HKUST Institute for Advanced Study

Conference on
Cosmology since Einstein

30 May – 1 June 2011

The Hong Kong University of Science and Technology

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Department of Physics, HKUST

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List of Speakers

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Program Schedule

Venue: Mr & Mrs Lee Siu Lun Lecture Theater (Lecture Theater K) *[except where indicated]*

30 May 2011 (Monday)		
Time	*Event*	*Presenter*
9:00 – 9:15	Registration	
9:15 – 9:30	Welcome Address	Tony F Chan *[President of The Hong Kong University of Science and Technology]*
9:30 – 10:20	Plenary Talk #1: "Cosmological Challenges – The View of a String Theorist"	David Gross *[Kavli Institute for Theoretical Physics, University of California, Santa Barbara]*
10:20 – 10:40	Coffee Break	
10:40 – 11:20	Talk #1: "First Physics Highlights from the Large Hadron Collider (LHC)"	Peter Jenni *[European Organization for Nuclear Research (CERN)]*
11:20 – 12:00	Talk #2: "Electroweak Symmetry Breaking Scenarios and Their Signals"	Csaba Csaki *[Cornell University]*
12:00 – 12:40	Talk #3: "Delta N Formalism and Curvature Perturbations on Superhorizon Scales"	Misao Sasaki *[Yukawa Institute for Theoretical Physics, Kyoto]*
12:40 – 14:00	Welcome Lunch *Venue: UC Bistro,* *Lo Ka Chung University Center*	
14:00 – 14:40	Talk #4: "String Cosmology: An Update"	Gary Shiu *[University of Wisconsin – Madison]*
14:40 – 15:20	Talk #5: "Some Peculiar Cosmological Solutions of Einstein's Theory"	Shamit Kachru *[Stanford University]*
15:20 – 16:00	Talk #6: "Non-Gaussianity Generated at the End of Multi-field Inflation"	Qing-Guo Huang *[Institute of Theoretical Physics, Chinese Academy of Sciences]*
16:00 – 17:30	Buffer Time / Break *(The Inaugural Lecture of Henry Tye, Director of IAS, will be held at Tin Ka Ping Hall, Lo Ka Chung University Center, from 16:45-17:30)*	
17:30 – 18:30	Cocktail Reception *Venue: Quiet Lounge,* *Lo Ka Chung University Center*	

31 May 2011 (Tuesday)		
Time	*Event*	*Presenter*
9:00 – 9:50	Plenary Talk #2: "Dark Matter and Dark Energy from Topology"	Hitoshi Murayama *[University of California, Berkeley and Institute for the Physics and Mathematics of the Universe, Tokyo]*
9:50 – 10:30	Talk #7: "Gravitational Lenses of the Dark Universe"	Adam Amara *[ETH Zürich]*
10:30 – 10:50	Coffee Break	
10:50 – 11:30	Talk #8 : "Relativistic Effects in Weak Gravitational Lensing"	Camille Bonvin *[University of Cambridge]*
11:30 – 12:10	Talk #9: "Recent Developments in Observational Cosmology"	Uroš Seljak *[University of Zürich, UC Berkeley and Ewha University, Seoul]*
12:10 – 12:50	Talk #10: "21cm Cosmology"	Xuelei Chen *[National Astronomical Observatories, Chinese Academy of Sciences]*
12:50 – 14:00	Lunch Break	
14:00 – 14:40	Talk #11: "Black Holes, Big and Small: Impact on Galaxy Formation"	Luis Ho *[The Observatories of the Carnegie Institution for Science]*
14:40 – 15:20	Talk #12: "Searching for Remnant String Loops by Microlensing"	David Chernoff *[Cornell University]*
15:20 – 16:00	Talk #13: "Astrometric Effects of a Stochastic Gravitational Wave Background"	Éanna Flanagan *[Cornell University]*
16:00 – 16:20	Coffee Break	
16:20 – 17:00	Talk #14: "Connection between Thermodynamics and Gravitational Dynamics"	Rong-Gen Cai *[Institute of Theoretical Physics, Chinese Academy of Sciences]*
17:00 – 18:30	Poster Presentations	
18:30 – 21:00	Banquet *Venue: China Garden Restaurant (G/F)*	

1 June 2011 (Wednesday)		
Time	*Event*	*Presenter*
9:00 – 9:50	Plenary Talk #3: "Eternal Inflation and Its Implications"	Alan Guth *[Massachusetts Institute of Technology]*
9:50 – 10:30	Talk #15: "What Do Galaxy Surveys Really Measure?"	Ruth Durrer *[University of Geneva]*
10:30 – 10:50	Coffee Break	
10:50 – 11:30	Talk #16: "The Cosmic Microwave Sky: Beyond the Power Spectrum"	Paul Shellard *[University of Cambridge]*
11:30 – 12:10	Talk #17: "Testing Gravity on Cosmological Scales"	Wayne Hu *[University of Chicago]*
12:10 – 12:50	Talk #18: "Bubble Collisions and Inflationary Perturbations"	Lam Hui *[Columbia University]*
12:50 – 14:00	Lunch Break	
14:00 – 14:40	Talk #19: "Constructing a Wilsonian Cosmological Effective Action"	Koenraad Schalm *[Leiden University]*
14:40 – 15:20	Talk #20: "Cosmological Inflation and the Standard Model"	Mikhail Shaposhnikov *[École Polytechnique Fédérale de Lausanne]*
15:20 – 15:40	Coffee Break	
15:40 – 16:20	Talk #21: "Einstein's 'Zurich Notebook' and his Journey to General Relativity"	Norbert Straumann *[University of Zürich]*
16:20 – 16:40	Closing Remarks	Henry Tye *[The Hong Kong University of Science and Technology]*

Plenary Talks

Cosmological Challenges – The View of a String Theorist

(Plenary Talk #1)

David Gross

Kavli Institute for Theoretical Physics, University of California, Santa Barbara

[Abstract is not provided]

Dark Matter and Dark Energy from Topology

(Plenary Talk #2)

Hitoshi Murayama

University of California, Berkeley &

Institute for the Physics and Mathematics of the Universe, Tokyo

Topological defects have been an important ingredient in early cosmology, while relevant to a wide variety of research including condensed matter and atomic physics. Cosmologists have relied on the Kibble mechanism to estimate the abundance of such defects, while it has become well-known in the atomic physics community that it has to be revised by the Zurek's estimate. Surprisingly, little attention has been paid by cosmologists on the Kibble-Zurek estimate. I point that the abundance has been grossly underestimated, that the monopole constraints exclude Pati-Salam phase transitions below the inflation scale. It also points to a new possibility of dark energy.

Eternal Inflation and Its Implications

(Plenary Talk #3)

Alan Guth

Massachusetts Institute of Technology

Almost all models of inflation lead to eternal inflation: once inflation starts, it never stops, but instead goes on forever producing a multiverse of pocket universes. If the multiverse is real, then it can offer a plausible explanation for the smallness of the cosmological constant. But if we really live in a multiverse, then anything that can happen will happen an infinite number of times, and the distinction between common and rare events becomes hard to define. I will discuss attempts to define a probability measure that regularizes these infinities. Different measures can give very different probabilities, but I will argue that only a narrow class of measures – similar to scale factor cutoff measure – appear to be viable. A common feature of successful measures is that they do not favor huge amounts of inflation, so the probability of observing spatial curvature is not absurdly small.

Invited Talks

Gravitational Lenses of the Dark Universe

(Talk #7)

Adam Amara
ETH Zürich

Gravitational lensing, which occurs when the light from distant objects is bent as it passes by matter, is a uniquely powerful tool in astronomy. It allows us to make direct measurements of the unseen components of the Universe, including dark matter and dark energy, which dominate the Universe around us but are not understood. Explaining these two dark components remains one of the key unresolved issues in fundamental physics today. This lecture will introduce the basic physical principles of gravitational lensing and show how it can be used on cosmological scales to measure the properties of dark matter and dark energy. The focus will be on a gravitational lensing technique known as 'cosmic shear', which has allowed us to map the three-dimensional distribution of the dark matter around us. In addition to its potentials in exploring dark matter and dark energy, the utility of gravitational lensing extends well beyond cosmology. It can be used to measure the detailed dynamics of stars, as well as detecting large populations of Earth-like planets outside our solar system. We will conclude by discussing how on-going and future experiments in cosmic shear will continue to give us unprecedented insights into the inner workings and evolutionary history of the Universe.

Relativistic Effects in Weak Gravitational Lensing

(Talk #8)

Camille Bonvin
University of Cambridge

Future lensing surveys aim at observing almost the whole sky. They will measure lensing correlations at very large scales. At those scales, new relativistic effects will come into play and open the way to new type of studies. In this talk, I will present a fully relativistic calculation of weak gravitational lensing up to second order in the gravitational potential. First, I will show that the convergence part of weak lensing contains new effects that are neglected at small scales. I will show that one of these contributions, generated by peculiar velocities of galaxies, becomes important at large scales. At small redshifts, it has an observable impact on the convergence power spectrum. Then I will present a calculation of the shear part of weak lensing up to second order. I will show that at large scales various non-linear couplings appear that can potentially provide new tests of gravity.

Connection between Thermodynamics and Gravitational Dynamics

(Talk #14)

Rong-Gen Cai
Institute of Theoretical Physics, Chinese Academy of Sciences

Black hole thermodynamics indicates there exists some relation between gravity and thermodynamics. In this talk I will briefly summarize three aspects of the connection between gravitational dynamics and thermodynamics by focusing on three kinds of spacetime horizon: local Rindler horizon of spacetime, black hole event horizon and apparent horizon in a Friedmann-Robertson-Walker (FRW) universe.

21cm Cosmology

(Talk #10)

Xuelei Chen
National Astronomical Observatories, Chinese Academy of Sciences

The 21cm radiation emitted by neutral hydrogen provides a very powerful cosmological probe, in principle it could be used to observe the Universe from present up to redshift 100. At present, a large number of experiments are devoted to search for the 21cm signal at the epoch of reionization. In addition, the 21cm observation can also be used to study the Universe at a lower redshift, to provide information on dark energy. I will review some recent progress in this field, then discuss my own work on 21cm theory, and also the Tianlai project, an experiment dedicated to dark energy observation in China.

Searching for Remnant String Loops by Microlensing

(Talk #12)

David Chernoff
Cornell University

Superstring loops form by intercommutation of horizon-crossing superstrings. The loops are captured and accreted during galaxy formation and a population of these loops resides within the galaxy today. A loop can lens background stars generating a unique signature of repeated, achromatic flux doubling events. The Large Synoptic Survey Telescope is a large aperture, wide field telescope that is able to image faint astronomical objects across the sky. This instrument can potentially probe the range of string tensions $10^{-13.5} < G \mu/c^2 < 10^{-9.5}$ which corresponds to characteristic energies $\sim 10^{12} - 10^{14}$ GeV. Event rates are discussed.

Electroweak Symmetry Breaking Scenarios and Their Signals

(Talk #2)

Csaba Csaki
Cornell University

I will present a survey of recent ideas for new mechanisms for electroweak symmetry breaking and TeV scale physics. For supersymmetric theories I will review the "little hierarchy problem" and explain what the potential ways of evading it are. I will comment on buried/hidden higgs models and their signals at the LHC. After a short summary of strongly coupled (technicolor-type) models I will spend the rest of the lecture on summarizing the various warped extra dimensional scenarios. I will explain why and how the original Randall-Sundrum model has been augmented over the past decade, and what the most popular version of the model currently is. If one wants to resolve the little hierarchy of the Randall-Sundrum models as well, one needs to consider either higgsless of composite pseudo-Goldstone higgs models. I will summarize the main features of these theories as well as their expected experimental signals.

What Do Galaxy Surveys Really Measure?

(Talk #15)

Ruth Durrer
University of Geneva

In large galaxy surveys which go out to redshift z=1 or more, relativistic effects, e.g. from the fact that our observations are not on a spatial hypersurface but on the past lightcone which itself is perturbed by structure formation, can no longer be neglected.

I present these effects to first order in perturbation theory and propose and angular and redshift power spectrum which are both directly observable.

We shall see that the complications due to the fact that we only observe on our past lightcone and that we do not truly know the distance of the observed galaxy, but only its redshift, is not only an additional difficulty, but especially a new opportunity for future galaxy surveys.

Astrometric Effects of a Stochastic Gravitational Wave Background

(Talk #13)

Éanna Flanagan
Cornell University

A stochastic gravitational wave background causes the apparent positions of distant sources to fluctuate, with angular deflections of order the characteristic strain amplitude of the gravitational waves. These fluctuations may be detectable with high precision astrometry, as first suggested by Braginsky et al. in 1990. Several researchers have made order of magnitude estimates of the upper limits obtainable on the gravitational wave spectrum \Omega_gw(f), at frequencies of order f ~ 1 yr^-1, both for the future space-based optical interferometry missions GAIA and SIM, and for VLBI interferometry in radio wavelengths with the SKA. For GAIA, tracking N ~ 10^6 quasars over a time of T ~ 1 yr with an angular accuracy of \Delta \theta ~ 10 \mu as would yield a sensitivity level of \Omega_gw ~ (\Delta \theta)^2/(N T^2 H_0^2) ~ 10^-6, which would be roughly comparable with pulsar timing. We take a first step toward firming up these estimates by computing in detail the statistical properties of the angular deflections caused by a stochastic background. We compute analytically the two point correlation function of the deflections on the sphere, and the spectrum as a function of frequency and angular scale. The fluctuations are concentrated at low frequencies (for a scale invariant stochastic background), and at large angular scales, starting with the quadrupole. The magnetic-type and electric-type pieces of the fluctuations have equal amounts of power. [based on Laura Book, EF, *Phys. Rev. D* 83, 024024 (2011)]

Black Holes, Big and Small: Impact on Galaxy Formation

(Talk #11)

Luis C. Ho
The Observatories of the Carnegie Institution for Science

Supermassive black holes, weighing a million to a billion Suns, have been shown to be a ubiquitous component of massive galaxies in the local Universe.

The mass of the black hole is closely linked to the properties of its host galaxy, suggesting that they share a closely coupled formation and evolutionary history. Energy feedback from quasars and active galactic nuclei may play an essential role in regulating star formation and structure formation on galactic scales. Even some small, low-mass galaxies contain central black holes, 10 to 100 times lighter than their supermassive cousins.

This recently discovered population sheds new light on the primordial seeds of quasars in the early Universe, serves as useful laboratories for accretion physics, and may be an important source of gravitational waves detectable with future experiments.

Testing Gravity on Cosmological Scales

(Talk #17)

Wayne Hu
University of Chicago

I will discuss attempts to explain cosmic acceleration through modification of gravity on cosmological scales. The modified action f(R) model and the DGP braneworld gravity model provide fully worked toy models under which one can explore the relationship between tests of gravity on cosmological, astrophysical and local scales.

Non-Gaussianity Generated at the End of Multi-field Inflation

(Talk #6)

Qing-Guo Huang
Institute of Theoretical Physics, Chinese Academy of Sciences

A convincing detection of a large local form non-Gaussianity will rule out all single-field inflation models. From the viewpoint of fundamental theories going beyond the standard model, such as string theory, a large number of light scalar fields are expected and some of them may play a role in the early universe. We will illustrate how the quantum fluctuations of these light fields can contribute to the curvature perturbation and generate a large local form non-Gaussianity at the end of multi-field inflation.

Bubble Collisions and Inflationary Perturbations

(Talk #18)

Lam Hui
Columbia University

I will discuss methods to distinguish fluctuations caused by bubble collisions from stochastic inflationary perturbations.

First Physics Highlights from the Large Hadron Collider (LHC)

(Talk #1)

Peter Jenni
European Organization for Nuclear Research (CERN)

Since one year experiments at the Large Hadron Collider (LHC) have started exploring physics at the high energy frontier. A rich harvest of initial physics results has been obtained that allow one already to test, at highest energies ever reached in a laboratory, the Standard Model (SM) of elementary particles, and to make searches Beyond the SM (BSM). Significant results have been already obtained in searches for the Higgs Boson, which would establish the postulated electro-weak symmetry breaking mechanism in the SM, as well as for BSM physics like Supersymmetry (SUSY), extra dimensions, quark compositeness and others. The SUSY searches are particularly topical as they could reveal a candidate for the Dark Matter in the Universe. The status of these searches, and the future prospects at the LHC, will be covered in this talk.

Some Peculiar Cosmological Solutions of Einstein's Theory

(Talk #5)

Shamit Kachru
Stanford University

I discuss some very simple but peculiar solutions of general relativity which, in the classical limit, closely approximate cyclic Universes admitting an infinite sequence of bounces, without requiring exotic stress-energy sources. This occurs in a perfect fluid approximation for the sources supporting the cosmology; I argue that any more realistic modeling of the sources, or even proper accounting of quantum particle production (e.g. of gravitons), indicates that within a finite time, sufficient entropy would accumulate to violate the covariant entropy bound. This indicates that after a finite number of cycles, such Universes are no longer reliably captured by general relativity, and likely crunch. I speculate about whether such cosmologies could be of use in real cosmological model-building.

Delta N Formalism and Curvature Perturbations on Superhorizon Scales

(Talk #3)

Misao Sasaki
Yukawa Institute for Theoretical Physics, Kyoto

I will discuss the properties of the curvature perturbation on superhorizon scales. In particular, I will discuss the condition for the nonlinear curvature perturbation to be conserved on superhorizon scales and its relation to the delta N formalism.

Constructing a Wilsonian Cosmological Effective Action

(Talk #19)

Koenraad Schalm
Leiden University

Wilsonian effective actions always presume energy conservation. This prevents a straightforward application to cosmological and other non-equilibrium time-dependent backgrounds. We argue that late-time expectation values computed directly in the Schwinger-Keldysh approach should not suffer from any complications as opposed to transition amplitudes computed in the standard path-integral. We give an explicit example by integrating out a heavy-field in a Schwinger-Keldysh model and show that novel terms are generated that modify the density matrix. These non-adiabatic terms can be interpreted as generating effective low-energy boundary conditions at the New-Physics Hypersurface. The physics interpretation is the production of heavy particles at threshold. Applying this formalism to slow-roll inflation we find that the power spectrum is universally modified at order H/M, where H is the scale of inflation. This ratio is optimistically estimated to be 10^{-2}, a precision obtainable by upcoming experiments.

Recent Developments in Observational Cosmology

(Talk #9)

Uroš Seljak
University of Zürich, University of California, Berkeley and Ewha University, Seoul

I will present some recent developments in measuring the large scale structure of the universe, including new observational constraints from weak lensing and galaxy clustering and their implications for cosmological parameters. I will also discuss some theoretical ideas how to improve these constraints in the current and future surveys.

Cosmological Inflation and the Standard Model

(Talk #20)

Mikhail Shaposhnikov
École Polytechnique Fédérale de Lausanne

I will overview the proposal that the Higgs boson of the Standard Model plays the role of the inflaton.

The Cosmic Microwave Sky: Beyond the Power Spectrum

(Talk #16)

Paul Shellard
University of Cambridge

Some of the most stringent tests of the standard inflationary cosmology relate to its statistical properties beyond the power spectrum: primordial fluctuations are predicted to deviate from Gaussianity by less than 1 part in 100,000. New high resolution experiments will place standard inflation firmly in the dock, especially forthcoming data from the Planck satellite survey of the cosmic microwave background (CMB). I will describe new modal estimator methods which allow the efficient and optimal extraction of higher order correlators (the bispectrum and trispectrum) from these large datasets. I will review current polyspectra constraints from the WMAP CMB maps, as well as forecasts for Planck. Finally, I will discuss future prospects for uncovering non-Gaussian signatures of new physics from the early universe.

String Cosmology: An Update

(Talk #4)

Gary Shiu
University of Wisconsin – Madison

String Theory and Cosmology are two disparate fields that are increasingly drawn to each other. Fundamental questions about the early universe call for an understanding of quantum gravity. Just as importantly, observational cosmology provides a promising window to probe physics at ultra-high energies. In this talk, I will highlight some recent developments in string cosmology. I will focus on cosmic inflation, and discuss how its sensitivity to short distance physics may serve as a bridge between string theory and observations. Issues such as non-Gaussianity, and the effective field theory of multi-field inflation will be discussed.

Einstein's 'Zurich Notebook' and his Journey to General Relativity

(Talk #21)

Norbert Straumann
University of Zürich

On the basis of his 'Zurich Notebook' I shall describe a particularly fruitful phase in Einstein's struggle on the way to general relativity. These research notes are an extremely illuminating source for understanding Einstein's main physical arguments and conceptual difficulties that delayed his discovery of general relativity by about three years. Together with the 'Ent-wurf' theory in collaboration with Marcel Grossmann, these notes also show that the final theory was missed late in 1912 within a hair's breadth. The Einstein-Grossmann theory, published almost exactly hundred years ago, contains, however, virtually all essential elements of Einstein's definite gravitation theory.

Poster Presentations

Influence of Long Wavelength Modes on Local Dynamics and Galaxy Bias

Tobias Baldauf
University of Zürich

The gravitational coupling between short and long wavelength modes is of essential influence for modern cosmology, for instance for perturbation theory, galaxy biasing and primordial non-Gaussianity. In the case of local non-Gaussianity the high-k behaviour of galaxy clustering is a promising probe for constraints on inflationary physics. This motivated us to revisit the coupling in a general relativistic context making use of Fermi local coordinates. We show that long wavelength modes can be generally interpreted as curved Universes and present a mapping that enables the inclusion of long modes into intermediate scale simulations.

Optimal Constraints on Local Primordial Non-Gaussianity from the Two-Point Statistics of Large-Scale Structure

Nico Hamaus
University of Zürich

One of the main signatures of primordial non-Gaussianity of the local type is a scale-dependent correction to the bias of large-scale structure tracers such as galaxies or clusters, whose amplitude depends on the bias of the tracers itself. The dominant source of noise in the power spectrum of the tracers is caused by sampling variance on large scales (where the non-Gaussian signal is strongest) and shot noise arising from their discrete nature. Recent work has argued that one can avoid sampling variance by comparing multiple tracers of different bias, and suppress shot noise by optimally weighting halos of different mass. Here we combine these ideas and investigate how well the signatures of non-Gaussian fluctuations in the primordial potential can be extracted from the two-point correlations of halos and dark matter.

Dark Matter and Entropic Gravity

Chiu Man Ho
Vanderbilt University

We provide a holographic dual description of Milgrom's scaling associated with galactic rotation curves. Our argument is based on the recent entropic reinterpretation of Newton's laws of motion. We propose a duality between cold dark matter and modified Newtonian dynamics (MOND).

Multi-field DBI Inflation and Non-Gaussianities

Minxin Huang
Institute for the Physics and Mathematics of the Universe, Tokyo

[Abstract is not provided]

In Search of Dark Matter

Wai-Yee Keung
University of Illinois at Chicago

Some of promising direct and indirect searches for dark matter (DM) are presented. They include neutrinos at about a few 100 GeV from the DM annihilation in the core of the sun, excess of cosmological high energy positrons and photons, DM electromagnetic moments, etc.

Relativistic Effects in Weak Gravitational Lensing

Xu Kong
University of Science and Technology China

Using a simple two color selection based on g-, z-, and K-band photometry, we pick out 1609 star-forming galaxies (sgzks) and 422 passively evolving galaxies (pgzks) at 1.4<z2.5 from a K-band selected sample in an area of 0.44deg^2 of the All-wavelength Extended Groth Strip International Survey (AEGIS). The surface density of gzks is 1.28 arcmin^-2. For a sample selected at K< 22.0, we reach an average redshift accuracy of dz/(1+z) = -0.014 with the normalized median absolute deviation sigma=0.031$. The number counts of pgzKs in our sample turn over at K=21.0, and both the number of faint and bright objects in our catalogs exceed the predictions of a recent semi-analytic model of galaxy formation, a more successful model is need to explain this diversity.

Based on our reddening-corrected UV luminosities and SED fitting of the multiband photometry, we find the median values of star formation rate (SFR) and stellar mass of sgzKs corresponding to 184$ M_sun/yr and ~8.8x10^10 M_sun respectively. We also find that the specific star formation rate (sSFR) and SFR of sgzKs increases with redshift at all masses, implying that star-forming galaxies were much more active on average in the past. Moreover, the sSFR of massive galaxies is lower at all redshifts, suggesting that star formation contributes more to the mass growth of low-mass galaxies than to high-mass galaxies. Finally, We also study the fraction of AGNs in the gzKs by using the IRAC band color criteria and the Mid-IR spectral index. 828 gzKs in our sample have four IRAC bands, 82 of which with alpha<-0.5 (using the power-law selection) can be classified as AGNs, so the fraction of AGNs is ~10% in our sample. Most of these AGN candidates have L_{0.5-10kev}>10^41 erg s^{-1}.

Primordial Non-Gaussianity and Its Signature on the Peculiar Velocity PDF

Tsz Yan Lam
Institute for the Physics and Mathematics of the Universe, Tokyo

We study how primordial non-Gaussianity affects the pairwise velocity probability density function (PDF) using an analytical model and cosmological N-body simulations. We develop an analytical model based on the Zeldovich approximation to describe the evolution of the pairwise velocity PDF. We show that our analytical model matches the measurements while linear theory fails to predict the PDF in the local f_nl model. We also show explicitly how f_nl induces correlations between originally independent velocities along the parallel and the perpendicular to the line of separation directions.

Dark Matter Admixed Neutron Stars

Shing Chi Leung
The Chinese University of Hong Kong

We study the hydrostatic equilibrium configuration of an admixture of cold dark matter and normal nuclear matter -a hybrid neutron star (HNS) - by using a general relativistic two-fluid formalism. We calculate its mass-radius relation and moment of inertia, and show that two branches of these stars exist, depending on which component dominates. Also, we prove the stability of this class of stars by calculating their radial oscillation modes. A possible formation track of these HNS's is discussed. If cold dark matter dominates, a new class of compact stars emerges from HNS, which has qualitatively different properties as ordinary neutron stars.

Reconstruction Real-space Density and Velocity Power Spectra from a Redshift Galaxy Survey

Jiayu Tang
Institute for the Physics and Mathematics of the Universe, Tokyo

Since the mass density and velocity fields in large-scale structure are related via gravity, comparing the density and velocity power spectra gives a way of testing Einstein's gravity theory on cosmological scales. Here we develop a maximum likelihood based method of reconstructing band powers of the density and velocity power spectra at each wavelength bins from the measured clustering features of galaxies in redshift space, including marginalization over uncertainties inherent in the small-scale, nonlinear redshift distortion, the Fingers-of-God (FoG) effect. By using N-body simulations and the halo catalogs, we test our method by comparing the reconstructed power spectra with the spectra directly measured from the simulations.

Perturbation Theory of Mass Weighted Velocity Moments

Zvonimir Vlah
University of Zürich

Consideration of mass weighted velocity moments is of certain interest in studying LSS. In this work perturbation theory has been used to study these moments in LCDM cosmology. Results are compared to N-body simulations.

Resonant Tunneling in Superfluid Helium-3

Daniel Wohns
The Hong Kong University of Science and Technology & Cornell University

The resonant tunneling phenomenon is well understood in quantum mechanics. I argue why a similar phenomenon must be present in quantum field theory. Using the functional Schrödinger method I show how resonant tunneling through multiple barriers takes place in quantum field theory with a single scalar field. I also show how this phenomenon in scalar quantum field theory can lead to an exponential enhancement of the single-barrier tunneling rate. My analysis is carried out in the thin-wall approximation. I discuss a possible explanation of the fast nucleation of the B phase of superfluid Helium-3 as an application.

Universality in D-brane Inflation

Gang Xu
The Hong Kong University of Science and Technology & Cornell University

We study the six-field dynamics of D3-brane inflation for a general scalar potential on the conifold, finding simple, universal behavior. We numerically evolve the equations of motion for an ensemble of more than 7 \times 10^7 realizations, drawing the coefficients in the scalar potential from statistical distributions whose detailed properties have demonstrably small effects on our results. When prolonged inflation occurs, it has a characteristic form: the D3-brane initially moves rapidly in the angular directions, spirals down to an inflection point in the potential, and settles into single-field inflation. The probability of N_{e} e-folds of inflation is a power law, P(N_{e}) \propto N_{e}^{-3}, and we derive the same exponent from a simple analytical model. The success of inflation is relatively insensitive to the initial conditions: we find attractor behavior in the angular directions, and the D3-brane can begin far above the inflection point without overshooting. In favorable regions of the parameter space, models yielding 60 e-folds of expansion arise approximately once in 10^3 trials. Realizations that are effectively single-field and give rise to a primordial spectrum of fluctuations consistent with WMAP, for which at least 120 e-folds are required, arise approximately once in 10^5 trials. The emergence of robust predictions from a six-field potential with hundreds of terms invites an analytic approach to multifield inflation.

A Phenomenological Model of Binary AGNs: The Binary AGN Frequency and the Merger Rate of Galaxies

Qingjuan Yu
Peking University

Binary AGNs (bAGNs) are natural byproducts of hierarchical mergers of galaxies in the LambdaCDM cosmogony. Recent systematic searches of bAGNs have shown that only a small fraction (~0.1%-1%) of AGNs at redshift z<~0.3 are bAGNs with separations on kpc scales, which appears far lower than previous thoughts. Here we construct a phenomenological model to estimate the number density of bAGNs and its evolution. We show that the model can well reproduce the bAGN frequency and bAGN separation distribution obtained from observations.

These results suggest that the seemly low observed bAGN frequency supports rather than contradicts with the hypothesis that major mergers lead to AGN/QSO activity. We also predict that the bAGN frequency become even smaller at higher redshift z~0.5-1.2, which may be tested by future observations on searching high-redshift bAGNs.

General Information and Maps

Catering Facilities on Campus

Restaurants	Types of Food	Location
China Garden Restaurant	Chinese dim sum, and Peking & Cantonese dishes	G/F (near Lifts 13-15)
Coffee Shop and Coffee Kiosk	Hot meals, sandwiches, baked potatoes, snacks, pastries, fruits, desserts and drinks	1/F (near Lifts 25-26)
LG1 Canteens	Fast food, sandwiches, snacks and desserts	LG1 (via Lifts 10-12 / 13-15)
LG5 Canteens	McDonald's, Hong Kong and Asian style fast food	LG5 (via Lifts 10-12)
UC Bistro	Western menu, lunch, dinner and snacks	Lo Ka Chung University Center

Wireless Internet Access

Wireless network "**sMobileNet**" is available in the conference venue, catering outlets and most of the public areas on campus:

User name = ***iascosmo***

Password = ***iashkust3***

Free wireless Internet service "**GovWiFi**" is also available at some public premises and designated tourist spots in town.

Useful Phone Numbers

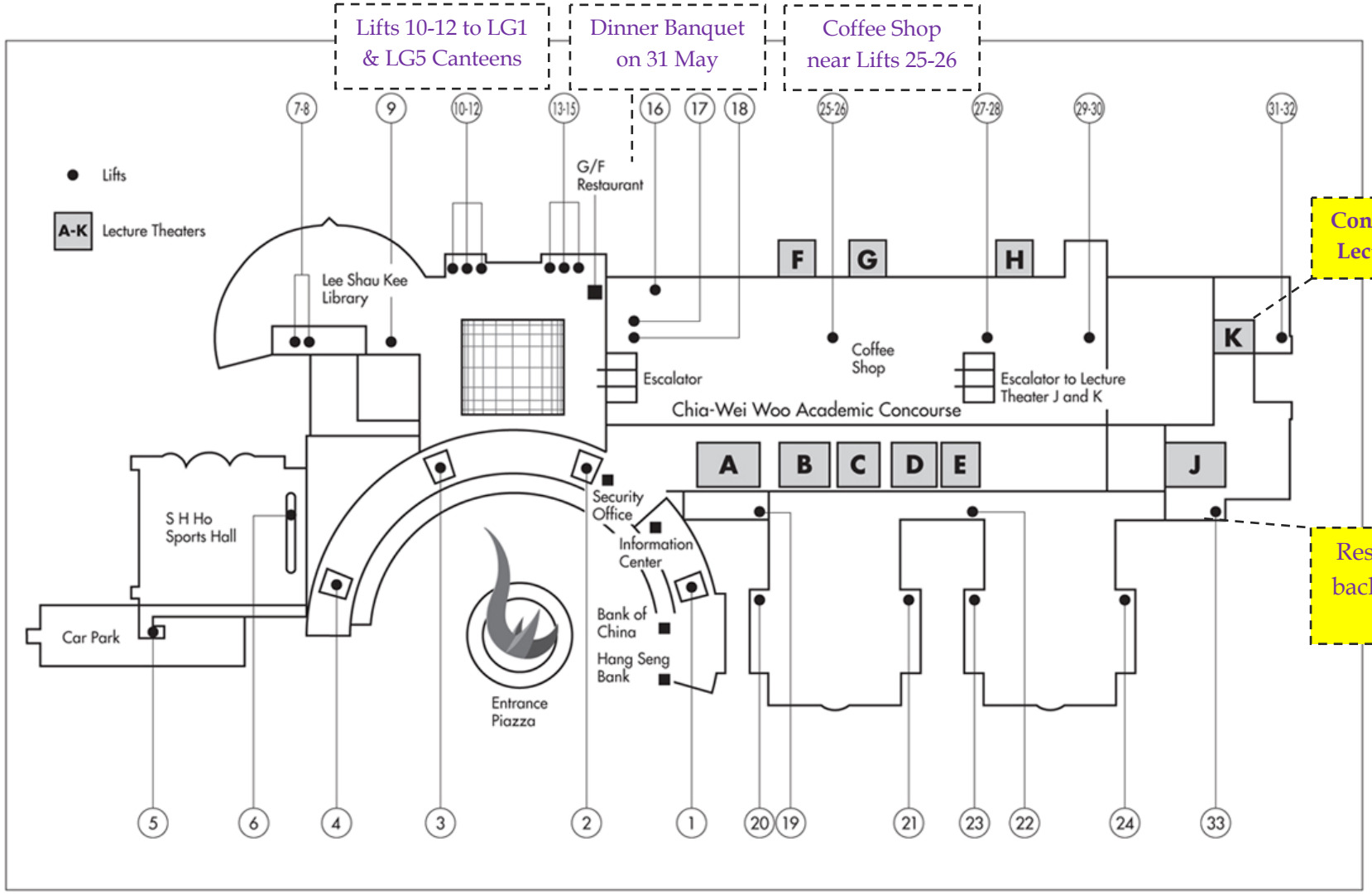
Conference Secretariat (HKUST IAS)	2358-5912 / 2358-8424
China Garden Restaurant (Reservations)	2358-1133
UC Bistro (Reservations)	2335-1875
Campus Security	2358-6565
Emergency / Ambulance	999 / 2358-8999
Regal Kowloon Hotel	2722-1818
Local Telephone Directory Inquiry	1081 (English) / 1083 (Chinese)

CAMPUS MAP

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

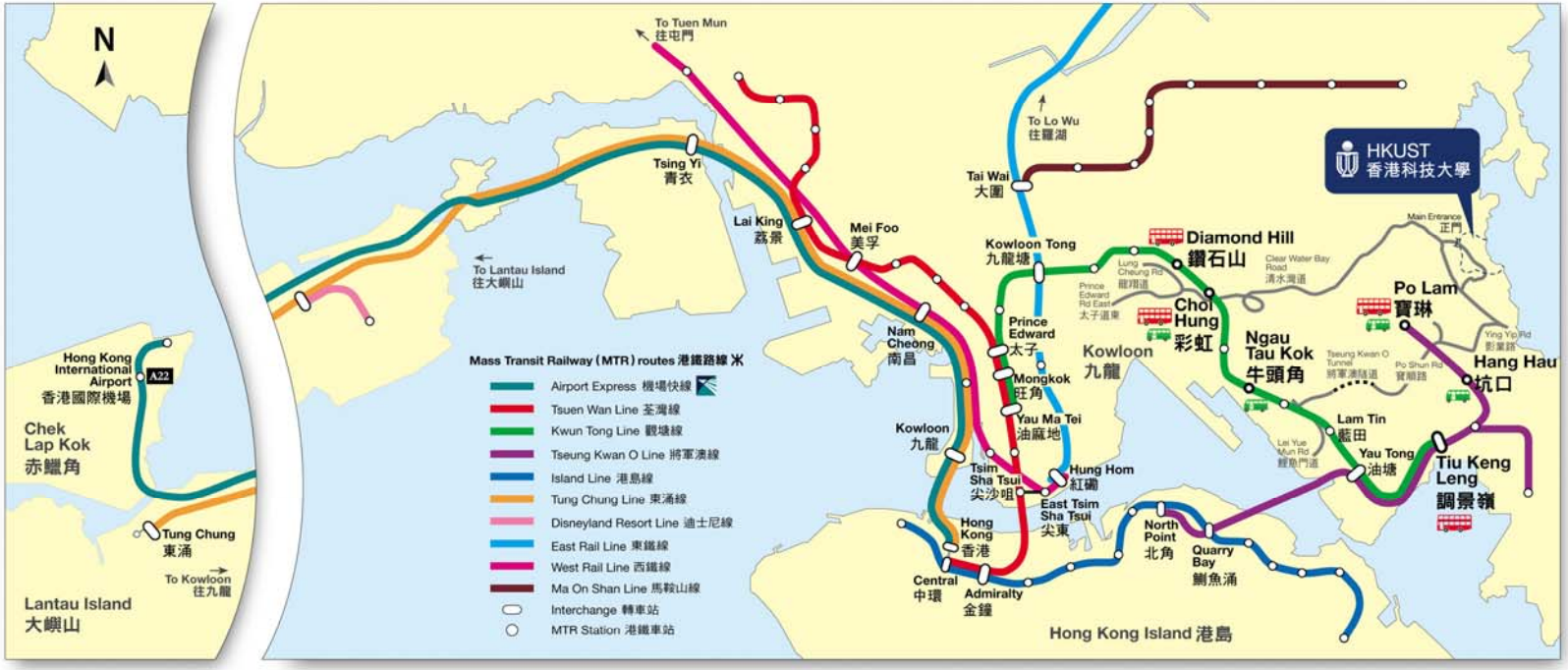
Academic Building Directory

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY



LOCATION MAP

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY



MTR Stations with bus or green minibus service to HKUST 提供往科大巴士或綠色專線小巴服務的港鐵車站		
Diamond Hill 鑽石山：	91, 91M	
Choi Hung 彩虹：	91, 91M	11, 11S
Ngau Tau Kok 牛頭角：		104
Tiu Keng Leng 調景嶺：	792M	
Hang Hau 坑口：		11, 11M, 11S
Po Lam 寶琳：	91M	11S, 12

Transportation from airport to HKUST:

For passengers with bulky luggage, taking a taxi to HKUST direct is recommended.
Those with simple luggage may take Airport Bus A22 to Lam Tin, and change for taxi to HKUST.

Bus Routes 巴士路線

Green Minibus Routes 綠色專線小巴路線