The Winnipeg Institute for Theoretical Physics Summer Symposium

Conference Program

Brandon University

August 27, 2018

Schedule

9:50	Coffee
10:20	Words from Dean
10:30	Darian
11:00	Xiaohong
11:30	Brad
12:00-1:00	Lunch
1:00	Paul
1:30	Shawna
2:00	Coffee
2:30	LJ
3:00	Chris
3:30	Depart

Coffee and lunch breaks to be held in Brodie Building (BB) 1-54; talks to be held in BB 1-53.

Abstracts

Title Variations on the Dirac String [arXiv:1807.07401]

Speaker Brad Cownden (cowndenb@myumanitoba.ca)
Department of Physics & Astronomy, University of Manitoba
Department of Physics, University of Winnipeg

Co-authors Andrew R. Frey (a.frey@uwinnipeg.ca)
Department of Physics, University of Winnipeg

Abstract Following results derived from considering the motion of D3-branes in extra dimensions, we examine a variant of the Dirac string description for magnetic monopoles. We construct this formulation by expanding the monopole's position about an arbitrary, unphysical reference monopole. We then show equivalence between this description and Dirac's string description, as well as with conventional dual potential formulations. Finally, the advantages and potential applications of this description of monopoles is discussed.

Title Inducing Quantum State Transfer

Speaker Darian Mclaren (mclareda17@brandonu.ca)
Department of Mathematics & Computer Science, Brandon University

Co-authors Sarah Plosker (Brandon University), Chi-Kwong Li (College of William and Mary)

Abstract If we consider the particles of a spin network (with XX couplings) to be nodes and the couplings between particles to be edges we can model the spin network through the use of graph theory. By restricting to the single-excitation subspace the Hamiltonian of the spin network is simply the adjacency matrix of the graph. We then say that the graph admits *perfect state transfer* (PST) if after the spin network is initialized with an input node in the excited state, there exists a time t in which the probability of the excitation being at some other target node is 1. Alternatively, we get *pretty good state transfer* (PGST) if the probability of this occurring can be made arbitrarily close to 1. In this talk we explore graphs which do not exhibit PGST, but can be made to do so by adding potentials to the nodes (i.e. loops on the graph).

Title Gradient Flow in Holographic Superconductors

Speaker Paul Mikula (mikulap@myumanitoba.ca)
University of Manitoba / University of Winnipeg

Co-authors

Abstract

The AdS/CFT correspondence provides an equivalence between a gravity theory in some bulk anti-deSitter spacetime and a conformal field theory (CFT) in one fewer dimensions on the boundary. A superconductor that can be described by a gravity theory through this correspondence is referred to as a 'holographic superconductor'. Gradient flow equations will evolve any given initial field configuration towards one that is a solution to the equations of motion, this allows us to study stability of solutions as well as the behavior of a system far from equilibrium. Through the AdS/CFT correspondence, the gradient flow in the gravity theory should have a corresponding flow in the CFT and vice-versa. We focus on the flow of the matter fields in a gravity theory containing a black hole and a charged scalar field. In this system the flow equations move the system from a configuration with no scalar hair to a hairy black hole solution. We study the corresponding flow on the boundary superconducting theory, where a normal metal state transitions to a superconducting state.

Title Computational Renormalization of the 4PI Effective Theory

Speaker Christopher Phillips (christopherdphillips7@gmail.com)
Department of Physics, Brandon University

Co-authors M.E. Carrington: Department of Physics, Brandon University; D. Pickering: Department of Mathematics, Brandon University; S.A. Friesen: Department of Physics, Brandon University

Abstract
All quantum field theories contain infinite contributions in the form of divergent integrals. In order to obtain physical results, these divergences must be somehow extracted. For weakly interacting systems, a solution to this problem (perturbative renormalization) was discovered in the 1970's. However, many physically interesting systems are not weakly interacting - one example is the study of stellar evolution. Field theories that describe strongly interacting systems are much more complicated. One technique is called n-particle irreducible (nPI) effective theories. Preliminary calculations using these theories have produced some promising results. However, the problem of divergent integrals has never been resolved, except in the simplest (2PI) case. We are studying the 4PI effective theory at 4-loop order. We introduce a method to renormalize using a regulator function at the classical level, and calculating flow equations that translate the n-point functions of the theory between the classical and quantum realms. A tuning procedure is used to enforce the physical properties of the quantum system that is obtained. A complex logical structure is needed to numerically evaluate the resulting system of integro-differential equations. In this talk i will discuss the different components of this structure.

Title Lost Horizons: Formation and Evaporation of Regular CGHS Black Holes

Speaker Shawna Skelton(skelton-s84@webmail.uwinnipeg.ca)

Co-authors Gabor Kunstatter, Department of Physics, University of Winnipeg and Winnipeg Institute for Theoretical Physics, Winnipeg, Manitoba, Canada.

Jonathan Ziprick, Applied Computer Education Department, Red River College, Winnipeg, Manitoba, Canada.

Abstract
We model the evolution of 2 dimensional, spherically symmetric, non-singular black holes. We consider both generalized Callan-Giddings-Harvey-Strominger and Einstein-Lanczos-Lovelock actions, both of which produce coordinate invariant equations of motion. Hawking radiation is accounted for with the Polyakov action. Scalar

fields are solved numerically in a python code. Using the solutions to these fields at each point, the black holes evolution is modelled in light ray coordinates.

Title Switched and Partially Switched Hypercubes and their PST Property

Speaker Xiaohong Zhang(zhangx42@myumanitoba.ca)
Department of Mathematics, University of Manitoba

Co-authors Steve Kirkland (University of Manitoba), Sarah Plosker (Brandon University)

Abstract A graph is said to admit perfect state transfer (PST) if there are two distinct vertices a and b, and a time $t_0 > 0$, such that the information input at vertex a at time $t = 0$ can be transferred to vertex b at time $t = t_0$ perfectly. It is known that all the vertices of hypercubes pair up to exhibit PST at time $t = \pi/2$. In this talk, we introduce a new class of graphs - switched hypercubes, which are cospectral to the hypercubes and can be obtained from hypercubes with Godsil-McKay switching. We will show that exactly half of the vertices of a switched hypercube pair up to exhibit PST. We will also talk about partially switched hypercubes, which still admit PST, but between fewer pair of vertices, as well as about switching systems.

Title Models for Firewall Creation in Massless Scalar Field Theory

Speaker LJ Zhou (zhoul346@myumanitoba.ca)
Department of Physics, University of Manitoba & University of Winnipeg

Co-authors M. Carrington, Brandon University; G. Kunstatter, University of Winnipeg; J. Louko, University of Nottingham

Abstract

Recently, Brown and Louko (JHEP 1508 (2015) 061) proposed a 1+1 dimensional mechanism for evolving boundary condition that mimic the creation of firewalls, which are thought by some to be needed to resolve the black hole information loss conundrum. We extend this calculation to the more physical case of 3+1 dimensions. In particular, we consider a spherically symmetric scalar field with specifically designed time dependent boundary conditions at the origin. These boundary conditions correspond to the creation at the origin of a point-like source that produces a null energy pulse.

In contrast to what happens in 1+1, the 3+1 dimensional pulse of energy is singular enough to break correlations that happen near the horizon of an evaporating black hole and may provide a viable model for firewalls. The detector response is

finite except in the instantaneous creation limit where the energy density blows up everywhere in the future of the creation event.

Participants

Meg Carrington
Brad Cownden
Gabor Kunstatter
Darian Mclaren
Brett Meggison
Paul Mikula
Chris Phillips
Sarah Plosker
Shawna Skelton
Jeff Williams
Xiaohong Zhang
LJ Zhou