Parallel Workshop Session on Quantum Gravity

Parthasarathi Majumdar
Theory Group, Saha Institute of Nuclear Physics, AF/1 Bidhannagar, Kolkata 700 064.
E-mail: parthasarathi.majumdar@saha.ac.in

Abstract.
This is a summary of presentations in the Parallel Workshop Session on Quantum Gravity (QG including aspects of black hole physics, string theory and noncommutative geometry) at the ICGC-2007.

1. Introduction
There were four parallel sessions with twenty one presentations in all. These can be grouped into Quantum Gravitation, Semiclassical Black Hole Physics, String Effective Actions and Noncommutative Spaces

2. Quantum Gravitation
There were three presentations in this session, two related to Loop Quantum Gravity/Cosmology and one on general Quantum Gravity.

   Loop Quantum Cosmology claims to resolve cosmological singularities of general relativity through a canonical quantization of cosmological minisuperspace models embodying isotropy and homogeniety down to the Planck scale. Kinjal Banerjee discussed the canonical quantization of the Gowdy model, which is an inhomogeneous spatially compact singular cosmological spacetime. The inhomogeneity entails handling a full quantum field theory nonperturbatively, and the work is still in progress. Technical difficulties associated with this quantization were discussed substantively.

   The extraction of classical spacetime geometries from a semiclassical limit of Loop Quantum Gravity is a long-standing problem. Alok Ladda presented a toy version of the problems and some of their possible resolution by analyzing diffeomorphism-invariant free scalar field theory.

   Quantum measurement either entails a many-worlds interpretation with associated decoherence, or involves collapse of quantum states warranting modification of standard quantum mechanics. T. P. Singh contended that requiring that a reformulated quantum theory which makes no reference to a classical spacetime leads inevitably to a collapse scenario. A nonlinear Schrödinger theory was used as a theory of quantum gravity to illustrate the idea, and possible experimental checks of the idea were discussed.

3. Semiclassical Black Hole Physics
L. Sriramkumar presented collaborative work with S. Sarkar and S. Shankaranarayanan using the Brick Wall model to compute the entropy of quantum scalar fields in classical spherically symmetric spacetimes. Using certain prescriptions to handle the ambiguities in the computation,
and claiming that the result is an estimate of the entropy of the black hole spacetime, power-law and logarithmic corrections to the area law were discussed.

A proper derivation of black hole radiance ought to use a coordinate system well-defined at the event horizon, like the Kruskal-Szekeres frame. In this frame, there is also a white hole spacetime with a past spacelike singularity and an event horizon which is perfectly reflecting. The classically forbidden process of a thermal absorption spectrum was discussed by P. Mitra, using a variant of the Hamilton-Jacobi approach to obtain black hole radiance within a tunneling scenario.

A. K. Dawood (in collaboration with S. Shankaranarayan and L. Sriramkumar) used the idea of ‘path integral duality’ wherein Planck length is used as an ultraviolet cutoff for semiclassical processes, possible corrections to the energy-momentum tensor were presented, arising due to Planck scale effects within the rotating BTZ spacetime.

Primordial black holes arising out of density fluctuations in the early universe have implications for cosmic evolution. A. S. Majumdar discussed such black holes within alternative scenarios of gravitation like the scalar-tensor theories and braneworld models, and pointed out conditions under which such black holes may survive evaporation to current epochs and exist as dark matter.

Gravitational dust collapse in asymptotically anti-de Sitter spaces in 2+1 dimensions, within a quantum cosmological model regularized on a lattice, was presented by S. Gutti (work in collaboration with C. Vaz, L. Witten and T. P. Singh). The formation of an event horizon is linked to Hawking radiation for which an approximate thermal spectrum has been obtained, as well as the mass spectrum of the BTZ black hole.

Ng Ibohal discussed the embedding of a Kerr-Newman black hole spacetime in a rotating Vaidya spacetime and also how the evolving temperature of Hawking radiation from this system could lead to a negative mass of the embedded black hole.

Interpreting the scalar field of the scalar-tensor theory of gravitation as a Higgs field, H. Nandan (with N. M. Bezares-Roder and H. Dehnen) discussed the dependence of black hole horizons on this field for the Schwarzschild and Reissner-Nordstrom spacetimes.

R. Sini (with V. Varghese and V. C. Kuriakose) considered quasinormal modes of Dirac fermions in an extreme Reissner-Nordstrom background with a cosmic string singularity. These quasinormal modes were obtained in the WKB approximation and bore signature of the cosmic string part of the spacetime.

P. I. Kuriakose presented a solution of a scalar field with a double-well potential in a non-rotating BTZ spacetime and discussed its stability.

4. Semiclassical and Braneworld Cosmology and String Effective Actions

B. C. Paul (with P. S. Thakur and A. Saha) discussed a version of the Generalized Chaplygin Gas model as a holographic model of dark energy, showing that at late times the model resembles a ΛCDM model. The issue of stability of the model was addressed.

I. Thongkool, in collaboration with E. Elizalde, S. Jhingan, S. Nojiri, S. D. Odintsov and M Sami, presented a string effective action approach to the issue of dark energy involving a dilaton field and higher order curvature terms. The structure of these terms were shown to be crucial to ascertain if the corresponding cosmological scenario has a realistic dark energy component.

S. Pal, reported joint work with S. Kar on the stability of branes in braneworld models. A criterion was given on the warp factor for which a flat brane embedded in five dimensional spacetime is stable, and this criterion was then generalized to curved branes. The generality of the scheme was emphasized.

D. Maity discussed how recent data from the PVLAS experiments constrained microscopic coupling parameters of a stringy axion field to electromagnetism, within a Randall-Sundrum I
braneworld scenario. The PVLAS data also put stringent restrictions on how large an axion mass could be to be consistent with the string-inspired couplings of the axion.

Einstein’s equation in a spacetime with null boundaries resembling event horizons have been interpreted from a thermodynamic perspective. S. Sarkar (with A. Paranjape and T. Padmanabhan) reported on the generalization of this to Lovelock-Lanczos theories of gravity, and how special aspects of black hole spacetimes appeared in this perspective.

5. Noncommutative spacetimes
K. S. Gupta discussed joint work with B. Dolan and A. Stern on noncommutative deformations of the BTZ black hole. It was claimed that a quantization of time may result from such deformations, leading to a new interpretation of the holographic principle for such spacetimes.

Assuming a Lie Algebraic noncommutative spacetime and the Seiberg-Witten map appropriately adapted, P. Mukherjee argued that the corrections to a canonical noncommutative framework were absent to leading order.

6. Miscellaneous
A. Pandya presented a scenario based on the geometry of quantum Hilbert spaces wherein a ‘cosmological constant’ may be accommodated.