'Historie' as the practical science of history there.

And in his early philosophy he referred to the relation between history and philosophy. But there was no difference between 'Geschichte' and 'Historie'. The word 'historisch' had positive sense. In his early philosophy the main thema was 'the historical', and philosophy is to consider historically 'the

historical'.

But what is 'the historical'? How is the relation between 'the historical' and philosophy? I tried to explain these two problems in his lecture of his early philosophy.

2. I researched 'the question of being' at Heidegger's interpretation of Schelling's philosophy in his lecture 1936. In this lecture he explained the meaning to search Schelling's concept of freedom as the question of being and he referred to the relation between Schelling's concept of freedom and the perform of philosophy. Heidegger said that the question of human freedom at Schelling's concept of freedom is not the problem of free will of a human being but 'freedom as the essence of human being' and as ground of philosophy. Carrying out philosophy is based on freedom as the essence of human being, and, on the other hand, Philosophy searches for a freedom as one's own ground by one's own performing, and furthermore Philosophy lay one's own performing by one's own accomplishment. Therefore, Heidegger said Schelling's question of freedom is <question of philosophy in itself> and his performing of philosophy is showed and laid through his interpretation of Schelling's concept of freedom.

## **II. Publications**

## **III. Presentations**

*none*