

# Interim Report

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The following is a brief summary of the research I have carried out during the past 2 and half year as research fellow at the Yukawa Institute for Theoretical Physics in Kyoto University.

- *Casimir Effect*. The problem of investigating how the Casimir force changes due to degrees of freedom beyond the Standard Model has recently become a rather topical field of research, especially in view of the current ongoing high precision experiments aiming at measuring the Casimir force in the nano-meter range. Such experiments may, in fact, allow to explore possible modifications to standard long range interactions. We clarified various aspects of this problem and shown how to compute the corrections to Casimir force in higher dimensional models with branes in relation to possible constraints that may arise from experiments [1].

- *Gauge Theories on the Lattice*. In 2008 I have joined a lattice QCD collaboration, lead by Prof. Onogi, involving about ten other researcher from around the world. Our ultimate goal is to study, using the techniques of lattice field theory, the nature of physics of a gauge theory with an approximate conformal behavior, which are essential ingredients of viable alternatives to the traditional spontaneous symmetry breaking mechanism. We developed a new scheme to compute the running of the coupling constant of a gauge theory on the lattice and applied it to the case of quenched QCD [2, 3]. The full study of gauge with dynamical fermions is currently on-going [4].

- *Quantum black holes and holography*. Motivated by the AdS/CFT correspondence, Tanaka and myself developed a formalism to study quantum polarization effects on non-asymptotically flat black holes [5]. Following this work, with Kashiyama and Tanahashi, we evaluated the energy-momentum tensor for the CFT on an AdS black hole, and studied the quantum back reaction problem. We described how CFT equilibrium configurations without horizons flow into black configurations, studied the thermodynamics of the system, and showed how the AdS/CFT correspondence may relate them to higher dimensional black holes [6].

- *Intersecting brane models*. Together with Minamitsuji, we have explored how the localization of fields proceeds on a brane intersection embedded in non-trivial backgrounds. Aside for the conditions necessary for localization, we showed how chirality is obtained in these models [7]. We are currently looking at models with multiple intersections and crystal-like structure.

- *Micro Black Holes at LHC*. The possibility that the LHC may have the chance to observe the evaporation of micro black holes has generated an enormous interest in the problem. With Sasaki and Tanaka, we studied spin-polarization effects in the black hole radiation spectrum and showed that they contain essential information about the black hole. We proposed to use these effects as indicator of the number of extra dimensions, and as a tool to achieve high statistics in the phenomenological analysis [9].

- *Branes & black holes*. During the past few years, my work has been devoted to a substantial study of the dynamics of branes and black holes, a now very topical field of research due to its relevance in cosmology and particle physics. Recently, in collaboration with Czinner, we looked at the role of curvature corrections and topology change transitions and how to go beyond the celebrated Dirac-Nambu-Goto approximation [8]. Currently, we are incorporating the important effects of rotation.

- *Spectral Geometry*. The techniques of spectral geometry have been central in my research work, and I always maintain an active interest in the topic. Recently I started collaborating with a mathematician to develop a new formalism to compute functional determinants in the contexts of singular manifolds called Riemann caps [10]. This work originated from my previous study of zeta function in the brane world.

## Selected Presentations

★ ‘*Quantum Black Holes in AdS space*’, Leung Center For Cosmology and Astroparticle Physics, National Taiwan University, Taipei (Taiwan), March, 2010

★ ‘*Micro Black Holes at the LHC*’, Dept. of Physics, National Taiwan University, Taipei (Taiwan), March, 2010

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- ★ *‘Micro Black Holes at the LHC’*, Center For Theoretical Physics, Jamia Millia Islamia University, Delhi (India) March, 2010
- ★ *‘Black Holes in the LHC era’*, Global COE International Symposium ‘Symmetry breaking and quantum phenomena’, Kyoto University, Feb 2010
- ★ *‘Beyond the Dirac-Nambu-Goto approximation in brane black hole systems’*, 18th Japanese Meeting on General Relativity and Gravitation (JGRG19), Rikkyo University, Nov 2009 (poster)
- ★ *‘CFT Quantum Back reaction and brane world black holes’*, 11th Joint Seminar on Cosmology and Gravitation, Waseda University, Tokyo, Oct 2009.
- ★ *‘Casimir effect in models with branes and extra dimensions’*, International Conference on ‘New frontiers in Casimir Force Control’, Santa Fe, Sept 2009.
- ★ *‘CFT quantum back reaction and brane world black holes’*, 9th workshop on quantum field theory under the influence of external conditions (QFEXT09), Norman, University of Oklahoma, Sept 2009.
- ★ *‘Micro Black Holes at the LHC’*, Baylor University Colloquium, Waco TX, September 16, 2009
- ★ *‘Casimir Effect on Branes’*, Institute of Space Science (IEEC), Barcelona, May 27, 2009
- ★ *‘Micro black holes at the LHC’*, International Workshop on Cosmology and Particle Physics, Kavli Institute for Theoretical Physics, Chinese Academy of Science, Beijing, Mar 2009
- ★ *‘Field Localization on brane intersections in anti-de Sitter space’*, International Symposium on Topological Science and Technology for young researchers, Sapporo (Japan), Mar 2009 (poster)
- ★ *‘Spin-Polarization Effects in Micro Black Hole Evaporation’*, 16th International Conference, ‘Progress in Particles Physics 2008’ (YKIS 16), Kyoto University, Feb 2009
- ★ *‘Evaporation of micro black holes’*, Center for Quantum Spacetime (CQUeST), Sogang University, Seoul, January 2009
- ★ *‘Signatures of spinning evaporating micro black holes’*, 18th Japanese Meeting on General Relativity and Gravitation (JGRG18), Hiroshima University, Nov 2008
- ★ *‘Signatures of spinning evaporating micro black holes’*, Mini-workshop ‘Brainstorming on higher dimensional black holes’, Yukawa Institute for theoretical Physics, Kyoto, October 2008.
- ★ *‘Spin patterns in micro black hole evaporation’*, Fuji-Yoshida Particle Physics Summer Institute, Aug 2008
- ★ *‘Evaporation of rotating micro black holes’*, Workshop ‘Quantum Black Holes, Brane Worlds and Holography’, University of Valencia, May 2008
- ★ *‘Vacuum polarization effects in non-asymptotically flat black hole geometries’*, Univ. of Barcelona, February 2008
- ★ *‘Vacuum polarization effects in non-asymptotically flat black hole geometries’*, Workshop on ‘New Ideas in Cosmology’, University of Paris VII, Feb 2008

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