An exact General Relativity solution for the Motion and Intersections of Self-Gravitating Shells in the Field of a Massive Black Hole

It is found the complete exact solution in the General Relativity for the intersection process of two massive self-gravitating spherically symmetric shells (in general with tangential pressure). It is shown how one can calculate all shell's parameters after intersection in terms of the parameters before the intersection. The solution was applied to the analysis of matter ejection effect from stellar clusters. Also it is shown that the motion of two intersecting shells in general reveal a chaotic behaviour.

Bianco Carlo Luciano

The equitemporal surfaces in GRB afterglows

Bini Donato

On the Fermi work on a gravitating charge

Test particle motion as well as Maxwell equations are discussed in the frame of an accelerated observer using Fermi coordinates.

Chardonnet Pascal
The gamma ray bursts: a new window on cosmology?

Filippi Simonetta

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Galactic models with rotation and vorticity

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GRB 980425/SN 1998 bw association within EMBH model

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On the charge in Reissner-Nordström geometry

The interaction of a Reissner-Nordström black hole with charged test particle is studied together with the lines of force of their electric fields. The electric properties of the black hole horizon are discussed in detail and used to explain the expulsion of the lines of force from the horizon as the hole becomes extreme. The particle backreaction is also taken into account, studying the effect of general static perturbations of the hole following the pioneering approach of Zerilli.

Gurzadyan Vahe

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Ellipticity analysis of CMB maps

I review the recent studies of Boomerang and WMAP CMB maps which revealed ellipticity of anisotropies independent on the temperature threshold. The algorithms of the study of anisotropy areas are discussed. The ellipticity is detected at scales both smaller and larger than the horizon at the large scattering epoch. If this effect is due to geodesic mixing and hence due to non precisely zero curvature of the hyperbolic Universe, it can be related with the low multipole anomaly detected by WMAP.

Bi Hong-Guang

The formation of the first objects from the primordial gas: the log-normal model

We study the baryonic gas clouds (the IGM) in the universe before the reionization with the lognormal model which is shown to be dynamically legitimate in describing the fluctuation evolution in quasilinear as well as nonlinear regimes in recent years. The probability distribution function of the mass field in the LN model is long tailed and so plays an important role in rare events, such as the formation of the first generation of baryonic objects. We calculate density and velocity distributions of the IGM at very high spatial resolutions, and simulate the distributions at resolution of 0.15 kpc from z=7 to 15 in the LCDM cosmological model. We performed a statistics of the hydrogen clouds including column densities, clumping factors, sizes, masses, and spatial number density etc. One of our goals is to identify which hydrogen clouds are going to collapse. By inspecting the mass density profile and the velocity profile of clouds, we found that the velocity outflow significantly postpones the collapsing process in less massive clouds, in spite of their masses are larger than the Jeans mass. Consequently, only massive (> 10^5 M_sun) clouds can form objects at higher redshift, and less massive (10^4-10^5) collapsed objects are formed later.

For example, although the mass fraction in clouds with sizes larger than the Jeans length is already larger than 1 at z=15, there is only a tiny fraction of mass (10^8) in the clouds which are collapsed at that time. If all the ionizing photons, and the 10^{-2} metallicity observed at low redshift are produced by the first 1% mass of collapsed baryonic clouds, the majority of those first generation objects would not happen until z=10.

Jantzen Robert

Fermi Time and the Square Root of 2
By examining the geodesic equation in a Fermi coordinate system using the gravitoelectromagnetic splitting, rewritten as a relative acceleration equation, one sees that the special property of the speed of light as a constant solution is transferred to the coordinate speed $\sqrt{2}$ for the approximation of the Fermi coordinates when using the coordinate time instead of the Fermi coordinate observer proper time. However, examining the exact Fermi coordinates in Rindler spacetime for uniform acceleration along a fixed direction, one sees that this is an artifact of the limitations of the Fermi coordinate approximation, frozen in at the lowest order of the approximation, and when higher order terms become important one sees that it is really the speed of light which is the important speed.

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**Using Scale-Scale Correlation to Detect SZ effect in WMAP**

Recently WMAP observation had provided CMB data with high quanlity, such data excited interest on additional anisotropy, SZ effects is such a candidate. It's contribution to CMB had been debated. Here we use SSC of the difference in Q and W band of WMAP data to show a definite signal not from CMB, noise, mask or foreground like synchrotron/free-free/dust emisssion, so SZ is very likey the contributor. Also we show SZ indeed had such SSC with simulation.

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**Neutrino asymmetry and cosmological parameters estimation**

The recent analysis of the cosmic microwave background data carried out by the WMAP team seems to show that the sum of the neutrino masses is <0.7 eV. However, this result is not model-independent, depending on precise assumptions on the cosmological model. We study how this result is modified when the assumption of perfect lepton symmetry is dropped out.

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The discrepancy between the large scale structures of baryon gas and dark matter in the universe

I will present the investigation on the relationship between the mass and velocity fields of the intergalactic medium (IGM) and dark matter. Although the evolution of the IGM is dynamically governed by the gravity of the underlying dark matter field, many statistical properties of the IGM inevitably decouple from those of the dark matter once the nonlinearity of the dynamical equations and the stochastic nature of the field is considered. Many features of cosmic large scales structures can be explained with this discrepancy.

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A Hybrid Cosmological Hydrodynamic/N-body Code Based on a Weighted Essentially Non-Oscillatory Scheme

I will present a newly developed cosmological hydrodynamics code based on weighted essentially non-oscillatory (WENO) schemes for hyperbolic conservation laws. WENO is a higher order accurate finite difference scheme designed for problems with piecewise smooth solutions containing discontinuities, and has been successfully applied for problems involving both shocks and complicated smooth solution structures. We couple hydrodynamics based on the WENO scheme with standard Poisson solver - particle-mesh (PM) algorithm for evolving the self-gravitating system. The third order low storage total variation diminishing (TVD) Runge-Kutta scheme has been used for the time integration of the system. To test accuracy and convergence rate of the code, we subject it to a number of typical tests including the Sod shock tube in multidimensions, the Sedov blast wave and formation of the Zeldovich pancake. These tests validate the WENO hydrodynamics with fast convergence rate and high accuracy. We also evolve a low density flat cosmological model ($\Lambda$CDM) to explore the validity of the code in practical simulations.

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Gamma Ray Bursts

Xiang Shou-Ping
**Properties of Ultra-Luminous Infrared Galaxies**

We study the properties of hot gaseous halos in 10 nearby ultraluminous IRAS galaxies observed with the ACIS instrument on board Chandra. For all sample galaxies, diffuse soft X-ray emissions are found within ~10 kpc of the central region; their spectra are well fitted by a MEKAL model plus emission lines from alpha-elements and other ions. The temperature of the hot gas is about 0.7 keV and metallicity is about 1 solar. Outside the central region, extended hot gaseous halos are found for nine out of the ten ULIRGs. Most spectra of these extended halos can be fitted with a MEKAL model with a temperature of about 0.6 keV and a low metallicity (~ 0.1 solar). We discuss the implications of our results on the origin of X-ray halos in elliptical galaxies and the feedback processes associated with starbursts.

**On the dynamical formation of the Dyadosphere**

We describe electron-positron pairs creation around an electrically charged star core collapsing to an electromagnetic black hole (EMBH), as well as pairs annihilation into photons. We use the kinetic Vlasov equation formalism for the pairs and photons and show that a regime of plasma oscillations is established around the core. As a byproduct of our analysis we can provide an estimate for the thermalization time scale.
Simulating the structure formation in the Universe

In this talk I present the current status of the research activities at the Partner Group of MPA in Shanghai Astronomical Observatory. The backbone for our research is high resolution simulations. With these simulations, we have discovered a tight relation between the inner radius of dark matter halos and the mass within the inner radius. Based on this finding, we have developed a recipe for predicting the concentration parameter of dark matter halos from their mass accretion history. This prescription has been demonstrated to be significantly more accurate than the previous empirical formula, and can be applied to many research subjects in cosmology. We have also implemented the semi-analytical modeling of galaxy formation into our simulations. Because the subhalos are well resolved, the dynamical merger of galaxies, which is a key process to drive the evolution of galaxies, can be reliably followed in our simulations. Our model, for the first time, can reproduce very well the luminosity functions of galaxies in the five wavebands of the SDSS observation. I also present our recent measurement for the luminosity dependence of the pairwise velocity dispersion of galaxies in the 2dF Galaxy Redshift Survey, and demonstrate that the statistic is an important input for the galaxy formation models, including the halo occupation models. In collaboration with the University of Toronto, we have already started our campaign for a new sample of giant simulations, which aims at cosmological simulations of 8 billion particles and individual halo simulations of 100 million particles. These simulations will be more accurate than ever to predict how the structures have developed in our Universe.

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The formation of Bulge in Late-type Galaxies

The dynamical evolution of super star clusters (SSCs) moving in the background of a dark matter halo has been investigated as a possible event responsible for the formation of bulges in late-type spirals. The underlying physical processes include sinking of SSCs due to the dynamical friction and stripping of SSCs on their way to the center. Based on the assumption of a universal density profile for the dark matter halo, and an isothermal model for the SSCs, our simulations have yielded bulges that are similar in many aspects to the observational ones. In particular, the derived surface density profiles can be well fitted by an exponential structure with nuclear cusps, which is consistent with HST observations. The preliminary simulations with the Burkert density profile yield very instructive predictions on the bulge formation, which is surely worth further investigating.