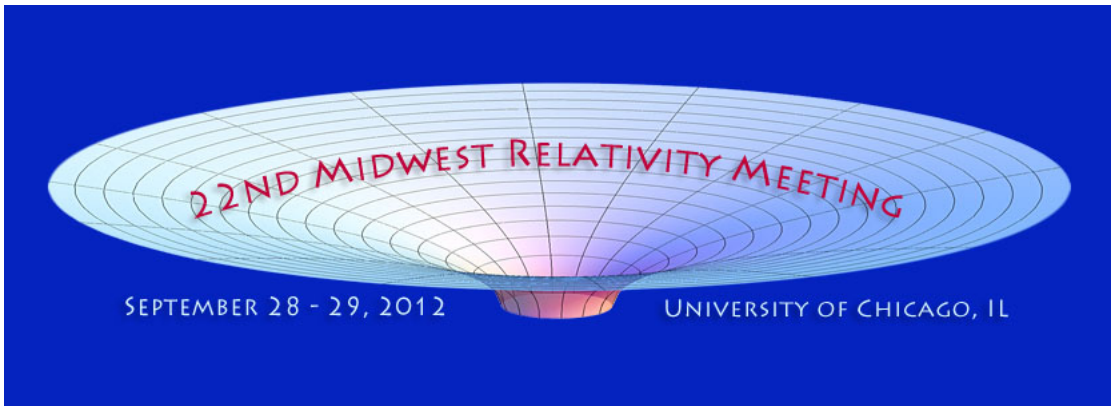

http://kicp-workshops.uchicago.edu/Relativity2012/

MEETING MATERIALS

The 22nd Midwest Relativity Meeting will be held Friday and Saturday, September 28 and 29, 2012 at the University of Chicago. The format of the meeting will follow previous regional meetings, where all participants may present a talk of approximately 10-15 minutes, depending on the total number of talks. We intend for the meeting to cover a broad range of topics in gravitation physics, including classical and quantum gravity, numerical relativity, relativistic astrophysics, cosmology, gravitational waves, and experimental gravity. As this is a regional meeting, many of the participants will be from the greater United States Midwest and Canada, but researchers and students from other geographic areas are also welcome.

Students are strongly encouraged to give presentations. The Blue Apple Award, sponsored by the APS Topical Group in Gravitation, will be awarded for the best student presentation.

We gratefully acknowledge the generous support provided by the Kavli Institute for Cosmological Physics (KICP) at the University of Chicago.

Organizing Committe

Daniel Holz
University of Chicago

Robert Wald
University of Chicago

List of Participants

1.	James Alsup	University of Michigan-Flint
2.	Newshaw Bahreyni	University at Albany, SUNY
3.	Satyen Baindur	None
4.	Lindsay Bassman	University of Chicago
5.	Scott Beck	Case Western Reserve University
6.	Sydney J Chamberlin	University of Wisconsin-Milwaukee
7.	Hui-Yiing Chang	Vanderbilt University
8.	Hsin-Yu Chen	University of Chicago
9.	Liang Chen	University of Mississippi
10.	Demian Cho	St. Mary's University
11.	Sagnik De	University of Mississippi
12.	Peter B Denton	Vanderbilt University
13.	Ema Dimastrogiovanni	UMNN
14.	William Donnelly	University of Waterloo
15.	Ariel Edery	Bishop's University
16.	Justin Ellis	University of Wisconsin Milwaukee
17.	Zachariah B. Etienne	University of Illinois
18.	Matteo Fasiello	Case Western Reserve University
19.	John Friedman	University of Wisconsin-Milwaukee
20.	Caixia Gao	University of Mississippi
21.	David Garfinkle	Oakland University
22.	Cristiano Germani	Ludwig-Maximilians-University
23.	Davide Gerosa	University of Mississippi
24.	Roman Gold	University of Illinois at Urbana-Champaign
25.	Pierre Gratia	University of Chicago
26.	Carlo Graziani	University of Chicago
27.	Stephen R Green	University of Guelph
28.	Lavinia Heisenberg	Case Western Reserve University
29.	Craig Hogan	U. Chicago/Fermilab
30.	Daniel Holz	University of Chicago
31.	Elise Jennings	University of Chicago
32.	Brittany Kamai	Vanderbilt University

33.	Shivaraj Kandhasamy	University of Minnesota
34.	Luke A Keltner	Case Western Reserve University
35.	Eleni-Alexandra Kontou	Tufts University
36.	Richard M. Kriske	University of Minnesota
37.	Hongkai Liu	The University of Mississippi
38.	Carlos O Lousto	Rochester Institute of Technology
39.	Andrew A Matas	Case Western Reserve University
40.	George E. A. Matsas	Instituto de Fisica Teorica (Sao Paulo - Brazil)
41.	Lee McCuller	University of Chicago
42.	Richard O'Shaughnessy	University of Wisconsin-Milwaukee
43.	Evan L Ochsner	University of Wisconsin-Milwaukee
44.	Nicholas A Ondo	Case Western Reserve University
45.	Vasileios Paschalidis	University of Illinois at Urbana-Champaign
46.	Nikodem Poplawski	Indiana University
47.	Kartik Prabhu	University of Chicago
48.	David D Reid	University of Chicago
49.	Carl L Rodriguez	Northwestern University
50.	Ko Sanders	University of Chicago
51.	Joshua S. Schiffrin	University of Chicago
52.	Savdeep Sethi	University of Chicago
53.	Robert S Stricklin	University of Texas Dallas
54.	Andrew Tolley	Case Western Reserve University
55.	Amol Upadhye	Argonne National Laboratory
56.	Alexander L Urban	University of Wisconsin - Milwaukee
57.	Ali Vanderveld	University of Chicago
58.	Leslie E Wade	University of Wisconsin - Milwaukee
59.	Madeline Wade	UW-Milwaukee
60.	Robert Wald	University of Chicago
61.	Shouhong Wang	Indiana University
62.	Douglas Watson	KICP Chicago
63.	Mark Wyman	University of Chicago
64.	Alan Zablocki	University of Chicago, KICP

MEETING PROGRAM

September 28-29, 2012 @ Kersten Physics Teaching Center (KPTC), Room 106

Friday - September 28, 2012

8:15 AM - 8:55 AM	*COFFEE & PASTRIES*
8:55 AM - 9:00 AM	*WELCOME* *Daniel Holz & Robert Wald*
	MORNING SESSION
9:00 AM - 9:15 AM	**Daniel Holz**, University of Chicago ***Gravitational-waves and gamma-ray bursts***
9:15 AM - 9:30 AM	**Hsin-Yu Chen***, University of Chicago ***GRB Beaming and Gravitational-Wave Observations***
9:30 AM - 9:45 AM	**Sydney J Chamberlin***, University of Wisconsin-Milwaukee ***Searches for a stochastic gravitational wave background with pulsar timing arrays: a data analysis pipeline***
9:45 AM - 10:00 AM	**Justin Ellis***, University of Wisconsin Milwaukee ***Gravitational Wave Searches in Pulsar Timing Data***
10:00 AM - 10:15 AM	**Shivaraj Kandhasamy***, University of Minnesota ***Search for long gravitational-wave bursts and high-energy neutrino coincidences***
10:15 AM - 10:30 AM	**Lee McCuller***, University of Chicago ***Interferometer Instrumentation on the Fermilab Holometer***
10:30 AM - 11:00 AM	*COFFEE BREAK & DISCUSSION*
11:00 AM - 11:15 AM	**Madeline Wade***, UW-Milwaukee ***Sub-Solar Mass Black Hole Search in S5 Initial LIGO Data***
11:15 AM - 11:30 AM	**Evan L Ochsner**, University of Wisconsin-Milwaukee ***Gravitational waves from BH-NS binaries: Effective Fisher matrices and parameter estimation using higher-harmonics***
11:30 AM - 11:45 AM	**Carl L Rodriguez***, Northwestern University ***Inadequacies of the Fisher Information Matrix in gravitational-wave parameter estimation***
11:45 AM - 12:00 PM	**Richard O'Shaughnessy**, University of Wisconsin-Milwaukee ***Precession during merger: Strong polarization changes are observationally accessible features of strong-field gravity during binary black hole merger***
12:00 PM - 12:15 PM	**Leslie E Wade***, University of Wisconsin - Milwaukee ***Studying the Effects of Tidal Corrections on Parameter Estimation***
12:15 PM - 1:45 PM	*LUNCH*

AFTERNOON SESSION

1:45 PM - 2:00 PM	**John Friedman**, University of Wisconsin-Milwaukee ***Update on the EMRI problem for a massive particle in a Kerr spacetime***
2:00 PM - 2:15 PM	**Joshua S. Schiffrin***, University of Chicago ***Dynamical and Thermodynamic Stability of Perfect Fluid Stars***
2:15 PM - 2:30 PM	**Kartik Prabhu***, University of Chicago ***Gauge Conditions and Black hole Stability***
2:30 PM - 2:45 PM	**Alexander L Urban***, University of Wisconsin - Milwaukee ***Causal structure of black hole interiors in spherical symmetry***
2:45 PM - 3:00 PM	**Eleni-Alexandra Kontou***, Tufts University ***Averaged null energy condition in curved space***
3:00 PM - 3:15 PM	**Stephen R Green**, University of Guelph ***Exact example of backreaction of small scale inhomogeneities in cosmology***
3:15 PM - 3:45 PM	*COFFEE BREAK & DISCUSSION*
3:45 PM - 4:00 PM	**Andrew Tolley**, Case Western Reserve University ***Progress in Massive Gravity***
4:00 PM - 4:15 PM	**Matteo Fasiello**, Case Western Reserve University ***The interplay of Stability Requirements and Observations in Massive Gravity***
4:15 PM - 4:30 PM	**Lavinia Heisenberg***, Case Western Reserve University ***A Proxy for Massive Gravity***
4:30 PM - 4:45 PM	**Caixia Gao***, University of Mississippi ***On charged black holes in nonlinear ghost-free massive gravity***
4:45 PM - 5:00 PM	**Pierre Gratia***, University of Chicago ***Cosmological constant from Massive Gravity***
5:00 PM - 5:15 PM	**Andrew A Matas***, Case Western Reserve University ***Galileon radiation from binary pulsars***
5:15 PM - 5:30 PM	**Newshaw Bahreyni***, University at Albany, SUNY ***A Potential Mechanism for Emergent Observer-Based Space-Time***

Saturday - September 29, 2012

8:15 AM - 9:00 AM	*COFFEE & PASTRIES*
	MORNING SESSION
9:00 AM - 9:15 AM	**Carlos O Lousto**, Rochester Institute of Technology ***Exploring the outer limits of Numerical Relativity***
9:15 AM - 9:30 AM	**Vasileios Paschalidis**, University of Illinois at Urbana-Champaign ***Importance of cooling in triggering the collapse of hypermassive neutron stars***
9:30 AM - 9:45 PM	**Zachariah B. Etienne**, University of Illinois ***General relativistic simulations of black hole-neutron star mergers: Effects of tilted magnetic fields***
9:45 AM - 10:00 AM	**Roman Gold**, University of Illinois at Urbana-Champaign ***Binary black hole mergers in magnetized disks: simulations in full general relativity***
10:00 AM - 10:15 AM	**Davide Gerosa***, University of Mississippi ***Spin Alignment Effects in Stellar Mass Black Hole Binaries***
10:15 AM - 10:30 AM	**David Garfinkle**, Oakland University ***Collapse of charged thick domain walls***
10:30 AM - 11:00 AM	*COFFEE BREAK & DISCUSSION*
11:00 AM - 11:15 AM	**Ema Dimastrogiovanni**, UMNN ***An estimator for statistical anisotropy from the CMB bispectrum***
11:15 AM - 11:30 AM	**Cristiano Germani**, Ludwig-Maximilians-University ***High friction inflation***
11:30 AM - 11:45 AM	**Hui-Yiing Chang***, Vanderbilt University ***Inflection Point Quintessence Cosmologies***
11:45 AM - 12:00 PM	**Nikodem Poplawski**, Indiana University ***Nonsingular big-bounce cosmology from spin and torsion***
12:00 PM - 12:15 PM	**Shouhong Wang**, Indiana University ***Gravitational Field Equations and Unified Theory of Dark Matter and Dark Energy***
12:15 PM - 12:30 PM	**Luke A Keltner***, Case Western Reserve University ***Classicalization as Possible UV Completion***
12:30 PM - 2:00 PM	*LUNCH*
	AFTERNOON SESSION
2:00 PM - 2:15 PM	**Amol Upadhye**, Argonne National Laboratory ***Dark energy fifth forces in torsion pendulum experiments***

2:15 PM - 2:30 PM	**George E. A. Matsas**, Instituto de Fisica Teorica (Sao Paulo - Brazil) ***Particle creation due to tachyonic instability in relativistic stars***
2:30 PM - 2:45 PM	**Ariel Edery**, Bishop's University ***Quantum corrections to the gravitationally coupled magnetic monopole: residual conformal symmetry and trace anomaly***
2:45 PM - 3:00 PM	**William Donnelly**, University of Waterloo ***Entanglement entropy of gauge fields***
3:00 PM - 3:15 PM	**Ko Sanders**, University of Chicago ***Topological effects in linear gauge theories***
3:15 PM - 3:30 PM	**James Alsup**, University of Michigan-Flint ***Gravity dual of FFLO states***
3:30 PM - 3:45 PM	**Robert Wald**, University of Chicago ***Negative Canonical Energy and Exponential Growth Instabilities***

Meeting Talks

1. **James Alsup**, University of Michigan-Flint
Gravity dual of FFLO states

September 29, 2012 (3:15 PM - 3:30 PM)

Co-authors: Eleftherios Papantonopoulos, George Siopsis
We discuss the gravity dual of FFLO states in strongly coupled superconductors. The gravitational theory utilizes two U(1) gauge fields and a scalar field coupled to a charged AdS black hole. The first gauge field couples with the scalar sourcing a charge condensate below a critical temperature, and the second gauge field incorporates a magnetic field that couples to spin in the boundary theory. The scalar is neutral under the second gauge field. By turning on a magnetic interaction between the second U(1) field and the scalar, it is shown that, in the high-field limit, an inhomogeneous solution possesses a higher critical temperature than the homogeneous case, giving rise to FFLO states close to zero temperature.

2. **Newshaw Bahreyni**, University at Albany, SUNY
A Potential Mechanism for Emergent Observer-Based Space-Time

September 28, 2012 (5:15 PM - 5:30 PM)

Co-authors: Prof. Kevin H. Knuth
Events representing some detectable change in the state of the universe can be partially ordered according to whether one event influences another. Such partially-ordered sets (posets) of events, also referred to as causal sets, can be characterized and quantified naturally by distinguishing an embedded chain, which we refer to as an observer chain, and identifying the relationship between events in the poset and numbered events on the observer chain. This construction enables a subset of events to be quantified by a pair of numbers. We show that under reasonable conditions, such quantification leads to the Minkowski metric, Lorentz transformations and the mathematics of special relativity [1]. Under more general conditions, the Minkowski result only holds locally. This suggests a potential mechanism for the emergence of an observer-based space-time. Furthermore, the observer-based nature has the potential to accommodate quantum mechanics as well as demonstrated by the fact that this picture leads to the Feynman checkerboard model of the Dirac equation in 1+1 dimensions [2,3]. References: [1] K.H. Knuth, N. Bahreyni, The Physics of Events, (2012). [2] R.P. Feynman & A.R. Hibbs, Quantum mechanics and path integrals, (1965). [3] Knuth, K.H. 2012. Inferences about Interactions: Fermions and the Dirac Equation. in U. von Toussaint (ed.) Bayesian Inference and Maximum Entropy Methods in Science and Engineering, Garching, Germany, July 2012, AIP Conference Proceedings, American Institute of Physics, Melville NY.

3. **Sydney J Chamberlin**, University of Wisconsin-Milwaukee
Searches for a stochastic gravitational wave background with pulsar timing arrays: a data analysis pipeline

September 28, 2012 (9:30 AM - 9:45 AM)

Co-authors: Jolien Creighton, Paul Demorest, Justin Ellis, Larry Price, Joe Romano, Xavier Siemens
Pulsar timing arrays are a promising tool for probing the universe through gravitational radiation. Supermassive black hole binaries (SMBHBs), cosmic strings, relic gravitational waves from inflation, and first order phase transitions in the early universe are expected to contribute to a stochastic background of gravitational waves (GWs) in the pulsar timing array (PTA) frequency band of 10^(-9)--10^(-7) Hz. Here, we present a fully functional data analysis pipeline for the detection of a stochastic background of gravitational waves in the PTA band. We describe the underlying statistics of our method and discuss the inherent challenges in stochastic GW searches. We provide a robust frequentist upper limit for the signal size detectable with this pipeline. We also present preliminary results obtained in this pipeline for the International Pulsar Timing Array (IPTA) Mock Data Challenge, and discuss future implications and limitations.

4. **Hui-Yiing Chang**, Vanderbilt University
Inflection Point Quintessence Cosmologies

September 29, 2012 (11:30 AM - 11:45 AM)

Co-authors: Robert J. Scherrer
We examine several different cosmologies where the scalar field potentials are power law functions. They end up with slow-roll behavior, tunneling or oscillating based on particular variances in the potential and other factors. The examples of tunneling are Inflection Point Quintessence models of the universe. The case for dark energy can be shown in some of these models, which accounts for the accelerated expansion of the universe.

5. **Hsin-Yu Chen**, University of Chicago
GRB Beaming and Gravitational-Wave Observations

September 28, 2012 (9:15 AM - 9:30 AM)

Co-authors: Daniel E. Holz
Using the observed rate of short-duration gamma-ray bursts (GRBs) it is possible to make predic- tions for the detectable rate of compact binary coalescences in gravitational-wave detectors. These estimates rely crucially on the growing consensus that short gamma-ray bursts are associated with the merger of two neutron stars or a neutron star and a black hole, but otherwise make no assump- tions beyond the observed rate of short GRBs. In particular, our results do not assume coincident gravitational wave and electromagnetic observations. We show that the non-detection of mergers in the existing LIGO/Virgo data constrains the progenitor masses and beaming angles of gamma-ray bursts (e.g., Î¸j > 4â—¦ for Mtotal â‰¥ 20MâŠ™, for uniform component mass), although these limits are fully consistent with existing expectations. We make predictions for the rate of events in future networks of gravitational-wave observatories, finding that the first detection of a NS-NS binary coalescence associated with the progenitors of short GRBs is likely to happen within the first 16 months of observation, even in the case of a modest network of observatories (e.g., only LIGO-Hanford and LIGO-Livingston) operating at modest sensitivities (e.g., advanced LIGO design sensitivity, but without signal recycling mirrors), and assuming a conservative distribution of beaming angles (e.g. all GRBs beamed with Î¸j = 30â—¦). Less conservative assumptions reduce the waiting time until first detection to a period of weeks to months. Alternatively, the compact binary coalescence model of short GRBs can be ruled out if a binary is not seen within the first two years of operation of a LIGO-Hanford, LIGO-Livingston, and Virgo network at advanced design sensitivity. We also demonstrate that the rate of GRB triggered sources is less than the rate of untriggered events if Î¸j ô•° 30â—¦, independent of the noise curve, network configuration, and observed GRB rate. Thus the first detection in GWs of a binary GRB progenitor is unlikely to be associated with the observation of a GRB.

6. **Ema Dimastrogiovanni**, UMNN
An estimator for statistical anisotropy from the CMB bispectrum

September 29, 2012 (11:00 AM - 11:15 AM)

Co-authors: N.Bartolo, M.Liguori, S.Matarrese, A.Riotto
Various data analysis of the Cosmic Microwave Background (CMB) radiation present anomalous features that can be interpreted as indications of statistical isotropy breaking. Some models of inflation involving vector fields predict statistical anisotropy in the correlation functions of primordial curvature perturbations. We employ a simplified vector field model and parametrize the bispectrum of curvature fluctuations in such a way that all the information about statistical anisotropy is encoded in some coefficients lambda_{LM} (representing the ratio of the anisotropic to the isotropic bispectrum amplitudes). We compute an optimal estimator for these coefficients and their Fisher error. We predict a sensitivity for an experiment like Planck to the anisotropic to isotropic amplitudes of about 10% if fNL is around 30. Our results are complementary to power spectrum analyses and particularly relevant for those models where statistical anisotropy is suppressed in the power spectrum and not negligible in the bispectrum.

7. **William Donnelly**, University of Waterloo
Entanglement entropy of gauge fields

September 29, 2012 (2:45 PM - 3:00 PM)

Co-authors: Aron Wall
For scalar and spinor fields, the one-loop correction to the Bekenstein-Hawking entropy is equal to the entanglement entropy. For gauge fields, the one-loop correction to the Bekenstein-Hawking entropy contains a negative divergent piece (a "contact term") that makes the entropy negative. This contact term has no known statistical interpretation. Most surprisingly, the divergence appears in two dimensions, where gauge fields have no local degrees of freedom. We show that in two dimensions the contact term results from an incorrect treatment of ghost zero modes. In a manifestly gauge-invariant reduced phase space quantization, the gauge field contribution to the Bekenstein-Hawking entropy is positive, finite, and equal to the entanglement entropy.

8. **Ariel Edery**, Bishop's University
Quantum corrections to the gravitationally coupled magnetic monopole: residual conformal symmetry and trace anomaly

September 29, 2012 (2:30 PM - 2:45 PM)

Co-authors: Noah Graham, Middlebury College
Spontaneous breaking of SU(2) gauge symmetry to U(1) that leads to the t'Hooft Polyakov monopole does not affect the symmetries of the Poincare group. If one now enlarges the symmetry group to the 15 parameter conformal group SO(2,4) by coupling the magnetic monopole to gravity, we show that spontaneous breaking of gauge symmetry yields a vacuum which is invariant only under a 14 parameter subgroup of the conformal group. In particular, dilatations (global scale invariance) is not broken. Quantum corrections introduce a length scale via the process of renormalization and yield the trace anomaly. An Einstein-Hilbert term or cosmological constant is barred from the original conformally invariant action and are not generated by the quantum fluctuations. However, both terms ultimately emerge due to spontaneous symmetry breaking.

9. **Justin Ellis**, University of Wisconsin Milwaukee
Gravitational Wave Searches in Pulsar Timing Data

September 28, 2012 (9:45 AM - 10:00 AM)

Co-authors: Xavier Siemens, Jolien Creighton
The Nanohertz Observatory for Gravitational Waves (NANOGrav) collaboration aims to detect gravitational waves (GWs) through the precise timing of millisecond pulsars. GWs will come in the form of a stochastic background, continuous sources and burst sources. Here we will review recent progress on the development of data analysis pipelines aimed at the detection of a stochastic background as well as continuous sources. We will introduce the Optimal Statistic and F-Statistic methods that are used in the stochastic and continuous pipelines, respectively. Both pipelines are fully functional on real pulsar timing data and take into account the timing models for each pulsar. Finally, we will present the efficacy of each pipeline on simulated data as well as present preliminary results on real data.

10. **Zachariah B. Etienne**, University of Illinois
General relativistic simulations of black hole-neutron star mergers: Effects of tilted magnetic fields

September 29, 2012 (9:30 AM - 9:45 PM)

Co-authors: Vasileios Paschalidis, Stuart L. Shapiro
Black hole--neutron star (BHNS) binary mergers can form disks in which magnetorotational instability (MRI)-induced turbulence may drive accretion onto the remnant BH, supporting relativistic jets and providing the engine for a short-hard gamma-ray burst (SGRB). Our earlier study of magnetized BHNSs showed that NS tidal disruption winds the magnetic field into a toroidal configuration, with poloidal fields so weak that capturing MRI with full-disk simulations would require $sim 10^8$ CPU-hours. In that study we imposed equatorial symmetry, suppressing poloidal magnetic fields that might be generated from plasma crossing the orbital plane. Here we show that initial conditions that break this symmetry (i.e., {it tilted} poloidal magnetic fields in the NS) generate much stronger poloidal fields in the disk, indicating that asymmetric initial conditions may be necessary for establishing BHNS mergers as SGRB progenitors via fully general relativistic MHD simulations. We demonstrate that BHNS mergers may form an SGRB engine under the right conditions by seeding the remnant disk from an unmagnetized BHNS simulation with purely poloidal fields dynamically unimportant initially, but strong enough to resolve MRI. Magnetic turbulence occurs in the disk, driving accretion and supporting Poynting-dominated jet outflows sufficent to power an SGRB.

11. **Matteo Fasiello**, Case Western Reserve University
The interplay of Stability Requirements and Observations in Massive Gravity

September 28, 2012 (4:00 PM - 4:15 PM)

Co-authors: A. J. Tolley
In de Sitter spacetime there exists an absolute minimum for the mass of a spin-2 field set by the Higuchi bound m2 â‰¥ 2H2. We generalize this bound to arbitrary spatially flat FRW geometries in the context of the recently proposed dRGT Massive Gravity with an FRW reference metric, by performing a Hamiltonian analysis for cosmological perturbations. We further generalize these results to Bigravity theories with generic matter content.

12. **John Friedman**, University of Wisconsin-Milwaukee
Update on the EMRI problem for a massive particle in a Kerr spacetime

September 28, 2012 (1:45 PM - 2:00 PM)

Co-authors: Abhay Shah
This talk reports on the current status of computations in a modified radiation gauge for a particle in circular orbit in a Kerr background. Recent results include comparisons with with post-Newtonian calculations and with a Lorenz-gauge EMRI calculation that finds agreement to within numerical accuracy for the change in angular velocity at fixed redshift (a quantity invariant under gauge transformations generated by gauge vectors respecting the helical symmetry of the perturbed spacetime).

13. **Caixia Gao**, University of Mississippi
On charged black holes in nonlinear ghost-free massive gravity

September 28, 2012 (4:30 PM - 4:45 PM)

Co-authors: Yi-Fu Cai, Damien A. Easson, Emmanuel N. Saridakis
We study the black hole solutions carrying a static electric charge in the frame of a nonlinear massive gravity model. In certain parameter space of $(alpha, beta)$, our result shows that below the Compton wavelength, the black hole solutions can be recovered to the usual Reissner-Nordstr"om ones via the Vainshtein mechanism in the weak field limit. In the simplest case with $alpha=beta=0$, the solution exhibits the vDVZ discontinuity but recovers to general relativity deeply inside the horizon due to the existence of a electric charge. In another case with $alphaneq0$ and $beta=0$, the post-Newtonian parameter of the charged black hole evolves to that of general relativity via the Vainshtein mechanism within a macroscopic distance, but a logarithmic correction to the metric factor of time coordinate is obtained. In a general parameter space with both $alpha$ and $beta$ being nonzero, there exist two branches of solutions depending on the positivity of $beta$. When $beta0$ the metric factors only exhibit small corrections to the solutions obtained in general relativity, and under a particular choice of $beta=alpha^2/6$ the standard Reissner-Nordstr"om-de Sitter solution can be reproduced.

14. **David Garfinkle**, Oakland University
Collapse of charged thick domain walls

September 29, 2012 (10:15 AM - 10:30 AM)

Co-authors: Tanmay Vachaspati, Ryan Zbikowski
Numerical simulations are performed of the gravitational collapse of thick, charged domain walls. We examine the limiting case where an extreme horizon is formed.

15. **Cristiano Germani**, Ludwig-Maximilians-University
High friction inflation

September 29, 2012 (11:15 AM - 11:30 AM)

In this talk I will point out that, contrary to the standard point of view, slow roll inflation is due to high gravitational friction. I will then argue that the requirement of slow roll coincides with the requirement of a flat scalar field potential in the case of minimally coupled scalar field. In this sense, the search for a successful inflationary theory may be more fruitful by shifting the focus on models with high gravitational friction. I will finally quickly review a gravitational mechanism, the so called "Gravitationally Enhanced Friction" mechanism, such that high gravitational friction is dynamically generated during inflation allowing even steep (i.e. non-flat) scalar potential to inflate.

16. **Davide Gerosa**, University of Mississippi
Spin Alignment Effects in Stellar Mass Black Hole Binaries

September 29, 2012 (10:00 AM - 10:15 AM)

Co-authors: Emanuele Berti, Michael Kesden, Ulrich Sperhake, Richard O'Shaughnessy
We use Monte Carlo simulations to investigate the spin alignment of stellar mass black hole binaries. Our simulations start at large separation, where the post-Newtonian (PN) approximation is valid. We follow the evolution of a statistical sample of binaries by numerically evolving the PN equations of motion. Stellar evolution calculations hint that black hole binary formation may favor configurations where either both spins have the same misalignment angle with respect to the orbital angular momentum, or one of the black hole spins is aligned with the orbital angular momentum by mass transfer events. We focus on these configurations to initialize our Monte Carlo simulations. Our goal is to understand if the existence of PN spin-orbit resonances, that was originally pointed out by Schnittman, can simplify the construction of matched-filtering templates in binary black hole data analysis.

17. **Roman Gold**, University of Illinois at Urbana-Champaign
Binary black hole mergers in magnetized disks: simulations in full general relativity

September 29, 2012 (9:45 AM - 10:00 AM)

Co-authors: Brian D. Farris, Vasileios Paschalidis, Zachariah B. Etienne, Stuart L. Shapiro
We present results from the first fully general relativistic, magnetohydrodynamic (GRMHD) simulations of an equal-mass black hole binary (BHBH) in a magnetized, circumbinary accretion disk. We simulate both the pre and post-decoupling phases of a BHBH-disk system and both "cooling" and "no-cooling" gas flows. Prior to decoupling, the competition between the binary tidal torques and the effective viscous torques due to MHD turbulence depletes the disk interior to the binary orbit. However, it also induces a two-stream accretion flow and mildly relativistic polar outflows from the BHs. Following decoupling, the accretion rate is reduced, while the EM luminosities peak near merger due to shock heating. This investigation, though preliminary, previews more detailed GRMHD simulations we plan to perform in anticipation of future, simultaneous detections of gravitational and electromagnetic radiation from a merging BHBH-disk system.

18. **Pierre Gratia**, University of Chicago
Cosmological constant from Massive Gravity

September 28, 2012 (4:45 PM - 5:00 PM)

Co-authors: Wayne Hu, Mark Wyman
In this talk, I will describe how a cosmological constant-type stress-energy tensor is obtained from an action that includes a massive graviton term. The result is valid for any isotropic distribution of matter, including static Schwarzschild-de Sitter, or dynamic FRW cosmologies, in accordance with our current knowledge of the cosmological expansion history of the Universe.

19. **Stephen R Green**, University of Guelph
Exact example of backreaction of small scale inhomogeneities in cosmology

September 28, 2012 (3:00 PM - 3:15 PM)

Co-authors: Robert M. Wald
We construct a one-parameter family of polarized vacuum Gowdy spacetimes on a torus. In the limit as the parameter N goes to infinity, the metric uniformly approaches a smooth "background metric". However, spacetime derivatives of the metric do not approach a limit. As a result, we find that the background metric itself is not a solution of the vacuum Einstein equation. Rather, it is a solution of the Einstein equation with an "effective stress-energy tensor", which is traceless and satisfies the weak energy condition. This is an explicit example of backreaction due to small scale inhomogeneities. We comment on the non-vacuum case, where we have proven in previous work that, provided the matter stress-energy tensor satisfies the weak energy condition, no additional backreaction is possible.

20. **Lavinia Heisenberg**, Case Western Reserve University
A Proxy for Massive Gravity

September 28, 2012 (4:15 PM - 4:30 PM)

Co-authors: Claudia de Rham
Massive gravity is an infrared modification of general ralativity. Recently it has been proposed a non-linear ghost-free massive theory of gravity (dRGT). The decoupling limit of the dRGT theory, and a Proxy Theory of massive gravity, its selfaccelerating and degravitating solution will be shortly discussed.

21. **Daniel Holz**, University of Chicago
Gravitational-waves and gamma-ray bursts

September 28, 2012 (9:00 AM - 9:15 AM)

Co-authors: Hsin-Yu Chen
We discuss what can be learnt from multi-messenger observations of gamma-ray bursts. In particular, we show that combined gravitational-wave and electromagnetic observations reveal the nature of the gamma-ray burst engine, measure the beaming angle of the gamma-rays, and potentially allow precision measurements of the Hubble constant.

22. **Shivaraj Kandhasamy**, University of Minnesota
Search for long gravitational-wave bursts and high-energy neutrino coincidences

September 28, 2012 (10:00 AM - 10:15 AM)

Gamma-ray bursts (GRBs) are predicted to be sources of both gravitational waves (GWs) and high energy neutrinos (HENs). The duration of gravitational waves from GRBs can vary from a few seconds to hundreds of seconds depending on the source mechanism. A coincident search for GWs and HENs can provide us useful information about GRB events, which are currently limited to photonic observations. Also such coincidences will improve the statistical confidence of observed GW candidates. I present here a new analysis method developed to look for such long duration (a few seconds to weeks) GWs in LIGO data using HEN triggers.

23. **Luke A Keltner**, Case Western Reserve University
Classicalization as Possible UV Completion

September 29, 2012 (12:15 PM - 12:30 PM)

Co-authors: Andrew Tolley
I will discuss the recently proposed Classicalization mechanism. I will present evidence that some models may UV complete themselves through this process.

24. **Eleni-Alexandra Kontou**, Tufts University
Averaged null energy condition in curved space

September 28, 2012 (2:45 PM - 3:00 PM)

Co-authors: Prof. Ken D. Olum, Tufts University
The achronal Averaged Null Energy Condition (ANEC) requires that the average along a complete achronal null geodesic of the projection of the stress-energy tensor onto the geodesic tangent vector can never be negative. It is sufficient to rule out many exotic phenomena in general relativity such as time travel. We show that ANEC cannot be violated by a quantized minimally coupled free scalar field along an achronal null geodesic surrounded by a tubular neighborhood with bounded curvature. To do that we generalize the Quantum Null Energy Inequality (QNEI) to apply in a spacetime with small curvature.

25. **Carlos O Lousto**, Rochester Institute of Technology
Exploring the outer limits of Numerical Relativity

September 29, 2012 (9:00 AM - 9:15 AM)

Co-authors: Yosef Zlochower
We perform a first exploration of black-hole binary evolutions using full nonlinear numerical relativity techniques at separations large enough that low-order post-Newtonian expansions are expected to be extremely accurate. As a case study, we evolve an equal-mass nonspinning black-hole binary in a quasicircular orbit at an initial separation of r=100M. The measured the orbital period of the binary and find T=6422M. We perform convergent simulations at three different grid resolutions and complete two, one and a half, and one orbits for the low, medium and high resolutions, respectively. The orbital motion agrees with post-Newtonian predictions to within 1%. We discuss on how to improve this accuracy in future simulations. The results are relevant for the generation of long-term waveforms for detection and analysis in the next generation gravitational wave detectors.

26. **Andrew A Matas**, Case Western Reserve University
Galileon radiation from binary pulsars

September 28, 2012 (5:00 PM - 5:15 PM)

Co-authors: Claudia de Rham, Andrew Tolley
We compute the radiation in Galileon modes from binary pulsars as a check of the Vainshtein mechanism in time dependent situations.

27. **George E. A. Matsas**, Instituto de Fisica Teorica (Sao Paulo - Brazil)
Particle creation due to tachyonic instability in relativistic stars

September 29, 2012 (2:15 PM - 2:30 PM)

Co-authors: A. G. S. Landulfo, W. C. C. Lima, D. A. T. Vanzella
Dense enough compact objects were recently shown to lead to an exponentially fast increase of the vacuum energy density for some free scalar fields properly coupled to the spacetime curvature as a consequence of a tachyonic-like instability. Once the effect is triggered, the star energy density would be overwhelmed by the vacuum energy density in a few milliseconds. This demands that eventually geometry and field evolve to a new configuration to bring the vacuum back to a stationary regime. Here, we show that the vacuum fluctuations built up during the unstable epoch lead to particle creation in the final stationary state when the tachyonic instability ceases. The amount of created particles depends mostly on the duration of the unstable epoch and final stationary configuration, which are open issues at this point. We emphasize that the particle creation coming from the tachyonic instability will occur even in the adiabatic limit, where the spacetime geometry changes arbitrarily slowly, and therefore is quite distinct from the usual particle creation due to the change in the background geometry. (arXiv:1204.3654v2)

28. **Lee McCuller**, University of Chicago
Interferometer Instrumentation on the Fermilab Holometer

September 28, 2012 (10:15 AM - 10:30 AM)

The Holometer is a pair of 40m power-recycled Michelson interferometers designed for sensitivity to high-frequency length fluctuations. This talk will detail the design and operation of long-baseline interferometers as applied to the holometer, with explanations of parallels to gravity-wave interferometry.

29. **Richard O'Shaughnessy**, University of Wisconsin-Milwaukee
Precession during merger: Strong polarization changes are observationally accessible features of strong-field gravity during binary black hole merger

September 28, 2012 (11:45 AM - 12:00 PM)

Co-authors: J. Healy, L. London, and D. Shoemaker
The short gravitational wave signal from the merger of compact binaries encodes a surprising amount of information about the strong-field dynamics of merger into frequencies accessible to ground-based interferometers. In this talk we interpret the inspiral, merger, and ringdown signal as "precession" of the peak emission direction with time, about the total angular momentum direction. We demonstrate the gravitational wave polarization encodes this time-dependent orientation in an observationally accessible way, both prior to and after merger.

30. **Evan L Ochsner**, University of Wisconsin-Milwaukee
Gravitational waves from BH-NS binaries: Effective Fisher matrices and parameter estimation using higher-harmonics

September 28, 2012 (11:15 AM - 11:30 AM)

Co-authors: Hee-Suk Cho, Richard O'Shaughnessy, Chunglee Kim, Chang-hwan Lee
This talk will introduce a new effective Fisher matrix approach to estimating the accuracies with which the parameters of a gravitational wave signal can be measured. This approach is then applied to gravitational waves emitted from black hole neutron star binaries. We use waveforms with and without spins, precession and amplitude corrections to understand how each of these effects can change the expected parameter accuracies.

31. **Vasileios Paschalidis**, University of Illinois at Urbana-Champaign
Importance of cooling in triggering the collapse of hypermassive neutron stars

September 29, 2012 (9:15 AM - 9:30 AM)

Co-authors: Zachariah B. Etienne, Stuart L. Shapiro
The inspiral and merger of a binary neutron star (NSNS) can lead to the formation of a hypermassive neutron star (HMNS). As the HMNS loses thermal pressure due to neutrino cooling and/or centrifugal support due to gravitational wave (GW) emission, and/or magnetic breaking of differential rotation it will collapse to a black hole. To assess the importance of shock-induced thermal pressure and cooling, we adopt an idealized equation of state and perform NSNS simulations in full GR through late inspiral, merger, and HMNS formation, accounting for cooling. We show that thermal pressure contributes significantly to the support of the HMNS against collapse and that thermal cooling accelerates its "delayed" collapse. Our simulations demonstrate explicitly that cooling can induce the catastrophic collapse of a hot hypermassive neutron star formed following the merger of binary neutron stars. Thus, cooling physics is important to include in NSNS merger calculations to accurately determine the lifetime of the HMNS remnant and to extract information about the NS equation of state, cooling mechanisms, bar instabilities and B-fields from the GWs emitted during the transient phase prior to BH formation.

32. **Nikodem Poplawski**, Indiana University
Nonsingular big-bounce cosmology from spin and torsion

September 29, 2012 (11:45 AM - 12:00 PM)

The Einstein-Cartan-Sciama-Kibble theory of gravity naturally extends general relativity to include matter with intrinsic spin by not requiring the affine connection to be symmetric and regarding its antisymmetric part, the torsion tensor, as a dynamical variable. The minimal coupling between torsion and Dirac spinors generates a spin-spin interaction which is significant in fermionic matter at extremely high densities. We show that such an interaction removes the unphysical big-bang singularity, replacing it with a cusp-like bounce at a finite minimum scale factor, before which the Universe was contracting. This scenario also explains why the observable Universe at largest scales appears spatially flat, homogeneous and isotropic, without needing cosmic inflation.

33. **Kartik Prabhu**, University of Chicago
Gauge Conditions and Black hole Stability

September 28, 2012 (2:15 PM - 2:30 PM)

Co-authors: Robert Wald (U. Chicago), Stefan Hollands (University of Cardiff)
Hollands and Wald showed that dynamic stability of a black hole is equivalent to the positivity of canonical energy on a space of linearised perturbations satisfying certain boundary conditions and gauge conditions. The boundary/gauge conditions are naturally formulated on the space of initial data for the perturbations in terms of orthogonality to gauge transformations. These perturbations can be uniquely specified in terms of transverse-traceless tensors. Using these transverse-traceless data, positivity of kinetic energy for perturbations can be proven.

34. **Carl L Rodriguez**, Northwestern University
Inadequacies of the Fisher Information Matrix in gravitational-wave parameter estimation

September 28, 2012 (11:30 AM - 11:45 AM)

Co-authors: Ilya Mandel, Benjamin Farr
For several years, the "first-order" approximation of parameter estimation capabilities for gravitational-wave detectors has been the Fisher Information Matrix (FIM) due to its ease-of-use and rapid computation time. While the theoretical failings of this method (such as the high signal-to-noise ratio (SNR) limit and Gaussian-only priors and posteriors) are well understood, the practical effectiveness compared to a real parameter estimation technique (e.g. Markov-Chain Monte Carlo) remains an open question. We present a direct comparison between the FIM error estimates and the Bayesian probability density functions produced by the parameter estimation code, LALInferenceMCMC. In addition to the low-SNR issues usually considered, we found that the FIM can greatly overestimate the standard deviations achievable by the MCMC. This was found to be a systematic effect for higher mass systems, with the disagreement increasing proportionally to total mass. In some cases, the MCMC search returned standard deviations smaller by several orders of magnitude. We conclude, to no great surprise, that the predictions returned by the FIM do not represent the capabilities of real parameter estimation techniques.

35. **Ko Sanders**, University of Chicago
Topological effects in linear gauge theories

September 29, 2012 (3:00 PM - 3:15 PM)

Co-authors: Claudio Dappiaggi, Thomas-Paul Hack (in preparation)
Linear field theories with a gauge freedom, such as linearised GR or electromagnetism, often display non-local, topological effects. Prime examples are Gauss' law and the Aharonov-Bohm effect in electromagnetism. Such topological effects are reflected in the Poisson bracket and therefore also in the quantised theory. For the example of electromagnetism we explain how a detailed study of the Poisson bracket in spacetimes with arbitrary topology leads to the apparently new insight that the Aharonov-Bohm effect and Gauss' law are intimately connected. The analysis also leads to a new understanding of electric monopoles.

36. **Joshua S. Schiffrin**, University of Chicago
Dynamical and Thermodynamic Stability of Perfect Fluid Stars

September 28, 2012 (2:00 PM - 2:15 PM)

Co-authors: Stephen R. Green, Robert M. Wald
We explore the stability of stationary axissymmetric perfect fluid configurations to axissymmetric perturbations in general relativity. We consider the class of perturbations which to first order do not change the baryon number density 3-form, the entropy per baryon, and the angular momentum per baryon. We show that the condition for dynamical stability with respect to such perturbations is equivalent to positivity of the canonical energy. Furthermore, we show that the canonical energy for such perturbations is equal to the usual thermodynamic expression whose positivity in the case of thermodynamic equilibrium would determine thermodynamic stability.

37. **Andrew Tolley**, Case Western Reserve University
Progress in Massive Gravity

September 28, 2012 (3:45 PM - 4:00 PM)

I will discuss the recent developments in massive gravity, and review work on obtaining cosmological solutions

38. **Amol Upadhye**, Argonne National Laboratory
Dark energy fifth forces in torsion pendulum experiments

September 29, 2012 (2:00 PM - 2:15 PM)

Chameleon dark energy and f(R) modified gravity screen their fifth forces by becoming massive in high-density environments. Nevertheless, laboratory searches for the residual fifth forces in such screened models provide powerful constraints. I will discuss constraints from torsion pendulum experiments such as Eot-Wash. Current experiments are on the verge of excluding chameleons with quantum-stable potentials, in which quantum corrections to the chameleon field and mass are subdominant to their tree-level values. I will show that upcoming experiments will exclude a wide range of quantum-stable models with gravitation-strength couplings.

39. **Alexander L Urban**, University of Wisconsin - Milwaukee
Causal structure of black hole interiors in spherical symmetry

September 28, 2012 (2:30 PM - 2:45 PM)

Co-authors: Patrick R Brady
We use a toy model of black holes to numerically probe the interior and study its causal structure. Of particular interest is the formation of a weak null singularity on the Cauchy horizon, which contracts to zero radius and intersects a crushing, spacelike central singularity. Our model is similar to the one in Brady & Smith (1995), with a scalar field incident on the event horizon of a charged, spherically symmetric black hole. The scalar field scatters off the internal geometry and builds up on the Cauchy horizon, inducing a mass-inflation singularity as first elucidated by Poisson & Israel. We also derive and numerically integrate evolution equations for timelike geodesics, as well as the radial and transverse tidal deformation of material bodies whose center of mass freely falls along these geodesics. Finally, we briefly indicate the extent to which these results anticipate the structure in rotating spacetimes.

40. **Leslie E Wade**, University of Wisconsin - Milwaukee
Studying the Effects of Tidal Corrections on Parameter Estimation

September 28, 2012 (12:00 PM - 12:15 PM)

Co-authors: Jolien Creighton, Benjamin Lackey, Evan Ochsner
Tidal deformations of neutron stars in binary systems during the in fall of gravitationally radiating neutron stars before merger call for analytic corrections to the post-Newtonian gravitational-wave waveform. Tidal deformation information is important to searches for gravitational waves from these sources because they can break degeneracies in the estimation of the physical parameters of the binary and could also lead to insights about the neutron stars' equation of state. We will outline plans to use a Bayesian MCMC (Markov Chain Monte Carlo) simulation to study how these corrections affect and inform parameter estimation for binaries involving neutron stars.

41. **Madeline Wade**, UW-Milwaukee
Sub-Solar Mass Black Hole Search in S5 Initial LIGO Data

September 28, 2012 (11:00 AM - 11:15 AM)

Co-authors: Chad Hanna, Kipp Cannon, Drew Keppel, Jolien Creighton
We have been developing a search pipeline to search for sub-solar mass black hole candidates in data from Initial LIGO's fifth science run (S5). The sub-solar mass region of parameter space has not yet been searched in this data. While we are not hopeful in finding sub-solar mass black hole candidates, the development of this search pipeline has an alternate motivation as a test of Advanced LIGO technologies. The search pipeline has been developed in gstlal and will demonstrate our capability to detect long signals with a low latency. The length and number of templates used in the sub-solar mass search of Initial LIGO data is comparable to compact binary coalescence searches in promising regions of parameter space in the Advanced LIGO era.

42. **Robert Wald**, University of Chicago
Negative Canonical Energy and Exponential Growth Instabilities

September 29, 2012 (3:30 PM - 3:45 PM)

For axisymmetric perturbations of black holes, the canonical energy can be shown to have a positive flux at infinity and at the horizon. The canonical energy can also be shown to vanish for stationary perturbations with vanishing perturbed mass and angular momentum. One may thereby argue that if a perturbation with vanishing perturbed mass and angular momentum has negative canonical energy, it must correspond to an instability, since it cannot decay or "settle down" to another stationary final state. However, one would like to prove a stronger result for such perturbations: They should correspond to exponential growth in time. I discuss the ingredients needed to prove this stronger result.

43. **Shouhong Wang**, Indiana University
Gravitational Field Equations and Unified Theory of Dark Matter and Dark Energy

September 29, 2012 (12:00 PM - 12:15 PM)

Co-authors: Tian Ma

The aim of this research report is to derive a unified theory for dark matter and dark energy. Due to the presence of dark energy and dark matter, we postulate that the energy-momentum tensor of the normal matter is no longer conserved. With this postulate, we derive new gravitational field equations, with an addition of second-order covariant derivative of a scalar potential field. Consequently, gravity theory is fundamentally changed: gravity is now described by the metric of curved space-time, the new scalar potential field and their interactions. Associated with this new scalar field is the scalar potential energy density, which represents a new type of energy/force caused by the non-uniform distribution of matter in the universe. This energy density consists of both positive (repelling) and negative (attracting) energies. The repelling force is fundamentally different from the known four forces. More importantly, this new energy and the new field equations give rise to a unified theory for dark energy and dark matter. Dark matter and dark energy are now represented by the sum of the new scalar potential energy density and the coupling energy between the energy-momentum tensor and the scalar potential field: Negative sum represents dark matter, and positive sum represents dark energy.