ICGA7

VII Asia-Pacific International Conference on Gravitation and Astrophysics

on the Occasion of the 90th Year of General Relativity

November 23 - 26, 2005

National Central University Chungli, Taiwan

(http://www.phy.ncu.edu.tw/gravity/ICGA7/)

Program and Abstracts

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This series of conferences has been aimed especially to serve the growing needs of the workers in this research area in the Asia-Pacific region although of course people from other regions are most welcome to participate. The previous conferences of this series, with a growing number of local, regional and international participants, were held in Seoul, Korea (1993), Hsinchu, Taiwan (1995), Tokyo, Japan (1997), Beijing, China (1999), Moscow, Russia (2001), and Seoul, Korea (2003). 2005 is an auspicious year: not only is it an International Year of Physics commemorating Einstein's great achievements of 1905 it also is the anniversary of Einstein's development of his gravity theory, General Relativity. He submitted the final form of his field equations on 25 November, 1915. 90 years later we wish to have an appropriate event marking this anniversary.

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Roh-Suan Tung (Shanghai Normal U.)
Hwei-Jang Yo (Cheng-Kung U.)
Hoi-Lai Yu (Academia Sinica)

ICGA7 - Time Table

	23 (Wed)	24 (Thu)	25 (Fri)	26 (Sat)
09:00-09:30	Misner	Gal'tsov	Page	Isenberg
09:30-10:00	Frolov	K. Maeda	Starobinsky	Y.K. Lau
10:00-10:30	Y.M. Cho	Mann	Melnikov	J.H. Yoon
10:30-11:00	*break*	*break*	*break*	*break*
11:00-11:30	S.W. Kim	Lindblom	H.J. Paik	Triay
11:30-12:00	S.P. Kim	Hayward	J. Luo	Y. Ling
12:00-12:30	Morikawa	C.G. Huang	C.M. Xu	L. Liu
12:30-14:00	*Lunch*	*Lunch* (Photo)	*Lunch*	*Lunch* (IOC)
14:00-14:30	B. L. Hu	*Contributed Talks*	*Excursion* (13:00 - 18:00)	*Contributed Talks*
14:30-15:00	Ford			
15:00-15:30	Kenmoku			
15:30-16:00	*break*			
16:00-16:30	Nester			
16:30-17:00	R.S. Tung			
17:00-17:30	R.X. Xu			
19:00-21:00		**Banquet**	**Public Talk** (19:30-21:00) Lindblom	

Contributed Talks

	24 (Thu)	26 (Sat)
14:00-14:20	H. Maeda	Harada
14:20-14:40	J.A. Gu	Narita
14:40-15:00	S. Lee	L.L. So
15:00-15:20	Miyamoto	C.M. Chen
15:20-15:40	H.L. Yu	H.J. Yo
15:40-16:00	C. Soo	Y. Tian
16:00-16:20	*break*	*break*
16:20-16:40	W. Chen	Y.Y. Keum
16:40-17:00	J.P. Hsu	Z.H. Zhu
17:00-17:20	S.Y. Lin	J.H. Fan
17:20-17:40	H.W. Yu	Y.F. Yuan
17:40-18:00	S.H. Fan	Z.Q. Luo
18:00-18:20		X.J. Wu

ICGA7-Program

November 23, 2005 (Wednesday)

8:00-9:00 Registration

8:40-9:00 Opening

Morning Session I 9:00-10:30 (Chair: Kim, Sung-Won)

9:00-9:30 Misner, Charles (University of Maryland)
Over the rainbow: Numerical algorithms that defend the physical domain from errors in 'Oz' (beyond Scri+)

9:30-10:00 Frolov, Valeri P. (University of Alberta)
Formation and evaporation of regular black holes

10:00-10:30 Cho, Yong-Min (Seoul National University)
Reparametrization of general relativity

10:30-11:00 Coffee Break

Morning Session II 11:00-12:30 (Chair: Melnikov, Vitaly N.)

11:00-11:30 Kim, Sung-Won (Ewha Woman's University)
1. Accelerating cosmological model with wormhole
2. Introduction to COREA (Cosmic ray Research and Education Array in Korea) project

11:30-12:00 Kim, Sang-Pyo (Kunsan National University)
Thermalization in the Inflationary Universe

12:00-12:30 Morikawa, Masahiro (Ochanomizu University)
Cosmic Bose Einstein Condensation - induced inflation and early formation of black holes

12:30-14:00 Lunch

Afternoon Session I 14:00-15:30 (Chair: Gal'tsov, Dmitry V.)

14:00-14:30 Hu, Bei-Lok (University of Maryland)
Black Hole Fluctuations and Backreaction

14:30-15:00 Ford, Larry (Tufts University)
Signatures of Spacetime Geometry Fluctuations

15:00-15:30 Kenmoku, Masakatsu (Nara Woman University)
Scalar Field Contribution to Rotating Black Hole Entropy

15:30-16:00 Coffee Break

Afternoon Session II 16:00-17:30 (Chair: Cho, Yong-Min)

16:00-16:30 Nester, James M (National Central University)
The Hamiltonian boundary term

16:30-17:00 Tung, Roh-Suan (Shanghai Normal University)
Dynamical Untrapped Hypersurfaces

17:00-17:30 Xu, Ren-Xin (Peking University)
To probe into pulsar's interior through gravitational waves

November 24, 2005 (Thursday)

Morning Session I 9:00-10:30 (Chair: Hu, Bei-Lok)

9:00-9:30 Gal'tsov, Dmitry V. (Moscow State University)
Radiation reaction in general relativity and string theory

9:30-10:00 Maeda, Kei-ichi (Waseda University)
Stationary Spacetime with Intersecting Branes in M/superstring theory

10:00-10:30 Mann, Robert (University of Waterloo)
Alice falls into a black hole: Entanglement in non-inertial frames

10:30-11:00 Coffee Break

Morning Session II 11:00-12:30 (Chair: Lau, Yun-Kau)

11:00-11:30 Lindblom, Lee (California Institute of Technology)
A New Generalized Harmonic Evolution System

11:30-12:00 Hayward, Sean (Pennsylvania State University)
Formation and evaporation of regular black holes

12:00-12:30 Huang, Chao-Guang (Chinese Academy of Sciences, Beijing)
De Sitter invariant special relativity

12:30-14:00 Lunch & **Group Photo**

Afternoon Session I 14:00-15:40 (Chair: Luo, Jun)

14:00-14:20 Maeda, Hideki (Waseda University)
Quasi-local mass and the final fate of gravitational collapse in Gauss- Bonnet gravity

14:20-14:40 Gu, Je-An (National Taiwan University)
Inhomogeneity-Induced Cosmic Acceleration in a Dust Universe

14:40-15:00 Lee, Seokcheon (Academia Sinica, Taiwan)
Coupled Quintessence and CMB

15:00-15:20 Miyamoto, Umpei (Waseda University)
On non-uniform charged black branes

15:20-15:40 Yu, Hoi-Lai (Academia Sinica, Taiwan)
The orgin of the Immirzi parameter

15:40-16:00 Soo, Chopin (National Cheng Kung University)
Simplification of the constraints of 4-dimensional gravity

16:00-16:20 Coffee Break

Afternoon Session II 16:00-18:00 (Chair: Page, Don N.)

16:20-16:40 Chen, Wenfeng (National Center of Theoretical Sciences, Taiwan)
2+1-dimensional Quantum Gravity as Chern-Simons Gauge Theory with Global Gravitational Anomaly

16:40-17:00 [1] Hsu, Jong-Ping (University of Massachusetts Dartmouth)
Cosmic Lee-Yang Force of Gauge Fields and Dark Energy

17:00-17:20 Lin, Shih-Yuin, (Academia Sinica, Taiwan)
Uniformly Accelerated Detectors in (3+1)D Spacetime: From Vacuum Fluctuation to Radiation Flux

17:20-17:40 Yu, Hong-Wei (Hunan Normal University)
Vacuum fluctuations and Brownian motion of test particles

17:40-18:00 Fan, Shu-Hua (Huazhong University of Science and Technology, Wuhan)
Progress in test Newtonian inverse-square law in submillimeter range

Banquet 19:00-21:00

November 25, 2005 (Friday)

Morning Session I 9:00-10:30 (Chair: Ng, Kin-Wang)

9:00-9:30 Page, Don N. (University of Alberta)
No Astrophysical Dyadospheres

9:30-10:00 Starobinsky, Alexi A. (Landau Institute)
The primordial perturbation spectrum

[1] Presented by Chen, Wenfeng.

10:00-10:30 Melnikov, Vitaly N. (Center for Gravitation and Fundamental Metrology)
Integrable Cosmological Models in DD and Variations of Fundamental Constants

10:30-11:00 Coffee Break

Morning Session II 11:00-12:30 (Chair: Mann, Robert)

11:00-11:30 Paik, Ho-Jung (University of Maryland)
Probing extra dimensions using a superconducting accelerometer

11:30-12:00 Luo, Jun (Huazhong University of Science and Technology, Wuhan)
Progress in measuring Newtonian gravitational constant G

12:00-12:30 Xu, Chong-Ming (Nanjing Normal University)
The Third Cloud over General Relativity - Anomalous Acceleration of Pioneer 10 and 11 and its Possible Explanation

12:30-13:00 Lunch Bag

Excursion 13:00-18:00

Public talk

19:30-21:00 Lindblom, Lee (California Institute of Technology)
Gravitational wave astronomy

November 26, 2005 (Saturday)

Morning Session I 9:00-10:30 (Chair: Ford, Larry)

9:00-9:30 Isenberg, James (University of Oregon)
Initial Data Engineering

9:30-10:00 Lau, Yun-Kau (Chinese Academy of Sciences, Beijing)
Bondi Sachs Formulation of Kerr Metric

10:00-10:30 Yoon, Jong-Hyuk (Konkuk University)
Geometric conditions for purely in- or out-going gravitational fluxes

10:30-11:00 Coffee Break

Morning Session II 11:00-12:30 (Chair: Kenmoku, Masakatsu)

11:00-11:30 Triay, Roland (Université de Provence and Centre de Physique Théorique, CNRS)
On the Cosmological Constant Problem

11:30-12:00 Ling, Yi (Nanchang University)
Modified dispersion relations and black hole physics

12:00-12:30 Liu, Liao (Beijing Normal University)
A Way to Quantize the Schwarzschild Black Hole

12:30-14:00 Lunch & **Meeting of IOC**

Afternoon Session I 14:00-15:40 (Chair: Frolov, Valeri P.)

14:00-14:20 Harada, Tomohiro (Kyoto University)
Growth of primordial black holes

14:20-14:40 Narita, Makoto (National Central University)
Wave maps on black holes in any dimensions

14:40-15:00 So, Lau-Loi (National Central University)
Classical pseudotensors and positive energy in small regions

15:00-15:20 Chen, Chiang-Mei (National Central University)
Quasilocal energy flux

15:20-15:40 Yo, Hwei-Jang (National Cheng Kung University)
Improved numerical stability of rapid-spinning black hole evolution

15:40-16:00 Tian, Yong (Army Armor School, Taiwan)
Theoretical Aspects of Gravitational Lensing in TeVeS

16:00-16:20 Coffee Break

Afternoon Session II 16:00-18:20 (Chair: Triay, Roland)

16:20-16:40 Keum, Yong-Yeon (National Taiwan University)
Cosmic connection between neutrinos and dark energy

16:40-17:00 Zhu, Zong-Hong (Beijing Normal University)
Observational constraints on cosmology from modified Friedmann equation

17:00-17:20 Fan, Jun-Hui (Guangzhou University)
The determination of central black hole masses for blazars

17:20-17:40 Yuan, Ye-Fei (USTC, Hefei)
Does the Event Horizon of Black Holes Exist?

17:40-18:00 Luo, Zhi-Quan (Xihua Normal University)
To be announced

18:00-18:20 Wu, Xue-Jun (Nanjing Normal University)
General Formula for Comparison of Clock Rates - Applications to Cosmos and Solar System

Posters

Ivanov, Michael (Belarus State University)
Low-energy quantum gravity

ICGA7-Abstracts

November 23, 2005 (Wednesday)

Over the rainbow: Numerical algorithms that defend the physical domain from errors in 'Oz' (beyond Scri+)

Charles W. Misner

University of Maryland, USA

J. van Meter

NASA Goddard Space Flight Center, USA

D. R. Fiske

Decisive Analytics Corporation and NASA Goddard Space Flight Center, USA

This is a study of the behavior of wave equations in conformally compactified spacetimes suited to the use of computational boundaries beyond Scri+. There light cones may be adjusted for computational convenience and/or Scri+ may be approximated by a "proto-Scri" spacelike hypersurface just outside a de Sitter horizon. Our preliminary numerical implementation excises the physically unnecessary universe somewhat beyond this outer horizon. As an entry level example we study a formulation of the Maxwell equations and causal relations for an outer boundary in that example. We find that an initial central pulse propagates to and through proto-Scri in an (hyperboloidal) coordinate time comparable to the pulse width, and that the numerical evolution remains stable for several times that long. This is a proposal for outer boundary conditions and wave extraction in numerical relativity for which further tests and development would be needed prior to an implementation in full GR.

Gravitational Field of Relativistic Gyratons

Valeri Frolov

University of Albert, Canada

We describe solutions of the Einstein equations for the gravitational field created by a beam-pulse of spinning radiation (gyraton) in a D-dimensional spacetime. First we demonstrate that these metrics belong to the class of metrics for which all scalar invariants constructed from the curvature and its covariant derivatives vanish. Next, we show that the vacuum Einstein equations for a gyraton reduce a linear problem in (D-2)-dimensional Euclidean space. We obtain gyraton-type solutions of the vacuum Einstein equations and discuss their properties. We also discuss generalizations of the gyraton metrics to the case when a gyraton is charges or it is moving in the asymptotically AdS spacetime.

Reparametrization of general relativity

Yong-Min Cho and S.W. Kim

Seoul National University, Korea

We present a new formalism of Einstein's theory of gravitation. Interpreting the gravitation as a gauge theory of Lorentz group we decompose the metric connection to the restricted part and the gauge covariant part, using the Abelian decomposition of non-Abelian gauge theory. We consider three different decompositions corresponding to three subgroups of Lorentz group, A_2, B_2, and $SU(2)$, and discuss the resulting theories of gravitation.

1. Accelerating cosmological model with wormhole 2. Introduction to COREA (Cosmic ray Research and Education Array in Korea) project

Sung-Won Kim

Ewha Womans University, Korea

1. In this talk, we study the accelerating cosmological model with a static traversable wormhole. In this model, the phantom energy is considered as the engine of the acceleration of the universe. In is shown that the time to 'Big Rip' by phantom energy will be delayed with sufficient wormhole distribution.
2. In this talk, the new school array project, entitled Cosmic ray Research and Education Array in Korea will be introduced. COREA is a unique project of detection of high energy cosmic ray with students, teachers, and professors in Korea.

Thermalization in the Inflationary Universe

Sang-Pyo Kim

Kunsan National University, Korea

Inflation scenario is the most successful model of the Universe. Recently WMAP and SDSS have confirmed that our universe would have undergone an inflation period and further a sequence of phase transitions in accord with particle physics. Most of inflation scenarios assume that our universe started from the vacuum state or some quantum state. In chaotic inflation the Universe expanded quasi-exponentially due to quantum fluctuations of the inflaton around the vacuum state. However, there still remains the mechanism for thermalization in the inflationary universe not completely resolved. The equation of state of matter, when dated back to the past, would be a hot thermal state of Big Bang scenario. Therefore there should be mechanisms, preheating or reheating, for thermalization of the inflaton or matter fields during or after the inflation epoch and the subsequent phase transitions. In this talk, I shall critically review inflation scenarios from the viewpoint of thermalization.

Cosmic Bose Einstein Condensation - induced inflation and early formation of black holes

Masahiro Morikawa

Ochanomizu University, Japan

We construct a cosmological model based on the Bose-Einstein Condensation, in which both Dark Energy and Dark Matter are naturally unified. Global cosmic acceleration caused by this BEC and multiple rapid collapses of BEC into black holes etc. are examined based on the relativistic version of the Gross-Pitaevskii equation. We propose (a) a novel mechanism of inflation free from the slow-rolling condition, (b) a natural solution for the cosmic coincidence problem through the transition from DE into DM, (c) very early formation of highly non-linear objects such as black holes, which might trigger the first light as a form of quasars, and (d) log-z periodicity in the subsequent BEC collapsing time. All of these are based on the steady slow BEC process. Some detail is in astro-ph/0509789.

Black Hole Fluctuations and Backreaction

Bei-Lok Hu

University of Maryland, USA

I give an update of our research program (with Albert Roura) on these two issues in two classes of problems: the quasi-equilibrium case of a black hole in a box and the non-equilibrium case of an evaporating black hole. In the former case the physical result is expected to be a simple shift in the Hawking temperature (same as obtained by York et al earlier). But our analysis based on stochastic gravity can provide a susceptibility function and the fluctuations spectrum for the black hole under this condition. In the latter case mainly qualitative arguments are presented in the literature, some even with conflicting results (e.g., Bekensteins versus Fords claims on the magnitude of horizon fluctuations). In contrast we provide a new platform based on the Einstein-Langevin equation which can yield quantitative results. We show that an important assumption made in many previous analyses relating the mean incoming flux near the horizon to the outgoing flux at infinity may not be valid for stochastic sources. This casts doubt on all earlier claims which make use of this assumption. The main points in our approach are outlined.

Signatures of Spacetime Geometry Fluctuations

Larry Ford

Tufts University, USA

The operational meaning of quantum fluctuations of spacetime geometry will be discussed. Three potential signatures of these fluctuations will be considered: luminosity fluctuations of a distant source, angular blurring of images, and broadening of spectral lines. Luminosity fluctuations arise only from passive geometry fluctuations, those driven by quantum fluctuations of the stress tensor. This effect can be described by a Langevin version of the Raychaudhuri equation. Angular blurring and line broadening can arise both from passive fluctuations and from the active fluctuations of the quantized gravitational field, and can be given a unified geometrical description using the Riemann tensor correlation function.

Scalar Field Contribution to Rotating Black Hole Entropy

Masakatsu Kenmoku

Nara Women's University, Japan

Scalar field contribution to entropy is studied in arbitrary D dimensional rotating spacetime by semiclassical method. By introducing the zenithal angle dependent cutoff parameter, the generalized area law is derived. The non-rotating limit can be taken smoothly and it yields known results. The derived area law is then applied to the Banados-Teitelboim-Zanelli (BTZ) black hole in (2+1) dimension and the Kerr-Newman black hole in (3+1) dimension. The generalized area law is reconfirmed by the Euclidean path integral method for the quantized scalar field. The scalar field mass contribution is discussed briefly.

The Hamiltonian boundary term

James M. Nester

National Central University, Taiwan

The Hamiltonian for a gravitating region necessarily includes a boundary term. Its role is to determine the quasi-local values and, via the vanishing of the boundary term in the variation of the Hamiltonian (required, as noted by Regge and Teitelboim, for a well defined Hamiltonian), the boundary conditions. With this boundary variation principle, the Hamiltonian formalism tames the ambiguities inherent in the traditional approaches to the (quasi-)localization of energy-momentum. Using our covariant Hamiltonian formalism we identified special boundary terms associated with particular physical boundary conditions. In the radiating regime we note that the Hamiltonian fails to be "well defined". This leads to a new energy flux expression. We report here on our new results for homogeneous cosmologies, the small region limit, and positivity. Although there are an infinite number of possible choices for the boundary term (reflecting the many choices for the boundary conditions and reference) we find that one expression is distinguished; it should be suitable for most applications.

Dynamical Untrapped Hypersurfaces

Roh-Suan Tung

Shanghai Normal University, China

Dynamical Untrapped Hypersurfaces are smooth three-dimensional timelike submanifolds of spacetime which can be foliated by a family of closed 2-manifolds S, such that the expansion of each leaf S along the expansion vector is positive (i.e. they are untrapped, mean convex surfaces). For each leaf S of a Dynamical Untrapped Hypersurface, the dual expansion vector is always timelike, and is the direction of zero expansion. Thus if the dual expansion vector is tangent to the Dynamical Untrapped Hypersurface, it is called a Stationary Untrapped Hypersurface. The dual expansion vector plays the role for Stationary Untrapped Hypersurfaces, which the stationary Killing vector plays for stationary black holes. For evolution along the region bounded by a Stationary Untrapped Hypersurface, the Hamiltonian (associated with a spacelike hypersurface spanning S) is well-defined. Thus the total energy-momentum for the region can be defined and is conserved. For evolution along the region bounded by a Dynamical Untrapped Hypersurface, there does not in general exist a Hamiltonian, but a gravitational radiation energy flux can be obtained. The boundary conditions for Stationary and Dynamical Untrapped Hypersurfaces reduce to the ones given by Isolated and Dynamical (Trapping) Horizons in the limit when the dual expansion vector is null.

To probe into pulsar's interior through gravitational waves

Renxin Xu

Peking University, China

The gravitational radiation from compact pulsar-like stars depends on the state of dense matter at supranuclear densities, i.e., the nature of pulsar (e.g., either normal neutron stars or quark stars). Possible gravitational emission of quark stars (either fluid or solid) during the birth and later lifetime are discussed. Several observational features to distinguish various models for pulsar-like stars are proposed.

November 24, 2005 (Thursday)

Radiation reaction in general relativity and string theory

Dmitry V. Gal'tsov

Moscow State University, Russia

We discuss some fundamental issues associated with the classical radiation reaction which recently were revived in the context of general relativity and string theory. This includes the questions: should we change the definition of the point particle momentum to account for the Schott term in the Lorentz-Dirac equation, whether the radiation reaction force can be non-vanishing in absence of radiation, how to renormalize mass of the self-gravitating point particle which does not enter the geodesic equation, and many others. We present a new approach for computation of the radiation reaction force acting on a point particle in curved space-time which is different from that of DeWitt-Brehme and its generalizations for other spins. We also formulate the radiation reaction problem for point-like and extended objects in other dimensions than four, and compute the bremsstrahlung-type radiation from colliding strings and branes.

Stationary Spacetime with Intersecting Branes in M/superstring theory

Kei-ichi Maeda and Makoto Tanabe

Waseda University, Japan

We study a stationary "black" brane in M/superstring theory. Assuming BPS-type relations between the first-order derivatives of metric functions, we present general stationary black brane solutions with a traveling wave for the Einstein equations in D-dimensions. The solutions are given by a few independent harmonic equations (and plus the Poisson equation). General solutions are constructed by superposition of a complete set of those harmonic functions. Using the hyperspherical coordinate system, we explicitly give the solutions in 11-dimensional M theory for the case with M2-M5 intersecting branes and a traveling wave. Compactifying these solutions into five dimensions, we show that these solutions include the BMPV black hole and the Brinkmann wave solution. We also find new solutions similar to the Brinkmann wave. We prove that the solutions preserve the 1/8 supersymmetry if the gravi-electromagnetic field F_{ij}, which is a rotational part of gravity, is self-dual. We also discuss non-spherical "black" objects (e.g., a ring topology and an elliptical shape) by use of other curvilinear coordinates

Alice falls into a black hole: Entanglement in non-inertial frames

Robert Mann

University of Waterloo, Canada

Quantum information and computation relies upon the phenomenon of quantum entanglement as a resource for tasks such as teleportation [1], quantum control [2] and quantum simulations. Here I consider how entangled is affected by the structure of spacetime. Specifically, a state that is maximally entangled in an inertial frame becomes less entangled if the observers sharing the state are relatively accelerated. Entanglement is therefore an observer-dependent quantity in non-inertial frames. I discuss how the situation arises for both bosons and fermions. In the high acceleration limit, these results can be applied to a non-accelerated observer falling into a black hole while the accelerated one barely escapes. If the observer escapes with (near) infinite acceleration, the state's distillable entanglement vanishes.

A New Generalized Harmonic Evolution System

Lee Lindblom

Caltech, USA

Pretorius has recently preformed some very impressive numerical simulations of binary black hole inspiral and merger. This talk will describe and extend the mathematical formalism on which that work is based: A first-order linearly-degenerate symmetric-hyperbolic representation of the Einstein equations will be presented which uses the generalized harmonic coordinate method to specify the coordinates. This evolution system includes terms that suppress all small short-wavelength constraint violations. New physical and constraint preserving boundary conditions will be presented for this system. Results of numerical tests will be shown that demonstrate the effectiveness of these constraint suppression terms and constraint preserving boundary conditions.

Formation and evaporation of regular black holes

Sean Hayward

Penn State University, USA

Regular (non-singular) space-times are given which describe the formation of a (locally defined) black hole from an initial vacuum region, its quiescence as a static region, and its subsequent evaporation to a vacuum region. The static region is Bardeen-like, supported by finite density and pressures, vanishing rapidly at large radius and behaving as a cosmological constant at small radius. The dynamic regions are Vaidya-like, with ingoing radiation of positive energy flux during collapse and negative energy flux during evaporation, the latter balanced by outgoing radiation of positive energy flux and a surface pressure at a pair creation surface. The black hole consists of a compact space-time region of trapped surfaces, with inner and outer boundaries which join circularly as a single smooth trapping horizon.

De Sitter invariant special relativity

Chao-Guang Huang and Han-Ying Guo

Chinese Academy of Sciences, China

In de Sitter spacetime, de Sitter invariant special relativity can be established more or less parallel to the Einstein special relativity, based on the principle of special relativity and the postulate of two-universal constants. There are two kinds of simultaneity in de Sitter invariant special relativity. One is the Beltrami-time simultaneity. By using the simultaneity, a new kind of inertial motion and a series of classical observables can be defined. In addition, the temperature of the horizon of de Sitter spacetime to an inertial observer should be zero! Therefore, there is no need to explain the statistical origin of the entropy for the horizon of de Sitter spacetime. Another is the proper-time simultaneity. With the proper-time simultaneity, the metric takes the Robertson-Walker-like form, which shows that the spacetime has positive spatial curvature of order Λ. This has already been shown by the CMB power spectrum from WMAP and should be further confirmed in future. The existence of the two kinds of simultaneity also makes possible to explain the origin of inertial motion. Further, based on de Sitter special relativity, dynamics for a relativistic particle, including the pseudo-Hamiltonian mechanics, can be established. The non-relativistic limit of de Sitter invariant special relativity gives rise to the Newton-Hooke mechanics. The possibility of the test of de Sitter invariant special relativity is also studied tentatively. Finally, a kind of the doubly special relativity may be viewed as the de Sitter invariant special relativity in energy-momentum space.

Quasi-local mass and the final fate of gravitational collapse in Gauss-Bonnet gravity

Hideki Maeda

Waseda University, Japan

We define a quasi-local mass in the $n(\geq 5)$-dimensional spherically symmetric spacetime in Gauss-Bonnet gravity. This quasi-local mass is a natural generalization of the n-dimensional Misner-Sharp mass. Considering the gravitational collapse in which a null dust fluid radially injects into an initially flat and empty region, we show that a naked singularity is inevitably formed and its properties are quite different between $n = 5$ and $n \geq 6$. In the $n \geq 6$ case, the naked singularity is massless and ingoing- null, while in the $n = 5$ case, a massive timelike naked singularity is formed, which does not appear in the general relativistic case. We also discuss the strength of the naked singularities.

Inhomogeneity-Induced Cosmic Acceleration in a Dust Universe

Je-An Gu

National Taiwan University, Taiwan

It is the common intuition and consensus that the expansion of a universe always slows down if the gravitational force provided by the energy sources therein is attractive universally. To this consensus we find counter examples for a spherically symmetric dust universe described by the Tolman-Bondi solution. Thus, the validity of this naive intuition is indeed doubtful and the effects of inhomogeneities should be restudied. Although it may still be difficult to explain the cosmic acceleration simply through inhomogeneities, these counter examples open a new point of view for understanding the evolution of our universe.

Coupled Quintessence and CMB

Seokcheon Lee

Academia Sinica, Taiwan

We show the effects of the coupled quintessence on CMB spectrum. Since the interaction of dark matter (DM) and dark energy (DE) would not be measured by any local gravity experiment, CMB spectrum and other cosmological observations are important to measure it. As the coupling becomes stronger, the amplitudes and the locations of acoustic peaks becomes lower and larger, respectively. These can be understood from the fact that the amount of baryon around the last scattering decreased and the angular diameter from the present to the last scattering increases as the coupling increased. We also check the speed of sound in this case which is important for the clustering of DE.

On non-uniform charged black branes

Umpei Miyamoto

Waseda University, Japan

Recently, the phase structure of black hole and black string (brane) system has been clarified in neutral cases. It is important how charges change the phase structure of such a system, and how stabilize the uniform (i.e., translationally invariant) black branes around the critical point at which they become thermodyamically stable. We investigate the phase structure of charged black branes by constructing non-uniform solutions perturbatively.

The orgin of the Immirzi parameter

Hoi-Lai Yu

Academia Sinica, Taiwan

We shall discuss the issue of Immirzi paramter in quantum gravity. In particular we shall use quadratic spinor techniques to show that the Immirzi parameter can be expressed as ratio between scalar and pseudoscalar contributions in the theory and can be interpreted as a measure of how the Einsten gravity differs from a generally constructed covariant theory for gravity.

Simplification of the constraints of 4-dimensional gravity

Chopin Soo

National Cheng Kung University, Taiwan

The super-Hamiltoninan of 4-dimensional pure gravity as simplified by Ashtekar through his use of gauge and triad variables can be expressed succinctly as the Poisson Bracket of the Chern-Simons operator and the volume element operator. Even when a non-zero cosmological constant is present, the super-Hamiltonian constraints can still be expressed as a commutator. The quantum constraint equation (the Ashtekar-Wheeler-DeWitt Equation) simplifies to the fact that the commutator should vanish when acting on physical states. Further implications of these observations will be discussed.

2+1-dimensional Quantum Gravity as Chern-Simons Gauge Theory with Global Gravitational Anomaly

Wenfeng Chen

National Center for Theoretical Sciences , Taiwan

It was proposed by Witten that 2+1-dimensional gravity can be considered as Chern-Simons theory with gauge group ISO(2,1) based on the identification of both classical action and symmetry between two theories. However, a careful observation shows that due to the possible existence of singularity in 2+1-dimensional and multi-connectedness of gauge group, these two theories actually are not fully physically equivalent. We try to verify quantitatively that 2+1-dimensional gravity can be interpreted as Chern-Simons theory with global gravitational anomaly.

Cosmic Lee-Yang Force of Gauge Fields and Dark Energy

Jong-Ping Hsu

University of Massachusetts Dartmouth

Lee and Yang discussed a new long-range repulsive force between baryon matters 50 years ago. The cosmic Lee-Yang force is due to a massless gauge field dictated by the established conservation law of baryon number. Similarly, the conservation of electron-lepton number also implies a cosmic repulsive force between electrons. Eotvos experiments showed the force to be undetectably small. However, such a force may be related to the dark-energy-induced acceleration of the expansion of the universe. Moreover, if the gauge invariant Lagrangian involves a spacetime derivative of the field strength, one has a fourth order partial differential equation for massless gauge field. The resultant potential has properties similar to that of the dark energy implied by the cosmological constant in Einsteins equation.

Uniformly Accelerated Detectors in (3+1)D Spacetime: From Vacuum Fluctuation to Radiation Flux

Shih-Yuin Lin

Academia Sinica, Taiwan

We consider a uniformly accelerated Unruh-DeWitt detector in (3+1) dimensional Minkowski space, and worked out the exact evolution of the detector from the initial transient to the final steady state. The radiation emitted by the detector during the whole process is studied. We confirm earlier claims from (1+1) dimensional calculations that there is no emitted radiation in the steady state, and verified that the total energy of the dressed detector and the monopole radiation from the detector is conserved.

Vacuum fluctuations and Brownian motion of test particles

Hong-Wei Yu

Hunan Normal University, China

The Brownian motion of a charged test particle caused by quantum electromagnetic vacuum fluctuations in flat spacetime with perfectly reflecting boundaries is examined and the mean squared fluctuations in the velocity and position of the test particle are calculated. We argue that this kind of Brownian motion in vacuum could be associated with an effective temperature which is accessible to future experimental test. Finally, the generalization to the case with finite temperature is briefly discussed.

Progress in test Newtonian inverse-square law in submillimeter range

Shu-Hua Fan, Jun Luo, Sheng-Guo Guan, and Liang-Cheng Tu

Huazhong University of Science and Technology, Wuhan

The nonrelativistic Newtonian inverse-square law (ISL) is conventionally assumed to be valid for all separations greater than the Planck length ($\sim 10^{-33}$ cm). However, the gravitational interaction has only been tested with good precision for distances ranging from the scale of the solar system down to a few millimeters. Recently, several novel new theoretical scenarios, inspired by string or M-theory, predict the possible violations of this inverse-square behavior at/below scale of submillimetre, expressed as $V(r) \sim (1 + \alpha \exp(-r/\lambda))/r$ with α denoting the strength of the interaction and λ being the range. We are testing the gravitational inverse square law at distance down to 100μm using a torsion balance and the gold plate masses. One of the gold plates is suspended by a 25-μm-diameter tungsten fiber to form a torsion balance, and the rotation of the torsion pendulum is detected by the autocollimator. A six-freedom platform, with the resolution of 1μrad for the circle goniometer and 0.1μm for the linear displacement, is used to adjust the gesture of the test mass when it approaches close enough to the source mass, while a Michelson interferometer, with the linear displacement sensitivity of 0.3μm, is used to monitor the gap variance between the source mass and test mass. The scheme in our experiment is mainly concentrated on several aspects for a higher sensitivity and reliability. Firstly, both the source and test masses are designed as gold plate shapes in order to increase signals of assumed new force and reduce Newtonian force. Secondly, the PID controller can maintain the torsion pendulum in its rest position which greatly reduced influence induced by the nonlinear of the fiber. The third aspect is the application of the magnetic damper, whose function is to eliminate the effects of various vibrations during the rotation of the whole system. The pendulum is located in a stainless vacuum vessel maintained at vacuum of $\leq 10^{-5}$Pa during experiment and the whole apparatus is located in our cave laboratory providing a very good condition for such precision experiment. The torque noise of our PID controlling system is about $\sim 10^{-14}$Nm. For different Yukawa ranges of λ, we finally will obtain constraints on a Yukawa violation of ISL. As for comparison with others, this result will improve in sensitivity by one order of magnitude. Current result has improved previous short-range constraints by up to a factor of about 4 (as shown in Fig. 1), and next goal is to improve the current constraints by one order at least at range of 100μm.

November 25, 2005 (Friday)

No Astrophysical Dyadospheres

Don Page

University of Alberta, Canada

It is shown how two independent processes would each prevent the astrophysical formation of dyadospheres, hypothetical regions where the electric field exceeds the critical value for rapid Schwinger pair production: (1) Pair production itself would discharge a growing electric field (say from a hypothetical collapsing charged stellar core) before it reached 6% of the minimum dyadosphere value, keeping the pair production rate more than about 26 orders of magnitude below the dyadosphere value, and keeping the efficiency below 2×10^{-4}. (2) Electrostatic forces would expel excess charges from a collapsing stellar core long before the field got up to even these values. If the excess charges were carried by protons bound to the core only by gravity, they would be expelled when the electric field reaches a value less than a trillionth of that of a dyadosphere. Even if the protons are bound to the core by nuclear forces, the charge will still leave when the electric field is just a fraction of a millionth of that of a dyadosphere. In either case the pair production rate is negligible.

The primordial perturbation spectrum

Alexi A. Starobinsky

Landau Institute for Theoretical Physics, Russia

Primordial scalar (adiabatic) perturbations and tensor ones (gravitational waves) are the main observable quantities which remained from very early stages of evolution of our Universe. Observational data show that the Fourier power spectrum of density perturbations is very close to the flat (i.e., the Harrison-Zeldovich) one and their statistics is Gaussian, in agreement with predictions of the simplest versions of the inflationary scenario of the early Universe. However, some small deviations from the flat spectrum and the Gaussian statistics are expected generically. I present recent theoretical results on the primordial perturbation spectrum including the new general expression for the spectrum of adiabatic perturbations unifying different ways of their generation both during and after inflation, as well the two exact solutions for inflaton field potentials producing a) the exactly flat adiabatic spectrum, b) the constant ratio of tensor/scalar perturbation power spectra. Also, the present observational situation regarding local deviations from a smooth approximately flat spectrum is reviewed.

Integrable Cosmological Models in DD and Variations of Fundamental Constants

Vitaly Melnikov

Centre for Gravitation and Fundamental Metrology, VNIIMS, Moscow, Russia

New cosmological challenges to theoretical physics and the role of gravity and cosmology are discussed. Problems of gravitation as the fundamental interaction and fundamental physical constants choice, their classification, number, precision of measurement, possible variations and their connection to fundamental physical theories are analyzed. Special attention is devoted to the problems of G: its absolute value measurements and possible time and range variations. Basic properties of integrable cosmological models with different matter sources in D and 4D are described.

Probing extra dimensions using a superconducting accelerometer

Ho-Jung Paik

University of Maryland, USA

In string theories, extra dimensions must be compactified. The possibility that gravity can have large radii of compactification leads to a violation of the inverse square law at submillimeter distances. We are preparing a null test of Newton's law with a resolution of one part in 1000 at 100 micrometers, which will probe the extra dimensions down to several micrometers. The experiment will be cooled to 2 K. To minimize Newtonian errors, a near null source in the form of a circular disk of large diameter-to-thickness ratio is employed. Two test masses, also disk-shaped, are suspended on the two sides of the source mass at a distance of 150 mm. The signal is detected by a superconducting differential accelerometer. I will discuss the design and principle of this experiment and report the progress.

Progress in measuring Newtonian gravitational constant G

Jun Luo, Qi Liu and Xiang-Dong Fan

Huazhong University of Science and Technology, Wuhan

The gravitational constant G was the first physical constant to be introduced and measured in the history of science. However, because of the extreme weakness of the gravitational force and the consequent difficult in generating a sufficiently large signal for accurate measurement, it is still the least well known. G was determined by means of a high-Q torsion balance and the time-of-swing method at our lab in 1999. The period of the torsion balance is altered by the presence of two 6.25kg stainless steel cylinders. Some related problems have also been studied, such as thermal noise limitation of a torsion balance, fitting method of the oscillation period, nonlinearity of the torsion fiber, responses of the torsion balance to temperature variation and ground vibration. The measured value of G is $(6.6699 \pm 0.0007) \times 10^{-11}\mathrm{m}^3\mathrm{kg}^{-1}\mathrm{s}^{-2}$ with a relative uncertainty of 105 ppm, which was adopted by CODATA in 1998 and named as HUST-99. Presently, a new experiment is carrying out. The torsion balance of this experiment (as shown in Fig.1), a cube of $91.5 \times 12.0 \times 27.6\mathrm{mm}^3$ made of glass coated with gold, is suspended by a tungsten fiber of 25μm in diameter and 890mm in length. The two attracting masses, 780g stainless spheres 57.14mm in diameter with an error of 0.28μm, are mounted on a turntable which can rotate around the torsion balance. The separation of the centers of the attracting masses, about 158 mm, could be determined with 0.3μm. Before and after the turntable rotated 90 degrees, the period would change about 5 seconds because of the background gravitational variance of the two balls. During the past 5 years, a great deal of problem has been found and resolved, such as the so called abnormal mode of the pendulum, the contact potential difference of the balance, the thermal effect of the fiber, the correlation method for period extraction, and so on. Now the final experiment is preparing and a new G value will be obtained in the near future.

The Third Cloud over General Relativity -Anomalous Acceleration of Pioneer 10 and 11 and its Possible Explanation

Chong-Ming Xu

Nanjing Normal University, China

In this talk, we introduce the problem of the anomalous acceleration of Pioneer 10 and 11 in the region of the deep space (> 10AU), which is un-modeled constant acceleration $(8.7 \pm 1.3) \times 10^{-8} cm/s^2$ forward to the sun. The anomalous acceleration has been discovered for long time ago (1992) by Anderson, but recently it is confirmed further more after excluding all of known conventional physical errors. The Pioneer anomaly is so called the third dark cloud over the general relativity besides the dark matter and the dark energy. We also briefly introduce several published explanation on the Pioneer anomaly by means of conventional physics or new physics, but none of them is fully successful or commonly acceptable in our point view. A new plan to launch a mission to explore the Pioneer anomaly is mentioned in the talk. At last the influence on the orbit motion of eight planets as a perturbation (perihelion-shift and radius) caused by the anomalous acceleration is recently calculated by us. To compare with the present observational precision, such kind of influence definitely does not exist for the bounded orbit motion. Therefore we conclude that, if the weak equivalence principle is correct in everywhere, it is impossible to explain the Pioneer anomaly by means of any revising gravitational theory.

Gravitational Wave Astronomy

Lindblom, Lee

Caltech, USA

Einstein's general relativity theory predicts that disturbances in the gravitational field can propagate as waves traveling across space at the speed of light. A new generation of instruments sensitive enough to detect gravitational waves from strong astrophysical sources in distant galaxies is just starting to operate. Once detected these waves will provide astronomers with a completely new way to view and study distant objects in the universe. This talk will present the basics of this new field of gravitational wave astronomy: What are gravitational waves? How are gravitational waves detected? How are gravitational wave emitted? What kinds of objects emit strong gravitational waves? Have gravitational waves been detected yet?

November 26, 2005 (Saturday)

Initial Data Engineering

James Isenberg

University of Oregon, USA

We show how to obtain new solutions of the Einstein constraint equations by gluing together old ones. Using these techniques, we show how to add wormholes and black holes to your favorite sets of initial data, and we prove three new results:
1) There exist vacuum, spatially compact, maximal globally hyperbolic spacetimes containing no constant mean curvature slices;
2) There exist vacuum, asymptotically Euclidean, maximal globally hyperbolic spacetimes containing no maximal slice;
3) For every closed 3-manifold M, there exist asymptotically Euclidean and asymptotically hyperbolic solutions of the vacuum constraints on $M \setminus$ point.

Bondi Sachs Formulation of Kerr Metric

Yun-Kau Lau

Chinese Academy of Sciences, China

Motivated by the prospect of describing the angular momentum carried by gravitational radiation in the characteristic formulation of numerical relativity, a one parameter family of Bondi-Sachs (BS) coordinates near null infinity, parametrised by the Carter constant, are constructed for the Kerr metric. A Newman-Penrose tetrad adapted to the BS coordinates is defined, with which the geometry of the the null hypersurfaces spanning the BS coordinates is studied. Information concerning angular momentum is shown to be encoded in the shear structure of these null hypersurfaces. It is also pointed out that due to rotational effects, BS coordinates generated by a light cone is in general different from that generated by null hypersurfaces emnating from a timelike world tube enclosing a rotating relativistic source. By means of asymptotic expansion of the eikonal equation, the asymptotic geometry of the BS coordinates generated by light cones is also worked out.

Geometric conditions for purely in- or out-going gravitational fluxes

Jong Hyuk Yoon

Konkuk University, Korea

The most natural framework for studying gravitational radiation in a generic situation is the null-surface formalism where the affine parameter is used as the retarded time. I discuss gravitational radiation using the 2+2 formalism adapted to the null-surface splitting of spacetimes, and identify quasi-local energy, linear momentum, and angular momentum flux of gravitational radiation in the most general setting. I also present local geometric conditions for purely in- or out-going waves at a finite distance, which are precisely the vanishing of the Weingarten maps associated with the in- or out-going null-surface, respectively. It is shown that this condition reduces to the Bondis out-going wave condition at the null infinity. Using the in- and out-going flux decomposition, I express the gravitational Hamiltonian that dictates the evolution along the retarded time, which turns out to be remarkably similar to the Hamiltonian of viscous fluids. I discuss some implications to gravitation of this fluid dynamics analogy.

On the Cosmological Constant Problem

Roland Triay

Universit de Provence and Centre de Physique Thorique CNRS, France

According to general relativity, the present analysis shows on geometrical grounds that the cosmological constant problem is an artifact due to the unfounded link of this fundamental constant to vacuum energy density of quantum fluctuations.

Modified dispersion relations and black hole physics

Yi Ling

Nanchang University, China

A modified formulation of energy-momentum relation is proposed in the context of doubly special relativity. We investigate its impact on black hole physics. It turns out that such modification will give corrections to both the temperature and the entropy of black holes. In particular this modified dispersion relation also changes the picture of Hawking radiation greatly when the size of black holes approaching the Planck scale. It can prevent black holes from total evaporation, as a result providing a plausible mechanism to treat the remnant of black holes as a candidate for dark matter.

A Way to Quantize the Schwarzschild Black Hole

Liao Liu

Beijing Normal University, China

If the situation of quantum gravity nowadays is nearly the same as that of quantum mechanics in its early time of Bohr and Sommerfeld, then a first-step study of the quantum gravity under Sommerfeld's quantum condition of action might be helpful. We present the spectra of quantum Schwarzschild black hole in non-relativistic quantum mechanics. It is found that the quantum of area is $\frac{8\pi}{3}l_p^2$, the quantum of entropy is $\frac{2\pi}{3}k_B$, and the Hawking evaporation will cease when the black hole reaches the ground state $m = \frac{1}{2\sqrt{3}}m_p$. So there is a remnant left for any SBH and the long unsolved information lost puzzle may have a solution now.

Growth of primordial black holes

Tomohiro Harada

Kyoto University, Japan

The evolution of primordial black holes in a flat Friedmann universe with a massless scalar field is investigated in fully general relativistic numerical relativity. A primordial black hole is expected to form with a scale comparable to the cosmological apparent horizon, in which case it may go through an initial phase with significant accretion. However, if it is very close to the cosmological apparent horizon size, the accretion is suppressed due to general relativistic effects. In any case, it soon gets smaller than the cosmological horizon and thereafter it can be approximated as an isolated vacuum solution with decaying mass accretion. We also discuss the evolution, structure and possibility of primordial black holes larger than the cosmological apparent horizon.

Wave maps on black holes in any dimensions

Makoto Narita

National Central University, Taiwan

During the past decade there has been a significant increase in interest in higher-dimensional black hole spacetimes, due to the recognition of their relevance to superstring/M-theory. Let us consider $D+1$-dimensional spherically symmetric spcetimes ($D \geq 3$). It is known already that one have black hole solutions to the Einstein equations under the stationary and some asymptotic conditions. From the viewpoint of the cosmic censorship, it is important to study whether such black hole spacetimes are stationary limit after dynamical evolution (i.e. naked singularities never appear by generic gravitational collapse) and/or the spacetimes are stable or not. It has been shown that $D+1$-dimensional static and spherical symmetric black hole spacetimes are stable against linear perturbation. As the next step, nonlinear perturbation should be considered. However, we have no mathematical tool to analyze nonlinear perturbation for curved spacetimes at the present time. Then, we will consider nonlinear scalar fields (as test fields) on the spacetimes. Our choice for the test fields are *wave maps*, which play an important role in classical general relativity. For example, dynamical evolution equations of the (four dimensional) Einstein equations for spacelike $U(1)$-symmetric spacetimes can be written as a wave map. Also, it is known that nonlinearity of wave maps is similar with one of the Einstein equations, that is "null form". This nonlinearity is a key to prove global existence theorems for the Einstein equations (for small initial data) and wave maps. Thus, wave maps are better choices as nonlinear test fields. Now, we show existence of global solutions of wave maps on static and spherically symmetric black hole spacetimes in any dimensions. Asymptotic behavior of the solutions are also analyze.

Classical pseudotensors and positive energy in small regions

Lau-Loi So, James M. Nester and Hsin Chen

National Central University, Taiwan

We have studied the famous classical pseudotensors in the small region limit, both inside of matter and in vacuum. A recent work [Deser et al. 1999 CQG 16, 2815] had found one combination of the Einstein and Landau-Lifshitz expressions which yields the Bel-Robinson tensor in vacuum. Using similar methods we found another independent combination of the Bergmann-Thomson, Papapetrou and Weinberg pseudotensors with the same desired property. Moreover we have constructed an infinite number of additional new holonomic pseudotensors satisfying this important positive energy requirement, all seem quite artificial. On the other hand we found that Mollers 1961 teleparallel tetrad energy-momentum expression naturally has this Bel-Robinson property.

Quasilocal energy flux

Chiang-Mei Chen

National Central University, Taiwan

The Hamiltonian includes a boundary term which determines the quasi-local values and the boundary conditions. Using our covariant Hamiltonian formalism, we found four particular quasi-local energy-momentum boundary term expressions. Here, from a consideration of the asymptotics, we show how a fundamental Hamiltonian identity naturally leads to the associated quasi-local energy flux expressions. For electromagnetism one of the four is distinguished: the only one which is gauge invariant; it gives the familiar energy density and Poynting flux. For Einstein's general relativity two different boundary condition choices correspond to quasi-local expressions which asymptotically give the ADM energy, the Trautman-Bondi energy and, moreover, an associated energy flux (both outgoing and incoming). Again there is a distinguished expression: the one which is covariant.

Improved numerical stability of rapid-spinning black hole evolution

Hwei-Jang Yo

National Cheng Kung University, Taiwan

We experiment with modifications of the Baumgarte-Shapiro-Shibata-Nakamura formulation of the Einstein field equations and demonstrate how these modifications affect the stability of numerical black hole evolution calculations. We focus especially on rapidly-rotating Kerr-Schild black holes in Pi-symmetry and in axisymmetry, and study the instabilities which arise due to the rapid rotation of the black holes.

Theoretical Aspects of Gravitational Lensing in TeVeS

Yong Tian

Army Armor School, Taiwan

Since Bekenstein's (2004) creation of his Tensor-Vector-Scalar theory (TeVeS), the Modified Newtonian dynamics (MOND) paradigm has been redeemed from the embarrassment of lacking a relativistic version. One primary success of TeVeS is that it provides an enhancement of gravitational lensing, which could not be achieved by other MONDian theories. Following Bekenstein's work, we investigate the phenomena of gravitational lensing including deflection angles, lens equations and time delay. We find that the deflection angle would maintain its value while the distance of closest approach vary in the MOND regime, this coincides with the conclusion of Mortlock and Turner's (2001) intuitional approach. Moreover, the scalar field, which is introduced to enhance the deflection angle in TeVeS, contributes a negative effect on the potential time delay. Unfortunately this phenomenon is unmeasurable in lensing systems where we can only observe the time delay between two images for a given source. However, this measurable time delay offers another constraint on the mass ratio of the DM and MOND scenarios, which in general differs from that given by the deflection angle. In other words, for a lensing system, if two masses, m_gN and m_gM, are mutually alternatives for the deflection angles in their own paradigm, regarding the time delay they are in general in an exclusive relation.

Cosmic connection between neutrinos and dark energy

Yong-Yeon Keum

National Taiwan University, Taiwan

We discuss a possible phenomenological solution for the accelerating universe with the mass varying neutrino model. We demonstrate an interacting dark energy model between neutrinos and acceleron field. According to this idea, dark energy and neutrinos are coupled such that the mass of the neutrinos is a function of the scalar field which drives the late time accelerated expansion of the universe. We also consider the effect on the anisotropies in the cosmic microwave background radiation (CMB) and the large scale structures (LSS).

Observational constraints on cosmology from modified Friedmann equation

Zong-Hong Zhu

Beijin Normal University, China

Recent measurements of type Ia supernovae as well as other concordant observations suggest that the expansion of our universe is accelerating. A dark energy component has usually been invoked as the most feasible mechanism for the acceleration. However, the effects arising from possible extra dimensions can mimic well the role of a dark energy through a modified Friedmann equation. In this work, we investigate some observational constraints on a scenario in which this modification is given by $H^2 = \frac{8\pi G}{3}(\rho + C\rho^n)$. We mainly focus our attention on the constraints from recent measurements of the dimensionless coordinate distances to type Ia supernovae and Fanaroff-Riley type IIb radio galaxies compiled by Daly and Djorgovski (2003) and the X-ray gas mass fractions in clusters of galaxies published by Allen et al. (2002,2003). We obtain the confidence region on the power index n of the modificative term and the density parameter Ω_m of the universe from a combined analysis of these databases. It is found that $n = 0.06^{+0.22}_{-0.18}$ and $\Omega_m = 0.30^{+0.02}_{-0.02}$, at the 95.4consistent within the errors with the standard ΛCDM model. These parameter ranges give a universe whose expansion switches from deceleration to acceleration at a redshift between 0.52 to 0.73.

The determination of central black hole masses for blazars

J.H. Fan et al.

Guangzhou University, China

In this work, we determined the central black hole mass (M) for gamma-ray loud blazars using their available variability timescales. In this method, the absorption effect depends on the γ-ray energy, emission size and property of the accretion disk. We found that the black hole masses range between $10^7 M_\odot$ and $10^9 M_\odot$.

Does the Event Horizon of Black Holes Exist?

Ye-Fei Yuan

USTC, Hefei, China

The existence of black holes is generally believed by astrophysicists. The accretion of its surrounding material into black holes is thought to be the central engine to power active galactic nuclei, gamma ray bursts, x-ray binaries and so on. From the gas dynamics and stellar dynamics, masses of some putative black holes which resides in the galactic centers are determined, unfortunately, the gas and stars are far away from their Schwarzschild radius. On the other hand, more than a dozen stellar black hole candidates have been discovered in X-ray binaries. These candidates have masses that exceed the maximum mass of a neutron star. In a word, all these observational achievements can not be the smoking gun for the existence of black hole. The key judgment should be the existence of the event horizons of black hole candidates. In this talk, I will briefly review recent progresses on this topic.

TBA

Zhi-Quan Luo

Xihua Normal University, China

General Formula for Comparison of Clock Rates - Applications to Cosmos and Solar System

Xue-Jun Wu

Nanjing Normal University, China

In this paper we deduce a quite general formula which allows the relation of clock rates at two different space time points to be discussed. In the case of a perturbed Robertson-Walker metric, our analysis leads to an equation for the comparison of clock rates at different cosmic space time points, which includes the Hubble redshift, the Doppler effect, the gravitational redshift and the Rees-Sciama effects. In the case of the solar system, when the 2PN metric is substituted into the general formula, the comparison of the clock rates on both the earth and a space station could be made. It might be useful for the discussion on the precise measurements on future ACES and ASTROD.

Posters

Low-energy quantum gravity

Michael A. Ivanov

Belarus State University, Belarus

If gravitons are super-strong interacting particles and the low-temperature graviton background exists, the basic cosmological conjecture about the Dopplerian nature of redshifts may be false. In this case, a full magnitude of cosmological redshift would be caused by interactions of photons with gravitons. Non-forehead collisions with gravitons will lead to a very specific additional relaxation of any photonic flux. It gives a possibility of another interpretation of supernovae 1a data - without any kinematics. These facts may implicate a necessity to change the standard cosmological paradigm. A quantum mechanism of classical gravity based on an existence of this sea of gravitons is described for the Newtonian limit. This mechanism needs graviton pairing and "an atomic structure" of matter for working it, and leads to the time asymmetry. If the considered quantum mechanism of classical gravity is realized in the nature, than an existence of black holes contradicts to Einstein's equivalence principle. It is shown that in this approach the two fundamental constants - Hubble's and Newton's ones - should be connected between themselves. The theoretical value of the Hubble constant is computed. In this approach, every massive body would be decelerated due to collisions with gravitons that may be connected with the Pioneer 10 anomaly. Some unsolved problems are discussed, so as possibilities to verify some conjectures in laser-based experiments.