Monday, Oct. 29th

9:50-11:00 Session 1

Author : John Wise
Title : First Galaxies
Abstract : I review recent results from early dwarf galaxy simulations that particularly focus on the transition from metal-free Population III stars to the formation of the first galaxies before redshift 7. We have investigated the variations in galaxy properties when changing the Pop III characteristic mass, critical metallicity, UV backgrounds, metal cooling, and feedback from radiation pressure. One constant result from all the simulations is a metallicity floor between [Z/H] = -3 to -4. We show that momentum transfer from ionizing radiation plays an important role in providing turbulent support and mixing metals, preventing the overproduction of stars and metals. This results in a stellar population with a tight metallicity distribution function centered at [Z/H] = -2, agreeing with the observed luminosity-metallicity relation in dwarf galaxies.

11:20-12:35 Session 2

Author : Juntai Shen
Title : Formation of the Milky Way
Abstract : **TBA**

Author : Greg Stinson
Title : Making Galaxies in a Cosmological Context (MaGICC)
Abstract: I will present results from the MaGICC project in which we used fully cosmological; smoothed particle hydrodynamics simulations of disk galaxy formation. This large computational project combines zoomed-in cosmological simulations of single galaxies at very high resolution with simulations of a large portion of the universe (100 Mpc)3 at moderate resolution to gain statistical information on the whole galaxy population. We have used a new implementation of the SPH scheme able to remove numerical artifacts due to inability of SPH to capture gas phase mixing. This project requires high performance computing and is generating one of the largest data-base for disc galaxy simulations. I will discuss the current success of MaGICC galaxies in reproducing several structural properties of observed galaxies.

14:00-15:30 Session 3

Author : Kohji Yoshikawa
Title : Vlasov-Poisson simulations of collisionless self-gravitating systems
Abstract : We present an alternative approach for simulating astrophysical collisionless self-gravitating systems; which directly integrates the collisionless.

Author : Qi Guo
Title : The limits of subhalo abundance matching
Abstract : We scale the Millennium and Millennium-II simulations of structure growth in a LCDM universe from the cosmological parameters with which they were carried out (based on first-year results from the Wilkinson Microwave Anisotropy Probe; WMAP1) to parameters consistent with the seven-year WMAP data (WMAP7). We implement semi-analytic galaxy formation modelling on both simulations in both cosmologies to investigate how the formation; evolution and clustering of galaxies are predicted to vary with cosmological parameters.

Author : Go Ogiya
Title : Landau resonance and the core-cusp problem in cold dark matter halos
Abstract : The coreusp problem still remains as one of the unsolved discrepancies between observations and theories predicted by the standard paradigm of cold dark matter (CDM) cosmology. Cosmological N-body simulations have always predicted a steep power-law mass-density profile at the center of CDM halos. However; recent observations of less-massive galaxies have revealed that the density profile of the dark matter (DM) halo is nearly constant around the center. The burst of star formation at the galactic center induces the large-scale outflow from the galactic center; and then the star formation terminates. Subsequently; gas component falls back toward the galactic center; if it loses a large amount of energy by the radiative cooling; and then a starburst arises again. This cycle of expansion and contraction of the interstellar gas could lead to the recurring change in the gravitational potential around the center of galaxies and have an impact on the density profile of the DM halos. To test this hypothesis; we investigate the

dynamical response of DM halos with a central cusp to recurring change of the baryon potential by using collisionless N-body simulations. The results show that the cycle of expansion and contraction of the interstellar gas is an effective mechanism for flattening the central cusp. The frequency of the star formation is one of the important factors in determining the dynamical response of DM halos. Furthermore; we compare these results with an analytical model of the resonance between the DM particles and the density waves of the interstellar gas which induce the recurring change of the gravitational potential. This analysis indicates that the resonance plays a decisive role for the cusp to core transition of the CDM halos; and can resolve the core-cusp problem.

Author : Taira Oogi
Title : Size evolution of early-type galaxies through dry mergers
Abstract : Recent observations show evidence that high-z ($z \sim 2-3$) early-type galaxies (ETGs) are more compact than those with comparable mass at $z \sim 0$. Such a size evolution is most likely explained by the 'Dry Merger Sceanario'. However; previous studies based on this scenario are not able to consistantly explain both the properties of the high-z compact massive ETGs and the local ETGs. We investigate the effect of multiple sequential dry minor mergers on the size evolution of the compact massive ETGs. From an analysis of the Millennium Simulation Database; we show that such minor (stellar mass ratio $M_2/M_1 < 1/4$) mergers are extremely common during hierarchical structure formation. We perform N-body simulations of sequential minor mergers with parabolic and head-on orbits; including a dark matter component and a stellar component. Typical mass ratios of the minor mergers are $1/20 < M_2/M_1 < 1/10$. We show that sequential minor mergers of compact satellite galaxies are the most efficient at promoting size growth and decreasing the velocity dispersion of the compact massive ETGs in our simulations. The change of stellar size and density of the merger remnants is consistent with recent observations. Furthermore; we construct the merger histories of candidates for the high-z compact massive ETGs using the Millennium Simulation Database; and estimate the size growth of the galaxies by the dry minor merger scenario. We can reproduce the mean size growth factor between $z = 2$ and $z = 0$; assuming the most efficient size growth obtained during sequential minor mergers in our simulations. However; we note that our numerical result is only valid for merger histories with typical mass ratios between 1/20 and 1/10 with parabolic and head-on orbits; and that our most efficient size growth efficiency is likely to an upper limit.

Author : Hesti R.T. Wulandari
Title : Impact of Orbital Eccentricity on the Capture of WIMP Dark Matter by Stars in the Galactic Center
Abstract : In the regions where high density of WIMP (Weakly Interacting Massive Particle) dark matter is expected; capture and annihilation of WIMPs have been suggested to influence the structure and evolution of stars (e.g. : Moskalenko & Wai (2007); Bertone & Fairbairn (2008) and Scott et al. (2009)). The capture rate depends on several parameters such as stellar mass; WIMP ambient density; WIMP mass; WIMP-nucleon cross section; metalicity and WIMP velocity distribution. In this presentation we will report results of study of the influence of orbital eccentricity on the capture rate of WIMPs by stars in the Galactic center. Especially; we study the influence on S-stars; young stars which are located very close to the Supermassive Black Hole at the Galactic center. The orbital parameters of 28 of the stars have been measured by Gillessen et al. (2009). We follow the orbital movements of these stars by using Mercury code (Chambers 1999); in which we introduce general relativity correction in the equations of motions. To simulate capture and annihilation of WIMPs by stars and follow their evolutions; we employ DarkStar code (Scott et al. 2009). Constraints from several current dark matter experiments on the value of WIMP mass and cross sections are used.

15:50-17:00 Session 4

Author : Hyesung Kang
Title : Particle Acceleration at Astrophysical Shocks
Abstract : **TBA**

Author : Franco Vazza
Title : The injection and evolution of cosmic ray hadrons in cosmological simulations
Abstract : The presence of relativistic protons within large scale structure is predicted by basic models of diffusive shock acceleration in cosmological shocks; and as a byproduct of active galactic nuclei and supernovae. I will review the recent implementations of cosmic rays evolution in our cosmological simulations employing adaptive mesh refinement; and their application to simulate observables in galaxy clusters. From the close comparison with available upper-limits of gamma observation (from the FERMI satellite) and radio data; important constraints on the efficiency of particle acceleration in the largest scale of the Universe can be derived from our simulations.

Tuesday, Oct. 30th

9:30-10:45 Session 5

Author : Tom Abel
Title : Following Dark Matter into Phase Space
Abstract : This talk gives some pedagogical remarks of how to understand the evolution of dark matter in phase space and then gives a more technical discussion of the use of N-body techniques in numerical cosmology. In fact, tessellating sheets in phase space allows one to derive accurate density estimates of and study details of the fine grain phase space distribution of dark matter in numerical simulations. Most surprisingly this information has always been included in N-body simulations but had previously been thought to be inaccessible. The insights gained from this new approach gives a clear path forward to devise simulation techniques that solve for the dark matter as a continuous fluid rather than Monte-Carlo sample it using the N-body technique. I show first results from new numerical techniques that can overcome some of the limitations of the current standard technique and discuss their own shortcomings. The approaches discussed here also generalize to the study of collisionless plasmas.

Author : Marcel Zemp
Title : Molecular Hydrogen based Star Formation
Abstract : I present results from cosmological structure formation simulations of galaxies at redshifts z ¿ 2. These simulations have an improved modeling of the interstellar medium and star formation. The simulations follow the formation and dissociation of molecular hydrogen and include star formation only in cold molecular gas. The molecular gas is more concentrated toward the center of galaxies than the atomic gas; and as a consequence; the resulting stellar distribution is very compact. I present results on the detailed structure of different matter components in the high redshift galaxies that form in these simulations.

11:05-12:35 Session 6

Author : Miguel-Angel Aloy
Title : "GRB Jets"
Abstract : **TBA**

Author : Jin Matsumoto
Title : Effect of Interacting Rarefaction Waves on Relativistically Hot Jets
Abstract : The effect of rarefaction acceleration on dynamics and structure of relativistically hot jets is studied through relativistic hydrodynamic simulations. We emphasize the nonlinear interaction of rarefaction waves excited at the interface between a cylindrical jet and the surrounding medium. From simplified one-dimensional models with radial jet structure; we find that a decrease in the relativistic pressure due to the interacting rarefaction waves in the central zone of the jet yields more a powerful boost of the bulk jet transiently than that expected from single rarefaction acceleration. This leads to a cyclic in-situ energy conversion between thermal and bulk kinetic energies which induces radial oscillating motion of the jet. It is confirmed from extended multi-dimensional simulations that this radial oscillating motion in one-dimensional system triggers Rayliegh-Taylor and Richtmyer-Meshkov instabilities in the relativistic jet.

Author : Akira Mizuta
Title : Jet Opening angle of gamma-ray burst outflows
Abstract : Gamma-Ray Bursts (GRBs) are the most energetic explosions in the Universe. The outflow is considered as ultra relativistic jet with small viewing angle ($\sim$ 0.1 rad.). It is important problem what physics determines the jet opening angle. Especially for long-GRBs the jet is not able to freely expand due to the cocoon confinement before jet break from the progenitor surface. We have done two dimensional relativistic hydrodynamic simulations to study the evolution of the jet opening angle. We have confirmed that the opening angle is smaller than the theoretically prediction; i.e. $\theta_j \sim \Gamma_0^{-1}$; where Γ_0 is initial jet Lorentz factor. The jet opening angle is rouhly $0.2\Gamma_0^{-1}$.

14:00-15:30 Session 7

Author : Yuichiro Sekiguchi
Title : Merger of Binary Neutron Stars
Abstract : In this talk; I will give a review on recent studies of numerical-relativity simulations of merger of binary

neutron stars. In particular; I will focus on recent studies on constraining the equation of state of neutron star matter using gravitational waves from the merger; and; possible electromagnetic counterparts of the merger events.

Author : Kenta Kiuchi
Title : General relativistic simulation of black hole - neutron star binary mergers
Abstract : I will give a talk about numerical relativity simulations of black hole - neutron star binary merger including a finite temperature equation of state and neutrino cooling.

Author : Ke-Jung Chen
Title : 3D Simulations of Thermonuclear Supernovae from the Most Massive Stars
Abstract : We present the results from our 3D simulations of thermonuclear supernovae from the stars with initial masses above 80 solar mass (Msun) using an AMR radiation-hydrodynamics code; CASTRO. Recent observations support the existence of very massive stars with initial masses over 100 Msun. After central helium burning; the core of such massive stars encounters electron/positron creation instabilities leading the stars to catastrophic collapse. The final fates of these stars are determined by the explosive burning during collapse. For the stars with initial masses between 80 and 140 Msun; they die as pulsational pair-instability supernovae (PPSNe). The collisions between shells of matter ejected by PPSNe might produce the superluminous SNe. For the stars with initial masses between 140 and 250 Msun; they die as pair-instability supernovae (PSNe); completely unbinding the stars and leaving no compact remnant. Our simulations model the explosive burning and resolve the fluid instabilities that occur during the explosion. We will discuss how the resulting mixing affects the explosion; nucleosynthesis; and observational signature of these supernovae.

Author : Yudai Suwa
Title : Numerical Simulation of Core-Collapse Supernovae
Abstract : I will present about our recent result of the multi-dimensional simulation for the core-collapse supernova explosion. We have performed 2D and 3D simulation including neutrino radiative transfer. The systematics of the modeling (e.g.; dimensionality; the equation of state; progenitor; etc.) will be discussed.

Author : Sergey Moiseenko
Title : Implicit Lagrangian method on variable triangular grid for magnetorotational supernova simulations
Abstract : We present specially developed implicit completely conservative operator-difference scheme on triangular Lagrangian grid of variable structure. The reconstruction of the grid allows dynamically adapt it. The Lagrangian nature of the method allows to conserve angular moentum.The method was applied for the simulations of magnetorotational (MR) supernova explosion mechanism. We show that MR supernova gives enough energy for the explanation core-collapse supernova event. MR instability in core-collapse supernova.

<u>15:50-17:00 Session 8</u>

Author : Michele Montgomery
Title : Missing Physics in Simulations of Accretion Disks
Abstract : Modulations in light curves and signals in associated Fourier transforms from compact binary systems inform us that disks precess in the prograde direction; in the retrograde direction; and sometimes simultaneously in both directions. Emission lines from these same systems show outlying data points around phase ; 0.5 that is often ignored in finding the orbital period and stellar mass of the system. Using 3D Smoothed Particle Hydrodynamics (SPH); we can reproduce all the observables and thus explain the outlying data points in the RV curves. By doing so; we confirm proposed models of disk tilt from decades ago. As shown in two Letters to the Astrophysical Journal in 2012; the source to disk tilt is not due to radiation from a central source; magnetic fields; or gravity; thereby supporting our model of lift as the source to disk tilt. Disk tilt is necessary to explain twisted disks around planets in addition to reproducing observables from compact binary systems; suggesting disk tilt is a common phenomena in many different accretion systems and thus a test to SPH codes on fluid flow in accretion disk systems. If time permits; we will discuss disk tilt results using 3D HD; MHD; and a radiative transfer grid code.

Author : Motoyuki Saijo
Title : Nonlinear effect of r-mode instability in uniformly rotating stars
Abstract : We investigate the r-mode instability of uniformly rotating stars by means of three dimensional hydrodynamical simulations in Newtonian gravity with radiation reaction. We propose a nonlinear anelastic approximation in the rotating reference frame; which kills the propagation of sound speed; in order to evolve the system beyond the acoustic timescale. We succeed in evolving uniformly rotating stars up to at least around several hundred rotation

period with our new scheme; which is at least 10 times longer than the previous standard hydrodynamical simulations. In order to verify our developed code; we impose the harmonic index of l=m=2 perturbation of an incompressible unstable r-mode eigenfunction to the equilibrium velocity; and find that the characteristic frequency of the unstable r-mode is excited throughout the evolution. We discuss the features of nonlinear r-mode instability with our newly developed code; such as saturation amplitude and the breaking wave effect of its instability.

Wednesday, Oct. 31st

9:30-11:00 Session 9

Author : Xian Chen

Title : Tidal Stellar Disruption by Binary Supermassive Black Holes

Abstract : Formation of binary supermassive black holes in galaxy centers is predicted by the hierarchical galaxy formation model. The coalescence of these binaries produces the loudest gravitational wave radiation detectable by LISA and PTA. Motivated by the recent success in detecting the electromagnetic flares from tidal disruptions of stellar objects by single supermassive black holes, we investigate the effects of binary black holes on the process of tidal stellar disruption, and their observational signatures. Using numerical scattering experiments, we calculated the stellar orbits around binary black holes, and found that the stellar-disruption rate differs from those in single black hole systems by orders magnitude. Based on such difference, we discuss the prospect of utilizing synoptic sky surveys to constrain the cosmic merger history of supermassive black holes. We also propose observational strategies to discover systems containing supermassive black hole binaries, especial for those in the regime of strong gravitational-wave radiation.

Author : Ken Ohsuga

Title : Radiation Magnetohydrodynamics of Black Hole Accretion Flows and Outflows

Abstract : By performing radiation magnetohydrodynamic (radiation-MHD) simulations, we succeeded in reproducing three distinct accretion modes, which are multi-dimensional version of slim disk, standard disk, and RIAF. In the case of moderate and low mass accretion rates (standard disk and RIAF), we find that the magnetic pressure force drives the outflows. The radiatively driven disk winds and jets are launched from the super-Eddington disks (slim disk). The jets are magnetically collimated and disk winds fragment into many clouds via radiation-pressure instability. Our model would resolve the recent X-ray observations of ULXs and AGNs.

Author : Kinsuk Giri

Title : Numerical simulations of a Two Component Advective Flow: Is The Flow Stable?

Abstract : Numerical simulations of a Two Component Advective Flow : Is The Flow Stable ? Two component advective flows are the most physical accretion disks which arise from theoretical consideration. Here high viscosity matter settles as the Keplerian disk on the equatorial plane; while low viscosity matter having lower angular momentum is accreted above and below this plane. Since viscosity is the determining factor; we investigate the effects of viscous stresses on accretion flows around a non-rotating black hole by time dependent hydrodynamical calculations; in great detail. As a consequence of angular momentum transfer by viscosity in a two-dimensional; rotating; axi-symmetric accretion flow; the angular momentum distribution is modified. We show that the centrifugal pressure supported shocks became weaker with the inclusion of viscosity. We also find that as the viscosity is increased; the amount of out flowing matter in the wind is decreased to less than a percentage of the inflow matter. Since the post-shock region acts as a reservoir of hot electrons or the so-called Compton cloud; the size of which changes with viscosity; the spectral properties are expected to depend on viscosity very strongly: the harder states are dominated by low-angular momentum and the low viscosity flow with a significant outflows while the softer states are dominated by the high viscosity Keplerian flow having very little outflows. We include cooling effects and found that a Keplerian disk is produced on the equatorial plane and the flow above and below remains sub-Keplerian. This gives a complete picture to date; of the formation of a Two component advective flow around a black hole.

Author : Tomohisa Kawashima

Title : Hot Spine and Compton-Cooled Sheath Structure of Radiation MHD Jet: Observational Feature of Super-Eddington Black Hole Accretion Flow with Outflow

Abstract : Recently; the structure of jets launched from super-Eddington accretion flows is studied by performing radiation MHD (hereafter Rad-MHD) simulations (Ohsuga et al. 2009; 2011: Takeuchi 2010). The previous studies; however; did not take into account the effects of Compton cooling; while radiation hydrodynamic simulations including Compton cooling/heating showed that the temperature of the jet is significantly decreased by Compton cooling (Kawashima et al. 2009). The detailed structure of outflows is important because the Compton cooled outflows significantly modify the photon spectra of super-Eddington accretion flows (Kawashima et al. 2012). We carried out; therefore; axisymmetric 2D Rad-MHD simulations of the super-Eddington black hole accretion flows; taking into account the effects of Compton cooling/heating. We found a hot spine and Compton-cooled sheath structure in the radiation pressure driven jets. The plasma temperature of the sheath jets decreases to $\sim 10^7$K via the Compton cooling; while the simulations without Compton cooling show hot ($\sim 10^9$K) sheath jets. We propose that the Compton downscattering in the sheath jet can form the photon spectral rollover at $\sim$ 5 keV observed in ultraluminous X-ray sources.

11:20-12:35 Session 10

Author : Yohei Miki

Title : Galaxy Merger and Hungry Black Hole: Suppression of Black Hole Activity due to Galaxy Merger

Abstract : Supermassive Black Holes (SMBHs) exist in the central region of galaxies universally; and have been considered to become luminous as Active Galactic Nuclei (AGN) by releasing gravitational energy of accreting gas; if a sufficient amount of gas accreted to the central SMBH. Galaxy collisions have been so far considered enhancing the AGN activity; by triggering mass fueling to the central SMBH due to angular momentum transfer (Sanders et al. 1988 etc.). However; galaxy collisions may be able to suppress the AGN activity: if mass reservoir of the central SMBH is swept away by galaxy collisions; then the AGN activity must be turn off due to lack of the fueling sources. So far; such a possible process has never been considered. Here; we investigate whether or not a galaxy merger can strip torus-shaped gas; considered as fueling source; surrounding an SMBH. Simple one-dimensional analytic model verifies that the gaseous torus is totally stripped via momentum transfer between the torus gas and the gas of an infalling satellite galaxy. The results of three-dimensional hydrodynamic simulations nicely confirm simple analytic estimate quoted above. Furthermore; the results clearly show that the stripping of the torus-shaped gas is significant; when the column density of the gas in the infalling galaxy is greater than that of the torus.

Author : Ataru Tanikawa

Title : Merger growth of a massive black hole in a primordial galaxy: conditions for successive merger of multiple massive black holes

Abstract : We have performed N-body simulation to follow the dynamical evolution of 10 massive black holes (MBHs) in galaxies with different 3 dimensional velocity dispersions. We include post-Newtonian gravity up to 2.5 order in MBH-MBH interactions; and give gravitational recoil to merger remnants of MBHs. The gravitational recoil velocity is several hundreds km/s. We have found that 4 - 6 MBHs merge successively to one dominant MBH within 1 Gyr in galaxies with velocity dispersions more than 200 km/s. On the other hand; only 3 MBHs merge in a galaxy with velocity dispersions with 120 km/s. Since galaxies with larger velocity dispersion have larger stellar mass density; MBHs receive dynamical friction more strongly; and fall more easily into the galactic center where MBHs merge. Furthermore; we discuss footprints of successive mergers of MBHs. Galaxies which experience such successive mergers have the feature that high-velocity stars are formed intermittently; in contrast to their constant formation in galaxies with only two MBHs.

Author : Takanobu Kirihara

Title : Galaxy Collision and the Outer Density Profile in Andromeda Galaxy

Abstract : Recent theory of the structure formation in the universe using cosmological N-body simulations predicts that cold dark matter (CDM) halos have a universal mass-density profile (Navarro; Frenk & White 1995; Fukushige & Makino 1997; Moore et al. 1998). The prediction of the density profile of CDM outer halos decreases with the cube of the distance from the galactic center. However; so far not much effort has been done to examine this hypothesis. Recent observation discovers a giant stellar stream and stellar shells in the halo of the Andromeda galaxy (M31). The giant stream extends over 100 kpc from the center of M31; and its spatial and velocity structure was observed in detail. Then; N-body simulations of a galaxy collision between a satellite dwarf galaxy and M31 nicely reproduced these structures (Fardal et al. 2007; Mori & Rich 2008; Miki et al. 2010). This giant stellar stream provides an attractive window to explore the structure of outer CDM halo in the Andromeda galaxy. In this study; we follow the approach of earlier studies (Fardal et al. 2006; 2007; Mori & Rich 2008) in simulating the infall of a massive satellite into M31. However; we change the density profile of the CDM halo of the Andromeda galaxy. Only for the DM halo with a density power-law slope of -3 ¡ x ¡ -4.5; the results of simulations successfully reproduce the giant stream and (for a similar but much older collision) the apparent shell structures that are observed in the star count maps. In other words; our result indicates that the actual density profile of the outer DM halo of the Andromeda galaxy is a steeper than that of the CDM model. In addition; we also focus on the inner structure of the satellite galaxy. Our latest simulation shows that the progenitor could be the disk-like galaxy to reproduce the observed asymmetric structure of the giant stellar stream.

Author : Ryoji Matsumoto

Title : Global Three-dimensional Magnetohydrodynamic Simulations of Disk Dynamos

Abstract : We present the results of global three-dimensional magnetohydrodynamic (MHD) simulations of accretion disks and galactic gas disks. The initial state is a differentially rotating gas disk threaded by weak azimuthal magnetic fields. We included a whole disk in the simulation region to avoid imposing symmetric or antisymmetric boundary condition at the equatorial plane. In simulations of black hole accretion disks; we applied an MHD code in cylindrical coordinates based on the HLLD scheme (Miyoshi and Kusano 2005). Numerical dissipation of magnetic fields is reduced by applying the 5th-order monotonicity-preserving (MP5) scheme. Numerical results indicate that the combination of the magnetic field amplification by magneto-rotational instability (MRI) and the buoyant escape of magnetic flux by Parker instability drives cyclic dynamos in the disk; the mean azimuthal magnetic fields reverse their direction in time scale of 10 rotation period. The buoyantly rising magnetic loops transport the magnetic energy from the disk to the halo. In simulations of galactic gas disks; we computed the distribution of the rotation measure and compared it with observations. Such comparison may reveal the previous magnetic activities of our galaxy.

Author : Alexander M. Beck

Title : Simulating Magnetic Fields in Interacting Galaxies and Forming Galactic Halos

Abstract : We present MHD simulations of the compact galaxy group Stephan's Quintet as well as simulations of cosmological Milky-Way like galactic halo formation performed with the N-body / SPMHD code GADGET. The simulations also include radiative cooling; star formation; supernova feedback and the description of non-ideal MHD. Within the cosmological simulations; a primordial magnetic seed field or a supernova seeded magnetic field agglomerates together with the gas within filaments and protohaloes. There; it is amplified within a couple of hundred million years up to equipartition with the corresponding turbulent energy. The magnetic field strength increases by turbulent small-scale dynamo action. The turbulence is generated by gravitational interactions and by supernova feedback. Subsequently; a series of halo mergers leads to shock waves and amplification processes magnetizing the surrounding gas within a few billion years. At first; the magnetic energy grows on small scales and then self-organizes to larger scales. Magnetic field strengths of microGauss are reached in the center of the halo and drop to nanoGauss in the IGM. Analyzing the saturation levels and growth rates; an analytical model is able to describe the process of magnetic amplification notably well and confirms the results of the simulations.

<u>14:00-15:30 Session 11</u>

Author : Axel Brandenburg

Title : "Dynamos"

Abstract : Many astrophysical bodies (for example the Sun or the Milky Way) consist of hot ionized gas which is electrically conducting. Such flows are also turbulent. However, a purely hydrodynamic turbulent state can become unstable to the dynamo instability, so the final state becomes magnetized. Significant amounts of energy can then be converted to and dissipated through magnetic fields. Numerical simulations show a turbulent forward cascade in which the magnetic spectral energy is always slightly larger than the kinetic spectral energy. The ratio of kinetic to magnetic energy dissipation scales with the magnetic Prandtl number approximately to the 1/2 power, so at low magnetic Prandtl numbers, most of the energy is dissipated magnetically. This leaves much less energy in the rest of the kinetic energy cascade than at unit magnetic Prandtl numbers. Consequently, at given numerical resolution the viscosity can be lower than otherwise. Simulations show that for isotropically forced turbulence, the so-called small-scale dynamo exists at magnetic Prandtl numbers down to 0.01.

Next, I will discuss two quite different examples in which turbulent hydromagnetic flows can develop spatio-temporal structures on scales much larger and longer than those of the turbulence. The first example is what is sometimes referred to as a mean-field or large-scale dynamo, which requires finite helicity of the flow. Since magnetic helicity is conserved in the limit of high electric conductivity, it is driven preferentially to larger scales. This process can be modeled quantitatively in terms of averaged equations in which the magnetic diffusivity is renormalized and other new terms (e.g. the alpha effect) appear.

The second example is about a process that is now sometimes referred to as negative effective magnetic pressure instability. In this case the magnetic pressure gets renormalized and can become negative. This process is general and exists even in isotropic non-helical turbulence. However, when it is applied to a strongly stratified gas with an applied uniform magnetic field, an instability develops that leads to magnetic flux concentrations on scales encompassing that of at least ten turbulent eddies. The physics behind this is straightforward: as the magnetic field is increased, it increases the magnetic pressure, but it also suppresses the turbulent pressure, and this effect can be stronger, rendering the total magnetic effect a negative one.

These two examples illustrate the general principle by which the consideration of averaged equations can lead to new

insights with quantitative predictions that are then also borne out by direct numerical simulations. Other dramatic examples include the turbulent pumping of passive scalars and angular momentum transport even for rigid rotation. An important application of such considerations are simulations of the solar dynamo. The principle problems faced so far include a proper understanding of the cycle period and the equatorward migration of its magnetic activity belts at low latitudes. While simulations are now beginning to reproduce such behavior of the Sun, we are still struggling to provide tenable explanations for what is now obtained in simulations.

Author : Youhei Masada

Title : Mean Field Generation in Local Convective Dynamo Simulation

Abstract : We study three dimensional dynamics of convection zone coupled with stably stratified tachocline by means of a local box simulation. It is reconfirmed by our numerical study that the networked convection pattern with narrow downflow lanes and broad upflow cells is strongly affected by both the latitudinal position and angular velocity of the simulation box: the faster rotation gives the smaller and more inclined convective cells to the rotation axis. Around the equatorial region; the convective cell is more elongated in the latitudinal direction for the model with the faster rotation. As was pointed out by Brandenburg et al. (1996); the turbulent magnetic field seems to be amplified in the whole convection zone by vortical swirling downdrafts. A part of the dynamo-generated magnetic field is then supplied to the stably stratified tachocline by the downward convective pumping. It is found from our study that the mean magnetic field; which might be responsible for the coherent sunspot field; can be generated in the boundary layer between the convection zone and the tachocline region (cf. Kapyla et al. 2009). In this meeting; we will explain the properties of the generated mean field in detail and will present its dependence on the physical parameters; such as the angular velocity; the latitudinal position and the strength of thermal stratification of the system.

Author : Federico A. Stasyszyn

Title : Global Mean Field Dynamo simulations with SPMHD

Abstract : Following the developments in SPMHD we implemented the turbulent transport terms in the induction equation for the evolution of the magnetic field in; with the aim to perform realistic modelling of dynamo action in global galaxy simulations. Besides the spatial dependent turbulent diffusion η also the α-tensor is included. For a disk setup we verify our numerical results with a known analytical model of Meinel 1990. Further comparisons with grid based numerical simulations for disks with a galactic rotation law and an anisotropic α-effect are shown. Additionally; an accurate method for measuring local turbulence as been implemented. This allow us to perform global galaxy simulations with a simple subgrid models accounting for the dynamo action; which can be linked to upcoming and present day radio observations.

15:50-17:35 Session 12

Author : Lin-Ni Hau

Title : "Magnetic Reconnection in Space Plasmas"

Abstract : One of the most important discoveries obtained from in-situ measurement of solar system plasma and magnetic field is the magnetic reconnection which may occur in the solar wind, at planetary magnetopause and magnetotail as well as heliopause etc. For the past half century substantial efforts have been made on the theory, simulation and observation of magnetic reconnection which remains to be one of the most outstanding research areas in space and laboratory plasmas. The Earth 's magnetopause separating two different origins of magnetized plasmas is an ideal site for the occurrence and study of reconnection physics due to its accessibility to spacecraft measurement. In this talk a brief overview is presented of the physics of magnetopause current and reconnection in the context of theory and observation.

Author : Hoonkyu Kim

Title : Inverse Energy Cascade and Imbalanced Magnetohydrodynamic Turbulence

Abstract : Electron magnetohydrodynamic (EMHD) turbulence provides a fluid-like description of small-scaleagnetized plasmas.ost EMHD turbulence studies consider alancedEMHD turbulence; in whicho magnetic helicity is injected. In this study; we numerically study mbalancedEMHDurbulence. When magnetic helicitys injectedt a scale; we expect toave inverse cascade of magnetic helicity; as well as magnetic energy; in three-dimensional (3D) EMHDurbulence. We injectagnetic helicity inhree different ways: (1) maximal magnetic helicity injection; (2) partial magnetic helicity injection; and (3) no magneticelicity injection. For no helicity injection; we do not observe inverse energy cascade. However; when partial or maximal helicity is injected; inverse cascade of magnetic helicitys clearly observed . Magnetic energy also show inverse cascade. InMHD turbulence; it is well known thathe magnetic energyn scales smaller than the energy injection scales direct-cascading quantity and the magnetic energy spectrum follows a $k^{-7/3}$ one. On the other hand; the inverse-cascading entity on scales larger than the energy injection scale is uncertain. Ifhe magnetic helicitys inverse-cascading quantity; we will obtain a $k^{-5/3}$ magnetic energypectrum. In our simulations; we do observen energy spectrum consistant with $k^{-5/3}$ on large scales. Therefore; we confirm that magnetic helicity indeed ishe inverse-cascading entity in 3D EMHD turbulence.

Author : Hyunju Yoo

Title : Effects of forcing scale on MHD turbulence

Abstract : Turbulence is ubiquitous in astrophysical fluids such as the interstellar medium (ISM) and the intracluster medium (ICM). There are many driving mechanisms which can inject energy into the fluid on variety of scales. In a real astrophysical fluid; it is likely that multiple driving mechanisms act on different scales simultaneously. Therefore; understanding different statistical properties between turbulence with single forcing scale and turbulence with double forcing scales is required. In this work; we perform 3-dimensional incompressible/compressible; magnetohydrodynamic (MHD) turbulence simulations. We drive turbulence in Fourier space in two wavenumber ranges; 2¡k¡3 (large scale) and 15¡k¡26 (small scale). We control energy injection rates by changing the amplitudes of forcing in these ranges. We present time evolutions of kinetic and magnetic energy densities and spectra of density; velocity and magnetic fields. We also examine second-order structure function of polarization angle.

Maarten Baes 3D dust radiative transfer in galaxies

Radiative transfer plays a central role in astrophysical research: virtually all information of astronomical objects is transported to us by radiation; but dust particles; omnipresent in many astrophysical environments; are extremely efficient in absorbing; scattering and re-emitting this radiation. The radiative transfer problem is one of the few grand challenge problems in computational astrophysics due to its high dimensionality and the underlying integro-differential transport equation. We present an overview of the recent advancements in developing efficient 3D Monte Carlo radiative transfer codes. We focus on the SKIRT radiative transfer code; a state-of-the-art tool developed to model the interstellar medium in galaxies and the dusty tori around active galactic nuclei. We present our new 3D clumpy torus models; as well as detailed panchromatic models for nearby edge-on spiral galaxies fitted to a large panchromatic data set.

Thursday, Nov. 1st

10:30-11:00 Session 13

Author : Ralf Klessen

Title : Star Formation Throughout the Cosmic Ages

Abstract : Stars and star clusters are the fundamental visible building blocks of galaxies at present days as well as in the early universe. Identifying the physical processes that initiate and regulate stellar birth in our Milky Way can therefore contribute significantly to our understanding of star formation at high redshifts.

Today, stars form by gravoturbulent fragmentation of interstellar gas clouds. The supersonic turbulence ubiquitously observed in Galactic molecular gas generates strong density fluctuations with gravity taking over in the densest and most massive regions. Collapse sets in to build up stars and star clusters. Turbulence plays a dual role. On global scales it provides support, while at the same time it can promote local collapse. Together with the thermodynamic properties of the gas it regulates the fragmentation behavior in star forming clouds.

I discuss our current understanding of present-day star formation and speculate about the implications for the first and second generation of stars in the universe. Special emphasis lies on the distribution of stellar masses and their dependency on metallicity. I argue that the characteristic stellar mass is roughly constant for a wide variety of environmental conditions and that we expect a transition towards higher masses for metallicities below about 10^-5 times solar due to dust cooling. I define the dominant fragmentation processes at different metallicities and speculate that the masses of zero-metallicity stars were smaller than previously thought and that even the very first stars in the universe formed as members of multiple stellar systems or small clusters.

Author : Tomoaki Matsumoto

Title : Protostellar collapse of magneto-turbulent cloud cores: formation of protoplanetary disks and outflows

Abstract : Protostellar collapse of magneto-turbulent cloud cores: formation of protoplanetary disks and outflows We investigate formation of protoplanetary disks and outflows inside collapsing turbulent molecular cloud cores by resistive MHD simulations. By using a self-gravitational adaptive mesh refinement (AMR) code; SFUMATO; the collapse of the cloud core is followed in a wide dynamic range; we resolve both a cloud cores scale and a protoplanetary disk scale. A protostar is modeled with a Lagrangian sink particle. The resistivity yields the ohmic dissipation; which is solved by an implicit scheme. We followed collapse of the turbulent molecular cloud cores and accretion onto the protostars (sink particles) up to 1000 yr after the protostar formation. The simulations show that the strong turbulence and weak magnetic fields promote a relatively rapid growth of a protoplanetary disk around the sink

particle. The strong magnetic field models exhibit the cavities in infalling envelopes around the protostars. All the models exhibit protostellar outflows.

11:20-12:20 Session 14

Author : Ruben Krasnopolsky
Title : "Formation of Protostellar Disks"
Abstract : The formation of rotationally supported disks (RSDs) is a crucial event of the early times of star formation.

There are theoretical difficulties in forming rotationally supported disks during the protostellar collapse of magnetized dense cores. It is often expected that disks would form automatically out of the collapse of rotating cores because of angular momentum conservation. In the presence of the observed level of magnetic fields, this simple explanation is no longer guaranteed to work, because of magnetic braking and magnetic instabilities. Indeed, in the simplest case of the ideal MHD limit, both analytic work and numerical simulations showed that RSD formation is completely suppressed by excessive magnetic braking. Our axisymetric simulations have shown recently that non-ideal MHD effects (including Ohmic dissipation, ambipolar diffusion and the Hall effect) do not weaken the magnetic braking enough to enable RSDs to form under typical cloud conditions. Nevertheless, RSDs are observed around at least more evolved young stellar objects and have to form sooner or later.

I will discuss possible resolutions to this problem, including non-axisymmetic magnetic interchange instabilities in 3D, misalignment of magnetic field and rotation, enhanced magnetic diffusivities (perhaps due to turbulence or reconnection), and outflow stripping of the protostellar envelope, and comment on the apparently discrepant results in the literature on this important topic of the early epoch of star formation.

Author : Kengo Tomida
Title : Formation of Protostellar Cores and Circumstellar Disks
Abstract : We perform 3D nested-grid radiation magnetohydrodynamic simulations of protostellar collapse with and without the Ohmic dissipation. We follow the evolution from molecular cloud cores to protostellar cores. In the ideal RMHD models; the evolution of the protostellar core is very similar to that in the spherically symmetric non-rotating model due to the efficient angular momentum transport. However; if the resistivity presents; the angular momentum transport is considerably suppressed due to the redistribution of magnetic flux; and rotationally-supported circumstellar disks are rapidly built up in the vicinity of the protostellar cores. In the resistive models; two different types of outflows are launched from different scales due to the interaction between magnetic fields and rotation; slow loosely-collimated outflows from the first cores; and fast well-collimated outflows from the protostellar cores.

Author : Kohji Tomisaka
Title : Expected Observations of Star Formation Process: from Molecular Cloud Core to First Hydrostatic Core
Abstract : We did MHD simulations of the contraction of rotating; magnetized molecular cloud cores. In the molecular cores; B-field and angular momentum (J) vector are not always aligned. When a first hydrostatic core forms; axisymmetric structure appears and average B and J are parallel in small scale. However; in large scale; the configuration is far from this. This means that contraction process is imprinted on the snapshot. We calculated two mock observations of MHD simulations (1) the polarization from dust thermal emission to reveal the magnetic evolution and (2) the line emissions from interstellar molecules to reveal the evolution of density and velocity. Comparing the mock observations with true ones; we can answer several questions: in which case the hourglass-shaped and S-shaped magnetic fields are seen; how the distribution of polarized intensity is understood; how the first hydrostatic core should be observationally identified.

13:40-15:25 Session 15

Author : Ing-Guey Jiang
Title : Debris Disks and Planetary Systems
Abstract : The formation and evolution of planetary systems have always been interesting and important topics; particularly after many extra-solar planets being discovered. Debris disks do not only play vital roles during the formation and evolution of planetary systems; but also act as a useful visible tool to provide hints for other invisible components in planetary systems. I will review what has been done so far and discuss what could be done in the near future to advance our knowledge in this field.

Author : He-Feng Hsieh
Title : On the secular behavior of dusts in an eccentric protoplanetary disk with an embedded massive planet

Abstract : We investigate the dust velocity and spacial distribution in an eccentric protoplanetary disk under the secular gravitational perturbation of an embedded planet of about 5 Jupiter masses. We employ the FARGO code to obtain the 2-dimensional gas profile; and then use the secular perturbation theory with gas drag to estimate the dust perturbed profile on the secular timescale. In the model with the planet at 5AU; we find that dusts smaller than one meter behave similarly to the gas and exhibit non-axisymmetric dynamics. However; for the case of 100 AU; a low-density gaseous disk; the azimuthal distributions of dust of various sizes can deviate significantly.

Author : Akimasa Kataoka

Title : Static Compression Process of Dust Aggregates in Protoplanetary Disks

Abstract : Planetesimal formation process in protoplanetary disks is a key issue in planet formation. Recently; internal density evolution of dust aggregates with collisional compression has been proposed to solve this problem (Okuzumi et al. 2012). However; other compression processes; which are caused by gas drag or self gravity; have not been considered. Such compression processes may differ from collisional compression processes; and thus it may greatly affect internal density evolution of dust aggregates. Therefore; we investigated static compression processes of porous aggregates by calculating N-body simulation with considering direct interaction forces (Wada et al. 2007); and we determine the equation of state of porous aggregates.

Author : Eiichiro Kokubo

Title : The final stage of terrestrial planet formation

Abstract : The final stage of terrestrial planet formation is known as the giant impact stage where protoplanets collide with one another to form planets. We derive an accretion condition for protoplanet collisions in terms of impact velocity and angle and masses of colliding bodies; from the results of numerical collision experiments. We adopt this realistic accretion condition in N-body simulations of terrestrial planet formation from protoplanets and compare the results with those with perfect accretion and show how the accretion condition affects terrestrial planet formation. We find that in the realistic accretion model; about half of collisions do not lead to accretion. However; the final number; mass; orbital elements; and even growth timescale of planets are barely affected by the accretion condition. For the standard protoplanetary disk model; typically two Earth-sized planets form in the terrestrial planet region over about 100 Myears in both realistic and perfect accretion models. We also find that typically 10-30% of the total protoplanet mass is released as collisional debris in this stage. We demonstrate that if the debris is distributed locally around a planet orbit; the orbital eccentricity of the planet can be damped to 0.01 through dynamical friction from the debris in 100 Myears.

15:45-17:00 Session 16

Author : Hyunjin Cho

Title : Density Distribution Functions in Supersonic Turbulence

Abstract : We study the properties of supersonic turbulence; using isothermal 3D MHD simulations and 13CO line observations of Galactic molecular clouds. We first calculated the density Probability Distribution Functions (PDFs) both in Position-Position-Position (PPP) space and in Position-Position-Velocity (PPV) space for the simulated turbulence; driven with a wide range of sonic Mach number and plasma beta. The simulated PDFs follow the log-normal distributions and their variances scale with the sonic Mach number. We then estimated the PDF variances and the Mach number of turbulence in the molecular clouds identified in the Galactic Ring Survey. The observed density PDFs in PPV space are not consistent with the scaling relation; which was derived from the numerical simulations. We suggest that the turbulence driven on small scales and the gravitational contraction of molecular clouds may explain this discrepancy.

Author : Tsuyoshi Inoue

Title : Formation of Turbulent and Magnetized Molecular Clouds

Abstract : Using 3D MHD simulation with the effects of radiative cooling/heating; chemical reactions; and thermal conduction; the formation of molecular cloud is studied. We consider the shock compression of HI clouds as a trigger of the molecular cloud formation; as suggested by recent observations. We find that the formed molecular cloud is very turbulent whose size-velocity dispersion relation is consistent with observations. We also find that dense molecular clumps in the cloud evolve toward magnetically supercritical cores via clump-clump collisions. Our results may provide a typical initial conditions of star formation.

Author : Elizabeth Tasker

Title : How to kill a GMC

Abstract : What controls the life expectancy of a giant molecular cloud is a hotly debated subject. One view is

that supernovae blow away the surrounding gas. Other opinions suggest this mechanism occurs too late; and earlier feedback is responsible for cloud destruction. This talk presents results from a high resolution (¡ 10pc) numerical simulation of a global Milky-way type galaxy which includes thermal feedback. We follow the evolution of the GMCs as they interact in the disc; form stars and undergo supernovae-type thermal energy injection. At the end; we postulate which of the events occurring in their lifetime dominates their evolution.

Author : Ui-Han Zhang
Title : Nonlinear instability of the cold cloud in a two-phase interstellar medium
Abstract : Usually; the interstellar medium can be regarded as a two-phase fluid. Dense cold molecular clouds of soft equation of state are immersed in a sea of hot gas of hard equation of state. Hence; the sonoluminescence mechanism can occur in such an environment. That is; a small amplitude sound perturbation in the hot gas can be greatly amplified when propagating onto the cold cloud; thereby forcing the Jeans stable cloud to collapse. In this work; we investigate this novel mechanism numerically with the adaptive-mesh-refinement scheme. Armed with the GPU-accelerated code; GAMER[1]; we are able to search for the parameter space for the nonlinear-instability boundary. [1] Schive; H.; Tsai; Y.; & Chiueh; T. (2010). GAMER: a graphic processing unit accelerated adaptive-mesh-refinement code for astrophysics. ApJS; 186; 457.

Author : Yuta Asahina
Title : Magnetohydrodynamic Simulations of the Formation of Molecular Clouds in Our Galactic Center
Abstract : We carried out magnetohydrodynamic (MHD) simulations to reveal the formation mechanism of molecular columns observed in the central region of our galaxy. These molecular clouds can be formed by the interaction of a magnetic tower jet with the interstellar gas. When the jet collides with dense neutral hydrogen (HI) clouds; the HI gas is compressed by the bow shock ahead of the jet. Since the density enhancement triggers the cooling instability because it increases the cooling rate; the shocked gas cools down and forms cold; dense gas. We carried out MHD simulations including the cooling. The magnetic loops emerging from the accretion disk around the central black hole are twisted by the differential rotation at the footpoints of the loops. Numerical results indicate that the magnetic loops expand; and form a magnetic tower. When the ambient density is small; the propagation speed of the tower can be as large as the rotation speed of the disk. When the jet collides with the HI cloud; it triggers the formation of the molecular column. The magnetic tower rotates with the rotation speed of the disk. On the other hand; the rotation speed of the dense molecular column is much smaller.

Friday, Nov. 2nd

9:30-10:45 Session 17

Author : Junichiro Makino
Title : "High Performance Computing for Cosmological Simulation"
Abstract : **TBA**

Author : Tomoaki Ishiyama
Title : The Gravitational Trillion-Body Problem on K computer
Abstract : The fine structure of dark matter halos is very important for dark matter detection experiments. The mass of the smallest dark matter structures in the Milky Way is predicted to be comparable to the earth mass; which is 18 orders of magnitude smaller than that of the Milky Way. In order to reveal such fine structures; extremely large simulations are demanded. However; developing a highly-scalable simulation code is not a trivial task. Our massively parallel code for large gravitational N-body simulations can address the scientific requirements. We used the hybrid TreePM method; in which the short-range force is calculated by the tree algorithm; and the long-range force is solved by the particle-mesh algorithm. We developed a highly-tuned gravity kernel for short-range forces; and a novel communication algorithm for long-range forces. We present the implementation in detail and report performance results of cosmological N-body simulations of one trillion particles performed on the full system of K computer. The average performance on 24576 and 82944 nodes of K computer are 1.53 and 4.45 Pflops; which correspond to 49% and 42% of the peak speed.

11:05-12:35 Session 18

Author : Jae-Min Kwon
Title : "Gyro-kinetic Code and Prospect for Astrophysics"

Abstract : **TBA**

Author : Yosuke Matsumoto
Title : Electron accelerations at high Mach number shocks: Two-dimensional Particle-in-Cell simulations on massively parallel supercomputer systems
Abstract : We present the results of global three-dimensional magnetohydrodynamic (MHD) simulations of accretion disks and galactic gas disks. The initial state is a differentially rotating gas disk threaded by weak azimuthal magnetic fields. We included a whole disk in the simulation region to avoid imposing symmetric or antisymmetric boundary condition at the equatorial plane. In simulations of black hole accretion disks; we applied an MHD code in cylindrical coordinates based on the HLLD scheme (Miyoshi and Kusano 2005). Numerical dissipation of magnetic fields is reduced by applying the 5th-order monotonicity-preserving (MP5) scheme. Numerical results indicate that the combination of the magnetic field amplification by magneto-rotational instability (MRI) and the buoyant escape of magnetic flux by Parker instability drives cyclic dynamos in the disk; the mean azimuthal magnetic fields reverse their direction in time scale of 10 rotation period. The buoyantly rising magnetic loops transport the magnetic energy from the disk to the halo. In simulations of galactic gas disks; we computed the distribution of the rotation measure and compared it with observations. Such comparison may reveal the previous magnetic activities of our galaxy.

Author : Yipeng Jing
Title : A new subhalo finder: Hierarchical Bound-Tracing code
Abstract : We develop a new code; the Hierarchical Bound-Tracing (HBT for short) code; to find and trace dark matter subhalos in simulations based on the merger hierarchy of dark matter halos. Application of this code to a recent benchmark test of finding subhalos demonstrates that HBT stands as one of the best codes to trace the evolution history of subhalos. The success of the code lies in its careful treatment of the complex physical processes associated with the evolution of subhalos and in its robust unbinding algorithm with an adaptive source subhalo management. We keep a full record of the merger hierarchy of halos and subhalos; and allow growth of satellite subhalos through accretion from its subordinate subhalos in the merger hierarchy hence allowing mergers among satellites. Local accretion of background mass is omitted while re-accretion of stripped mass is allowed. The justification of these treatments is provided by a case study of the life of individual subhalos and by the success in finding the complete subhalo catalog. Dependence of this tracing algorithm on the time resolution of simulation outputs has also been examined. We compare our result to other popular subhalo finders and show that HBT is able to well resolve subhalos in high density environment and keep strict physical track of subhalos' merger history. HBT also features its fast speed as it does not need density interpolation or spatial searching when constructing source subhalos; and because it is fully parallelized.

14:00-15:30 Session 19

Author : Dongwook Lee
Title : A Solution Accurate, Efficient and Stable 3D Unsplit Hydro/Magnetohydrodynamics Solvers in FLASH
Abstract : In this talk; I will focus on a new set of two unsplit solvers in FLASH for hydrodynamics and magnetohydrodynamics (MHD). The new unsplit solvers follow the basic ideas of the 2D corner-transport-upwind (CTU) unsplit algorithm by Colella and its 3D full CTU extension by Saltzman. The key difference in the unsplit algorithm is to implement transverse fluxes that stabilize an unsplit hyperbolic system without solving separate intermediate Riemann problems. The scheme instead uses multidimensional characteristic tracing to account for the stabilizing transverse fluxes; only requiring three Riemann solves in 3D rather than 12 Riemann solves in the full CTU scheme. The new 3D unsplit solvers provide a CFL limit close to unity. I will also talk about a new constrained transport (CT) MHD algorithm that evolves divergence-free magnetic fields using an upwind biased electric fields constructon. This upwind scheme is crucial to advect magnetic fields when there is a dominating direction for advection. Lastly; I will give an overview on the ongoing efforts to simulate high-energy-density physics experiments to explore the generation of cosmological magnetic fields via the Biermann Battery mechanism.

Author : Tomoyuki Hanawa
Title : Reconstruction Method for Solving M1 Equations for Radiative Transfer
Abstract : We propose a new method to construct numerical flux for the M1 equations of radiative transfer. The numerical flux is expressed as an explicit function of the energy density (E) and flux (F). It is constructed from the intensity distribution consistent with the closure relation. It has the upwind propoerty in the sense that the solution is guranteed to be physical (—E— ¿ c —F—) as far as the CFL condition is satisfied. We apply this method to an irradiated protoplanetary disk. The model reproduces spectral energy distribution (SED) for a transitional disk having an inner hole. Our model takes account of heating of the inner hole by irradiation from the disk wall.

Author : Hanbyul Jang
Title : A Relativistic Magnetohydrodynamic Code Based on an Upwind Scheme
Abstract : Building a code based on upwind schemes for numerical relativistic magnetohydrodynamics (RMHD) has been a challenging project; because of the absence of analytic expressions of eigenvalues and eigenvectors. For adiabatic RMHD flows; We obtained analytic expressions of eigenvalues and renormalized sets of right and left eigenvectors; which are relatively simple and manageable. Using these analytic forms; we built a code based on the total variation diminishing (TVD) scheme; and successfully performed one-dimensional shock tube tests.

Author : Tsungche Liu
Title : Web-based Cloud Computing for High Energy Neutrino Simulation
Abstract : The monte-Carlo code for the high energy neutrinos and leptons are developed; the code simulates the neutrinos and leptons interating with several kind of materials; such as rock; ice; air; iron and water. User can specifiy their experiment setup to generate the neutrino event and easy to link to the other program. The web version simulation code are developing now; user could submit his job on web; and get the preliminary result from e-mail. mod

Author : Hung-Hsu Chan
Title : A New Method for Computation of Self-Gravity in an Isolated System
Abstract : The gravity of isolated system has so far been efficiently solved by the modified Green's function method via Fast Fourier Transform (FFT). However; this method; in three dimensions; entails 8 times larger volume for the FFT computation; which can be not only memory consuming but also computationally expensive. We propose an alternative method based on multipole expansion; which is computationally economic. This method generally yields an error greater than that with the modified Green's function. However; in some relatively symmetric system; the present method can yield an error much smaller than the modified Green's function method.