**Submittee:** Dinesh Singh
**Date Submitted:** 2012-10-03 09:59
**Title:** Third Conference of the Canadian Prairie Theoretical Physics Network (CPTPN-3)
**Event Type:** Conference-Workshop

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**Location:**
First Nations University of Canada, 1 First Nations Way, Regina, Saskatchewan, S4S 7K2

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**Dates:**
August 21-22, 2012

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**Topic:**
Interdisciplinary conference promoting theoretical physics and related research on the Canadian prairie provinces. Research topics presented include various branches of theoretical physics (gravitation/cosmology, subatomic theory, condensed matter, mathematical physics), mathematics with theoretical physics applications, and philosophy of physics.

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**Methodology:**
The format consists of equal-time presentations given on the first day by faculty, postdoctoral fellows, and students (graduate and undergraduate) on research-related topics. The second day was devoted to workshops and meetings of the CPTPN to promote the growth of the network and to develop as a long-term goal the organization of distance education graduate-level classes to be taken by CPTPN student members in western Canada.

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**Objectives Achieved:**
Besides creating an opportunity for academics, postdoctoral fellows, and students to present their research, the long-term goal of CPTPN-3 is to foster the growth of the CPTPN by encouraging new members to join. In this respect, CPTPN-3 has been very successful with a significant gain in new membership as a result of this conference.

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**Organizers:**
Doolittle, Prof. Edward, Department of Interdisciplinary Studies, First Nations University of Canada // Singh, Dr. Dinesh, Department of Physics University of Regina

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**Speakers:**
Nils Deppe, Department of Physics, University of Winnipeg, Critical Phenomena in Einstein-Gauss-Bonnet Gravity in Painleve-Gullstrand Coordinates, Einstein-Gauss-Bonnet gravity (EGB) provides a natural higher dimensional and higher order curvature generalization of Einstein gravity. It contains a new, presumably microscopic, length scale that should affect short distance properties of the dynamics, such as Choptuik scaling. We present the results of a numerical

analysis of self-gravitating massless scalar spherical collapse in five and six dimensional EGB gravity near the threshold of black hole formation. Although the non-scale invariant nature of Einstein-Gauss-Bonnet gravity destroys the discrete self similarity, we nonetheless find evidence for a new type of scaling with interesting properties, including universality. // Wei-Jie Fu, Department of Physics, Brandon University, Hierarchy Structure of the Bethe-Salpeter Equation, Hierarchy structure of the Bethe-Salpeter (BS) equations is found. We also employ this structure to greatly improve on the approximations for the BS kernel. Resummation of the BS kernel in t and u channels to infinite order is equivalent to truncate the effective action to infinite order. Our approximation approaches ensure that the theory can be renormalized, which is very important for numerical calculations. Two-point function can also obtained from the four-point one through flow evolution equations resulting from the exact renormalization group. BS equations of different hierarchies and the flow evolution equation for the propagator constitute a closed system, which can be solved completely. // Robin Kleiv, Department of Physics and Engineering Physics, University of Saskatchewan, Pseudoscalar $J^{PC}=0^{-+}$ Charmonium and Bottomonium Hybrid Mass Predictions with QCD Sum-Rules, Masses of the pseudoscalar ($J^{PC}=0^{-+}$) charmonium and bottomonium hybrids are determined using QCD Laplace sum-rules. The effects of the dimension-six gluon condensate are included in our analysis and result in a stable sum-rule analysis, whereas previous studies of these states were unable to optimize mass predictions. The pseudoscalar charmonium hybrid is predicted to have a mass of approximately 3.8 GeV and the corresponding bottomonium prediction is 10.6 GeV. We discuss the implications of this result for the charmonium-like XYZ states and the charmonium hybrid multiplet structure observed in recent lattice QCD calculations. // Michael Kozdron, Department of Mathematics and Statistics, University of Regina, Conditional Expectation and Bayes' Rule for Quantum Random Variables and Positive Operator Valued Measures, A quantum probability measure is a function on a sigma-algebra of subsets of a (locally compact and Hausdorff) sample space that satisfies the formal requirements for a measure, but whose values are positive operators acting on a complex Hilbert space, and a quantum random variable is a measurable operator valued function. Although quantum probability measures and random variables are used extensively in quantum mechanics, some of the fundamental probabilistic features of these structures remain to be determined. In this talk, we introduce a quantum analogue for the expected value of a quantum random variable relative to a quantum probability measure. In so doing we are led to theorems for a change of quantum measure and a change of quantum variables. We also introduce a quantum conditional expectation which results in quantum versions of some standard identities for Radon-Nikodym derivatives as well as a quantum analogue of Bayes' rule. This talk is based on joint work with Doug Farenick of the University of Regina. // Gabor Kunstatter, Department of Physics, University of Winnipeg, Quantum Mechanics on the Discrete Half Line, We investigate nonrelativistic quantum mechanics on the discretized half-line, constructing a one-parameter family of Hamiltonians that are analogous to the Robin family of boundary conditions in continuum half-line quantum mechanics. For classically singular Hamiltonians, the construction provides a singularity avoidance mechanism that has qualitative similarities with singularity avoidance encountered in loop quantum gravity. // Ali Nassar, Department of Physics and Astronomy, University of Lethbridge, Rational Conformal Field Theory and Matrix Level for Strings on a Torus. Two-dimensional conformal field theories are very well understood: in many cases, the conformal symmetry is powerful enough to give a complete non-perturbative solution. Their applications range from critical phenomena to perturbative string theory. A particularly simple class are rational conformal field theories, characterized by having a finite number of primary fields. It is important to know the conditions for rationality. For example, the simplest compactifications of a string theory are on tori--when are they described by rational conformal field theories? For a two-dimensional torus, Gukov and Vafa gave a simple, geometric criterion for rationality. The modular parameter tau and Kahler parameter rho must take special values in the imaginary quadratic number field tau, rho \in Q(D) so that the torus possesses the property of complex multiplication. On the other hand, Gannon has studied the algebras involved in the corresponding conformal field theories: $U_{m,K}$ Kac-Moody algebras with a matrix-valued level K. We investigate the relation between the Gukov-Vafa geometric characterization of rationality and the algebraic results of Gannon. The Gauss product is used to give a geometric interpretation of U_{2,K} in terms of rational points in the Narain moduli space which correspond to complex multiplication tori. // James Nester, Department of Physics, National Central University of Taiwan, Gravitational Energy: Our Hamiltonian Approach, Identifying a good expression for the (quasi-)local energy-momentum of gravitating systems is still an outstanding fundamental puzzle. The Hamiltonian approach clarifies certain geometric and physical ambiguities of both the traditional pseudotensor approach and the more modern quasi-local idea. Our preferred covariant Hamiltonian boundary term quasi-local energy-momentum corresponds to an appropriate boundary condition. Now we have a technique for selecting the "best matched" Minkowski reference, which is needed to complete the determination of the quasi-local values. // Kent Peacock, Department of Philosophy, University of Lethbridge, Einstein on Separability, Einstein stated that physics must treat the world as made of objects arrayed in spacetime and obeying the Separation Principle (SP): spacelike separation at time t guarantees physical independence at time t. Without SP, Einstein argued, "physical thinking in the familiar sense would not be possible." I argue that his expectations for physics are unreasonable in several respects. // Nick Reid, Department of Physics, University of Winnipeg, Cosmological Constraints on New Dark Matter Models, Dark matter is a theoretical particle outside the standard model of physics used to explain the extra gravitational forces felt by visible matter in the universe. This dark matter is expected to gather at the center of galaxies in halo formation. Some models of dark matter are able to explain the large amount of positrons/electrons being produced in galactic centers. We are investigating the interactions of dark matter (annihilations, decays, etc.) in these models and the energy these interactions would add to the early universe. We can then impose constraints on different properties of dark matter, using observational data from WMAP7 along with future predictions for the Planck data. // Oleg Rubel, Thunder Bay Regional Research Institute & Department of Physics, Lakehead University, First-Principle Simulation of Disordered and Compound Semiconductors, The presentation is intended to provide several illustrative examples on the application of the density functional theory in various branches of solid state physics and material science: solid state detectors for radiation medical imaging, optoelectronics and photovoltaics. Particular examples include modelling of high-field transport in chalcogenide semiconductors, formation of a nearest-neighbor bond order in compound semiconductor alloys, surface phenomena during epitaxial growth and formation of two-dimensional structural defects. // Haryanto Siahaan, Department of Physics and Engineering Physics, University of Saskatchewan, Generalized Hidden Conformal Symmetry of Kerr-Sen Spacetimes, It is recently conjectured that generic non-extreme Kerr black hole could be holographically dual to a hidden conformal field theory in two dimensions. The hidden conformal structure can be revealed by looking at charged scalar wave equation in some appropriate values of frequency and charge. In this regard, we consider the wave equation of a charged massless scalar field in background of Kerr-Sen black hole and show in the "near region", the wave equation can be reproduced by the Casimir operator of a local SL(2,R)L x SL(2,R)R hidden conformal symmetry. By deforming the Laplacian operator by kappa parameter, we can have a generalized quadratic Casimir which reflects the SL(2,R)a x SL(2,R)b. In this regard, we then find an extension of vector fields that in turn yields an extended local family of SL(2,R)a x SL(2,R)b hidden conformal symmetries parameterized by kappa. For some special values of the parameter, we find a copy of SL(2,R) hidden conformal algebra for the charged Gibbons-Maeda-Garfinkle-Horowitz-Strominger black hole in the strong deflection limit. // Tim Taves, Department of Physics, University of Winnipeg, Hamiltonian Formulation of Scalar Field Collapse in Lovelock Gravity, The action of general relativity is first order in curvature. One higher order generalization to GR, which contains no higher than second derivatives of the metric, is known as Lovelock gravity. All Lovelock terms of order greater than one are identically zero in four dimensions but with recent interest in higher dimensions it makes sense to consider these terms. We perform the geometrodynamics analysis of Kuchar (1994) to find the Hamiltonian of Lovelock gravity in terms of a mass function. We then calculate the Hamiltonian of a massless scalar field minimally coupled to Lovelock gravity and find the equations of motion which are suitable for the simulation of gravitational collapse. Although we choose a gauge which puts the metric into Painleve-Gullstrand coordinates our analysis is quite general and may be easily generalized to alternate slicings.  Our analysis may also be generalized to alternate forms of matter.     //   Zhi-Wei Wang, Department of Physics and Engineering Physics, University of Saskatchewan,  Can Radiative Symmetry Give Higgs Mass Prediction?  In contrast to conventional symmetry-breaking mechanisms, radiative symmetry breaking does not require a quadratic Lagrangian term.  Instead, it dynamically generates a vacuum expectation value and mass term for the theory through loop (radiative) corrections.  This radiative mechanism for generating the Higgs mass is attractive because of its naturalness and absence of adjustable parameters compared with the conventional symmetry breaking.  In this talk, I will discuss how to use radiative symmetry breaking to predict the Higgs mass which can be compared with the recent LHC experimental results.  Phenomenological signatures of radiative symmetry breaking will also be discussed.

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**Links:**
http://cptpn-3.eventzilla.net

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**File Uploads:**
Additional Upload 1: http://www.pims.math.ca/files/final_report/CPTPN-3-Poster-Public-Release.pdf
Additional Upload 2:
http://www.pims.math.ca/files/final_report/CPTPN-3-2012-Scientific-Program.pdf
Additional Upload 3: http://www.pims.math.ca/files/final_report/CPTPN-3-Reconciled-Budget.pdf

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