2021 5th CHEA WORKSHOP

Oct 29 - 30, 2021

Shilla Stay Haeundae
3F, Ballroom

2021 5th CHEA Workshop

10/29 (FRI)

Chair	Chang-Hwan Lee	
13:00-13:10	Opening Remark	
13:10-13:25	Young-Min Kim (UNIST)	Observational constraints on dense matter EoS of a neutron star in Multi-Messenger Astrophysics
13:25-13:40	Yong-Beom Choi (PNU)	Bubble structure and shape coexistence for the ground state of $72 \leq Z \leq 80$ even-even isotopes
13:40-13:55	Chang-hoon Song (PNU)	Fusion-Fission Probability in Heavy Nuclear System with Langevin equation
13:55-14:10	Dae Ik Kim (PNU)	Models for Heavy ion collisions : DJBUU & SQMD
14:10-14:25	Chanhee Kim (SKKU)	Impact of the NiCu cycle strength in rp process on X-ray Bursts
14:25-14:40	Minju Kim (SKKU)	Proton branching ratio study of ^{21}Na energy levels for astrophysical ^{17}F(α,p)^{20}Ne reaction rate
14:40-14:55	Maurice van Putten (Sejong Univ.)	Observation of delayed black hole formation by independent H1- and L1-analysis of GW170817
14:55-15:10	Maryam Aghaei (UNIST)	GWXplore: A sweet of tools to analyze gravitational waves data
15:10-15:25	Sang In Kim (CNU)	The novel signal detection for gravitational waves via auto-regressive approach
15:25-15:45		Coffee break
Chair	David Hui	
15:45-16:00	Kyujin Kwak (UNIST)	Neutrino Emission from X-ray Bursts
16:00-16:15	Seonho Kim (UNIST)	Isotopic Compositions of Ruthenium Predicted from the NuGrid Project
16:15-16:30	Changhee Son (UNIST)	Photoneutrino process in astrophysical phenomena
16:30-16:45	Jeongyoon Choi (UNIST)	Perturbation in photon distribution in early universe
16:45-17:00	Jeongkwan Yoon (UNIST)	Equilibrium state chemistry in the simulation for primordial gas
17:00-17:15	Jongheun Kim (UNIST)	Simulation of Particles Collision in 1D
17:15-17:30	Jongsu Lee (CNU)	X-ray census of GC MSPs
17:30-17:45	Kwangmin Oh (CNU)	Classifying X-ray sources in globular clusters by ensemble learning
17:45-18:00	Youngmin Kim (CBNU)	Classical theory of an accretion flow onto a black hole
18:00-18:15	Teyoun Kang (UNIST)	The acceleration-dependent mass increase and acceleration limit of a charged particle

2021 5th CHEA Workshop

10/30 (SAT)

Chair	Min Sup Hur	
08:30-08:45	Paola Domínguez Fernández (UNIST)	Substructure and patchiness in radio relics
08:45-09:00	Eunyu Lee (UNIST)	Properties of Shocks in Simulated Merging Clusters
09:00-09:15	Hyunjin Cho (UNIST)	Investigation of Cosmic Magnetic Field using Faraday Rotation Measure
09:15-09:30	Ji-Hoon Ha (UNIST)	Electron Preacceleration at Weak Quasi-Perpendicular Shocks in Merging Galaxy Clusters: Effects of Preexisting Suprathermal Electrons
09:30-09:45	Sunjung Kim (UNIST)	Microinstabilities at Quasi-perpendicular Shocks in High-β ICM
09:45-10:00	Jeongbhin Seo (PSU)	FR-II radio jets and the acceleration of UHECRs
10:00-10:15	Ayan Bhattacharjee (UNIST)	A Simulation Study of FR-I Jets
10:15-10:30	Hyeseung Lee (UNIST)	Physical modeling of dust polarization spectrum by RAT alignment and disruption
10:30-10:45	Kyungjin Ahn (조선대)	Cosmic Reionization Seen in Local and Global Scales
10:45-11:00		Coffee break

Chair	Jungyeon Cho	
11:00-11:15	Min Sup Hur (UNIST)	Radiation burst from colliding beams
11:15-11:30	Manoj Kumar (UNIST)	Particle-in-cell simulations of THz emission from a plasma by oblique-collision of two electron beams
11:30-11:45	Hyung Seon Song (UNIST)	Magnetic effects on Plasma Dipole Oscillation
11:45-12:00	Bokkyun Shin (UNIST)	1MeV Neutrino Detection
12:00-12:15	SungNam Park (UNIST)	Towards the PAL-XFEL Experiment based on the Helium like Ar data with the UNIST EBIT
12:15-12:30	Jeong-Sook Kim (CBNU)	Identification of compact object in high mass X-ray binary Cygnus X-3 via VLBI
12:30-12:45	Dongsu Ryu (UNIST)	**Summary**
12:45-13:00		Closing Remark & Best Presentation Awards

Observational Constraints on dense matter EoS of a neutron star in Multi-Messenger Astrophysics

Young-Min Kim (UNIST)

Observations of GW170817 and its electromagnetic (EM) counterparts, GRB170817 and AT2017gfo opened a new era of multimessenger astronomy (MMA). The first MMA event provided a strong evidence of the origins of short-gamma ray burst and kilo-nova, and it leads to the implication on the origin of neutron-rich elements produced by r-process. The underlying physics for all of the above can be understood by equation of state (EoS) of dense matter.

In this work, to study the effect of dense matter EoS on neutron star (NS) properties in MMA, we adopted Bayesian analysis on the observational results with density functional EoS like KIDS, and specially we sampled nuclear symmetry energy parameters based on Bayesian inference. Through the posterior samples, we show the relation of nuclear symmetry energy parameters and NS properties such as mass and radius. In conclusion, we discuss prospects for LIGO/Virgo/KAGRA O4 observation.

Bubble structure and shape coexistence for the ground state of $72 \leq Z \leq 80$ even-even isotopes

Yong-Beom Choi (Pusan National University)

The nucleus composed of one or more protons may have a low central proton density because of Coulomb interactions. The nucleus with noticeably low central proton density is called a bubble nucleus. In the ground state, a nucleus may have different shapes at the same time, which is called a shape coexistence. This is possible because the nucleus is a quantum many-body system. We investigate the bubble nuclei and the shape coexistence in the ground state of $72 \leq Z \leq 80$ even-even isotopes using Deformed Relativistic Hartree-Bogoliubov theory in continuum (DRHBc).

Fusion-Fission Probability in Heavy Nuclear System with Langevin equation

Chang-hoon Song (Pusan National University)

The study of the little-known neutron-rich heavy nuclei is useful to understand the rapid neutron-capture process (r-process) of astrophysical nucleogenesis. The synthesis of superheavy nuclei has been explained by verifying the mass distribution of fission fragment because it can't be measured directly in the experiment. Especially, it's important to identify the probability of fusion-fission (FF) process and distinguish between the FF process and the quasi-fission (QF) process, which leads to most of the mass symmetric fission events. Main characteristics fo these processes can be explained by a simple liquid drop (LD) model. However, as the actual compound nucleus are excited, the asymmetry fragments are also produced. In order to solve this problem, calculation of fluctuation-dissipation dynamics with Langevin equation has been applied. Langevin equation can implement the dynamic deformation of colliding spherical nuclei which is one of the mass-asymmetry variables. Since the numerical results agree quite well with the experiments conducted so far, this method will be helpful to design new experiments in the future rare isotope facilities such as RAON.

Models for Heavy ion collisions : DJBUU & SQMD

Dae Ik Kim (Pusan National University)

Heavy ion collisions at intermediate energy (20 ~ 200 A MeV) are expected to produce dense matter whose density is beyond nuclear saturation density. It allow us to study important physical quantities such as symmetry energy related to radius of neutron star. Heavy ion collisions can be described by numerical models based on transport theory, so called transport models. There are two families of approaches, Boltzmann Uehling Ulenbeck (BUU) and Quantum Molecular Dynamics (QMD). BUU approach describes one-body phase-space density of test-particles, solving BUU equation. On the other hands, QMD approach describes correlated wave packets under many-body Hamiltionian. Models within each family are already developed in Korea, DaeJeon Boltzmann Uehling Ulenbeck model (DJBUU) [1] and Sindong Quantum Molecular Dynamics model (SQMD) [2] respectively. Comparing results from two models is extremely meaningful. In this research, we have been simulating collisions with same initial condition using both numerical codes for heavy ion collisions, DJBUU and SQMD. Code running and comparing results are on progress.

References

[1] Myungkuk, Kim et al., "Extend parity doublet model with a new transport code," Phys.Rev.C, 101, 6 (2020).
[2] Kyungil, Kim et al., "A New QMD code for Heavy-Ion Collision," Journal of the Korean Physical Society, 10, 71 (2017).

Impact of the NiCu cycle strength in rp process on X-ray Bursts

Chanhee Kim (Sungkyunkwan University)

Type I X-ray bursts are powered by nucleosynthesis processes such as the rp process with a complex nuclear reaction network. To correctly interpret the bursts, constructing the burst models with accurate nuclear knowledge is strongly required. Numerous sensitivity studies of the nuclear inputs to the results of the burst models have commonly extracted the strength of the NiCu cycle in the rp process, which is determined by the 59Cu(p, alpha)56Ni and 59Cu(p, gamma)60Zn reaction rates, as one of the most sensitive nuclear physics information. Here, the nuclear reaction rates were estimated for the first time based on the published experimental data. Nuclear properties on the compound nucleus 60Zn were evaluated for the reaction rate calculations. As the nuclear properties have large uncertainties, Monte Carlo calculations were carried to include the uncertainties in the rate calculations. The rates estimated by the present work expect a weak NiCu cycle, where the variations of the previous sensitivity studies form a strong NiCu cycle. To assess the impact on Type I X-ray bursts, simulations of the burst model were carried. The results show the estimated cycle strength doesn't strongly affect the outcome of the model.

Proton branching ratio study of ^{21}Na energy levels for astrophysical $^{17}F(\alpha,p)^{20}Ne$ reaction rate

Minju Kim (Sungkyunkwan University)

The $^{24}Mg(p,\alpha)^{21}Na^{*}(p)^{20}Ne$ reaction was measured at Holifield Radioactive Ion beam facility (HRIBF) of the Oak Ridge National Laboratory (ORNL). The light charged particles from reaction were detected by a silicon detector array. To identify the decay protons from ^{21}Na states, the coincidence between recoiling alpha particles and protons was required. Proton branching ratios of several ^{21}Na levels were extracted for the p0 and p1 decay channels. Details of data analysis will be discussed.

Observation of delayed black hole formation by independent H1- and L1-analysis of GW170817

Maurice van Putten (Sejong University)

GW170817 has significant rejuvenation potential by an enhanced energy reservoir in angular momentum following gravitational collapse into a black hole.

In previous analysis, ${\cal E}_{gw}=(3.5\pm1)\%M_\odot c^2$ in Extended Emission is found consistent with the spin-energy of a Kerr black hole, well in excess of the energy reservoir of a hyper-massive neutron star at the observed gravitational-wave frequencies $\lesssim700\,$Hz.

Here, we report on improved parameter estimation by generating probability density functions (PDF's) in time-slide analysis of merged and independent H1- and L1-spectrograms, the latter raising observational confidence to 5.7σ. Extended Emission post-merger starts at $t_s-t_m=\left(0.93\pm0.08\,\right)$s with a characteristic time-scale of decay $\tau_s=(3.00\pm0.09)\,$s in gravitational-wave frequency. We identify t_s with the instant of gravitational collapse and τ_s with the lifetime of black hole spin. The delay t_s-t_m is consistent with AT2017gfo and τ_s appears to effectively constrain the duration of GRB170817A.

GWXplore: A sweet of tools to analyze gravitational waves data

Maryam Aghaei (UNIST)

We report a novel software package to analyze gravitational waves data for uninitiated. This multi-tab software is a powerful tool capable of diagnosing the sensitivity of the dierent LIGO runs (dierent generations of LIGO), giving a road-map to the new partners of LIGO i.e. KAGRA and IndIGO. Simultaneously, it is an attractive app for the general users who are eager to explore gravitational waves; even those with zero programming or gravitational waves background.

The novel signal detection for gravitational waves via auto-regressive approach

Sang In Kim (Chungnam National University)

For detecting signal on gravitational wave data, we have employed stochastic autoregressive model. This novel framework is focusing on improving noise reduction, event candidate detections, and template-free parameter estimation. Currently, we are examining all detected GW signals in GWTC-1 catalog.

Neutrino Emission from X-ray Bursts

Kyujin Kwak (UNIST)

X-ray bursts (XRBs) are observed in the low-mass X-ray binary (LMXB) which is composed of a neutron star and a low-mass star. While LMXBs are bright in X-ray due to the hot accretion disk which forms around the neutron star, XRBs are powered by thermonuclear reactions on the surface of the neutron star. In this presentation, I explain some backgrounds of XRBs and their applications for the simultaneous measurement of the mass and the radius of the neutron star. I will also present an idea of the recent research topic, neutrino emission from XRBs.

Isotopic Compositions of Ruthenium Predicted from the NuGrid Project

Seonho Kim (UNIST)

The isotopic compositions of ruthenium (Ru) are measured from presolar silicon carbide (SiC) grains which survived in presolar molecular cloud during stellar evolution. Because of condensation of presolar SiC grains in atmosphere of an evolved low-mass star such as an asymptotic giant branch (AGB) star, SiC grains and Ru isotopes locked into the SiC grains show presolar system environment. we analyze the NuGrid data which provide the abundances of the Ru isotopes in the stellar wind during the evolution of a set of stars in a wide range of initial masses and metallicities. We obtain the isotopic compositions of Ru by applying the C>O (carbon abundance larger than the oxygen abundance) condition which is commonly adopted for the condition of the SiC condensation in outskirt of AGB stars. The NuGrid data show relation with measurement data under the low-mass star condition while C>O zone does not exist under the massive star condition. Also, we confirm that the abundance of 99Ru inside the presolar grain includes the contribution from the in-situ decay of ^{99}Tc.

Photoneutrino process in astrophysical phenomena

Changhee Son (UNIST)

For the accurate prediction of astrophysical neutrino sources, we need to calculate neutrino emissivity based upon the first principle. We derive explicit expressions for the energy-dependent (or differential) and total rates of neutrino emissivity from the photoneutrino process ($e^{\pm}+\gamma\rightarrow e^{\pm}+\nu+\bar{\nu}$) which occurs in hot and dense matter. We retain full information about the emitted neutrinos by evaluating squared matrix elements of this process. However, in the calculation of the total neutrino emissivity, the use of Lenard's identity allows us to bypass the evaluation of the squared matrix elements. We also derive analytical results that help us to understand the qualitative behaviors of the rate and the emissivity in the limiting situations. All the rates are calculated with Mathematica.

Perturbation in photon distribution in early universe

Jeongyoon Choi (UNIST)

I propose a correction of an equilibrium distribution of photon. In the early universe that Big Bang Nucleosynthesis(BBN) epoch, particles and photons satisfying Maxwell-Boltzmann and Planck distribution respectively in standard BBN model. However, standard BBN cannot explain the abundance of Lithium-7 in this epoch called cosmological lithium problem. Preceding research by Dr. Jang in *sung-sil* university propose one possible solution that gives deviation on photon distribution about this problem by using Tsallis statistics. This proposal does not have physical reason why photon distribution is deviated. So, to find physical reason I solve Boltzmann equation for photon with pair annihilation and creation process.

Equilibrium state chemistry in the simulation for primordial gas

Jeongkwan Yoon (UNIST)

Numerical simulations for molecular clouds must include the chemical reaction network in order to trace the evolution more accurately. Molecules in the interstellar space form through chemical reactions and affect not only the physical/chemical properties of the clouds but also their evolution. However, in practice, it is difficult and challenging to include all the chemical reactions in the simulations simply because there are too many molecules. A possible but limited solution can be obtained with an assumption that chemical reactions occur much faster than the general time scale of the system like hydrodynamical time scale. Based upon this assumption, we can build a table which contains ratios of chemical species as a function of temperature only. This table can be used to calculate the amounts of relevant molecules in the post process of hydrodynamic simulations. As an example of this equilibrium table, we show a case of the primordial gas chemistry.

Simulation of Particles Collision in 1D

Jongheun Kim (UNIST)

According to statistical mechanics, the velocity distribution of particles constituting the system is determined by the temperature when the system reaches the thermal equilibrium. Previous studies assumed that a star is at thermal equilibrium regardless of its internal structure which has different temperatures, and all of them used the Maxwellian distributions based upon this assumption. However, in a star, the temperature at the center is higher than that at the outer part, which may cause a break of thermal equilibrium. We investigate this possibility by using numerical simulations. We make simple models in which the distribution of particle velocity evolves through collisions under various conditions such as at a fixed temperature and with energy injection and/or subtraction. We also study the implications of our simulations in the context of stellar interior.

X-ray census of GC MSPs

Jongsu Lee (Chungnam National University)

We have performed a systematic survey for the X-ray properties of millisecond pulsars (MSPs) in globular clusters (GCs). Apart from the X-ray flux variability at different timescales from a subset of our sample, a negative correlation between X-ray luminosity and X-ray hardness has also been identified. We found that the X-ray properties of GC MSPs and Galactic field (GF) MSPs are comparable, which suggests that the frequent stellar encounters in GCs do not affect the X-ray production processes. On the other hand, our analysis shows that the distributions of the orbital period and rotational period can be different in these two populations. We discuss these findings in terms of dynamical interactions in GCs as well as possible observational effects.

Classifying X-ray sources in globular clusters by ensemble learning

Kwangmin Oh (CNU)

While there are many X-ray observations of globular clusters (GCs), the nature of many X-ray sources remain unidentified. Traditionally, these sources are classified by color-luminosity diagram (i.e. X-ray version of HR diagram) and multi-wavelength data. While the first method is restricted by the low-dimensional feature space (2-D), multi-wavelength observations can be hampered by the dense intracluster environment. For full utilising the X-ray data in high dimensional feature space, we propose a novel method of classifying X-ray sources in GCs by coupling ensemble learning and data augmentation. We use the largest data set from 47 Tuc to train our model and test it on predicting the nature of the X-ray sources in 10 other GCs. We demonstrate that our framework can achieve a performance in the binary classifications of CV/non-CV and MSP/non-MSP with ~80% overall accuracy.

Classical theory of an accretion flow onto a black hole

Youngmin Kim (Chungbuk National University)

Gravity is the most influential energy source of our Universe. Accretion onto a compact object such as a neutron star and black hole efficiently converts gravitational to radiation energies. Detecting the emitted photons informs us of the physical nature of compact objects. Accretion is an important physical process to examine the nature of gravity. In this talk, we will introduce the two topics of the basic theory of accretion: one is the nature of a spherically symmetric accretion (i.e., Bondi accretion) onto a point gravitational source. Another topic is a structure of an axisymmetric steady accretion disk around a BH. Based on it, we also explain what radiations are emitted from the disk around the BH with different masses. Finally, we briefly describe our future research plan, where we would apply the single BH disk spectrum to the binary BH case.

The acceleration-dependent mass increase and acceleration limit of a charged particle

Teyoun Kang (UNIST)

In the classical electrodynamics, it is mostly assumed that a charged particle is a point-charge whose radius is zero. However, this assumption causes many problems with formulating the equation of motion. Especially, calculating the self-force of a point-charge is challenging, and even the rigorous calculation (so-called Lorentz-Abraham-Dirac force) yields some problems such as causality violation and diverging mass. In fact, it is well-known that assuming a finite-size particle can resolve most of the problems. Of course, an element particle is believed to be a point-charge, and a finite-size model may not be compatible with this common sense. For this reason, in this talk, we suggest a new particle model that we named Lorentz particle model. A Lorentz particle has finite-volume, but its charge distribution makes itself indistinguishable from a point-charge when observed outside. In other words, a Lorentz particle always camouflages like a point-charge. We found that the effective mass of a Lorentz particle can be greater than the mass of the corresponding point-charge. Furthermore, we found that there is upper limits of the radius and acceleration of a Lorentz particle. At the end of this talk, we will discuss the relation between this upper limit and the Schwinger limit.

Substructure and patchiness in radio relics

Paola Domínguez Fernández (UNIST)

Radio relics track cosmological shocks propagating through the intracluster medium. High-resolution radio observations in total intensity and in polarisation have revealed complex structures on kiloparsec scales that are not well understood. In particular, the relation between the observed features and the underlying morphology of the magnetic field is not clear. In this work we use three dimensional MHD-Lagrangian simulations to study the radio emission produced by a shock wave that propagates through a turbulent medium that resembles the intracluster medium. We find that the synchrotron emission produced in a shocked turbulent medium can reproduce some of the observed features in radio relics. We additionally investigate if our set-up can reproduce the patchiness observed in the CIZA J2242.8+5301 radio relic at high frequencies with single-dish telescopes. We will discuss our preliminary results where we show that neither the injection or re-acceleration models can reproduce this type of patchiness at high frequencies. In fact, we show that if radio relics are patchy at high frequencies, they necessarily also are at low frequencies.

Properties of Shocks in Simulated Merging Clusters

Eunyu Lee (UNIST)

During the hierarchical structure formation of the Universe, galaxy clusters merge and very energetic shocks are induced in the intracluster medium because of the mergers. Radio relics detected in the outskirts of galaxy clusters have been interpreted as diffuse synchrotron emission from cosmic ray electrons accelerated at such merger shocks. Using a set of cosmological hydrodynamic simulations, we study how the properties of merger-driven shocks depend on the parameters such as the mass ratio and impact parameter of mergers. In particular, we examine the distribution of the Mach number and energetics of shocks associated with synthetic radio relics in simulated merging clusters. In this study, we expect the Mach number distribution depends on the physical parameters of merging galaxy clusters.

Investigation of Cosmic Magnetic Field using Faraday Rotation Measure

Hyunjin Cho (UNIST)

Cosmic magnetic field has significant implications on the evolution of the large-scale structure (LSS) of the universe. Yet, the strength and property of the magnetic field remain largely unconstrained. The Faraday rotation measure (RM) of extragalactic radio sources is one of tools that can explore the magnetic field in the cosmic web. We have investigated the statistical properties of the RM using the data of LSS formation simulations. Various modelings of the magnetic field as well as the redshift dependence and intrinsic RM of radio sources have been considered. We here present the structure functions (SFs) of simulated RMs for small angular separations, and compare them with observations, specifically the SFs from the NRAO VLA Sky Survey (NVSS) and LOFAR Two-Metre Sky Survey (LoTSS) of RM. We then discuss the implications of our work.

Electron Preacceleration at Weak Quasi-Perpendicular Shocks in Merging Galaxy Clusters: Effects of Preexisting Suprathermal Electrons

Ji-Hoon Ha (UNIST)

Major mergers of galaxy clusters generate shocks with low sonic Mach number, $M_s <\sim 3-4$ and such merger-driven shocks have been detected in radio and X-ray observations. In particular, the diffuse radio emission has been interpreted as synchrotron emission from the cosmic-ray (CR) electrons produced by diffusive shock acceleration (DSA; a.k.a. first-order Fermi acceleration). To describe the production of the CR electrons, the electron injection into DSA has to be understood. Recent studies have showed that electrons could be preaccelerated through stochastic shock drift acceleration (SSDA), a mechanism mediated by multi-scale plasma waves at shock transition zone. However, such preacceleration process seems to be effective only at the supercritical shocks with $M_s >\sim 2.3$, implying that further studies should be done to explain radio relics with weaker shocks. In this talk, we present the results obtained by two-dimensional particle-in-cell (PIC) simulations, which include preexisting suprathermal electrons possibly produced by previous episodes of turbulence/shock acceleration or ejected from active galactic nuclei. We find that the preexisting electrons enhance the upstream plasma waves in shocks with $M_s <\sim 2.3$, however, the wavelength of such waves is not long enough to scatter off suprathermal electrons and energize them to the injection momentum for DSA. So, preexciting suprathermal electrons alone would not solve the problem of electron injection into DSA at radio relic shocks.

Microinstabilities at Quasi-perpendicular Shocks in High-β ICM

Sunjung Kim (UNIST)

At collisionless shocks, various microinstabilities are occurred by the temperature anisotropy and/or drift motions of plasmas. Microinstabilities play important roles in particle acceleration in collisionless shocks. Recent studies have suggested that in the transition region of quasi-perpendicular shocks ($Q_\perp$) in the high-beta intracluster medium (ICM), the ion temperature anisotropy due to the reflected-gyrating ions could trigger the Alfv´en ion cyclotron (AIC) instability and the ion-mirror instability, while the electron temperature anisotropy induced by magnetic field compression could excite the whistler instability and the electron-mirror instability.

Adopting the numerical estimates for ion and electron temperature anisotropies found in the particle-in-cell (PIC) simulations of $Q_\perp$-shocks with sonic Mach numbers, M_s=2−3, we carry out a linear stability analysis for these microinstabilities. The kinetic properties of the microinstabilities and the ensuing plasma waves on both ion and electron scales are described for wide ranges of parameters, including β and the ion-to-electron mass ratio. In addition, the nonlinear evolution of the induced plasma waves is examined by performing 2D PIC simulations with periodic boundary conditions.

We find that for β≈20−100, the AIC instability could induce ion-scale waves and generate shock surface ripples in supercritical shocks above the AIC critical Mach number, $M^*_{AIC}\approx 2.3$. Also, electron-scale waves are generated primarily by the whistler instability in these high-β shocks. The resulting multi-scale waves from electron to ion scales are thought to be essential in the electron injection to diffusive shock acceleration in $Q_\perp$-shocks in the ICM.

FR-II radio jets and the acceleration of UHECRs

Jeongbhin Seo (Pusan National University)

Ultra-high energy cosmic rays (UHECRs), which have very high energies above EeV, are believed to be generated at relativistic jets of radio galaxies. Taking the advantage of the high accuracy of a recently developed relativistic hydrodynamic (RHD) code, based on the WENO scheme, we describe the distribution of shocks, turbulence, and shear generated in the jet-induced flows of a FR II radio galaxy in a stratified galaxy cluster halo. We then present the acceleration of UHECRs obtained through Monte-Carlo simulations that follow the transportation and energization of cosmic ray protons. Based on the results, we discuss implications on the generation of UHECRs at FR II radio jets.

A Simulation Study of FR-I Jets

Ayan Bhattacharjee (UNIST)

Recently, a highly accurate relativistic hydrodynamics code, based on high-order WENO-Z scheme, has been developed at CHEA (Seo et al. 2021). The code has been successfully used to study the morphology, energetics and detailed flow structure of FR-II (FR: Fanaroff-Riley) type jets, that are characterized by their ultra-relativistic velocity and high jet power (Seo, Kang and Ryu 2021). Here, we report the early results of the simulations of low-powered jets, injected into a stratified background medium, using that code. The cases we study are similar to the FR-I type jets, that are characterized by lower velocity, and low jet power. Here, we also discuss the effects of the variation of some jet parameters, on the morphology of such jets.

Physical modeling of dust polarization spectrum by RAT alignment and disruption

Hyeseung Lee (UNIST)

Dust polarization depends on the physical and mechanical properties of dust, as well as the properties of local environments. To understand how dust polarization varies with grain mechanical properties and the local environment, in this paper, we model the wavelength-dependence polarization of starlight and polarized dust emission by aligned grains by simultaneously taking into account grain alignment and rotational disruption by radiative torques (RATs). We explore a wide range of the local radiation field and grain mechanical properties characterized by tensile strength. We find that the maximum polarization and the peak wavelength shift to shorter wavelengths as the radiation strength U increases due to the enhanced alignment of small grains. Grain rotational disruption by RATs tends to decrease the optical-near infrared polarization but increases the ultraviolet polarization of starlight due to the conversion of large grains into smaller ones. In particular, we find that the submillimeter (submm) polarization degree at 850μm(P850) does not increase monotonically with the radiation strength or grain temperature (Td), but it depends on the tensile strength of grain materials. Our physical model of dust polarization can be tested with observations toward star-forming regions or molecular clouds irradiated by a nearby star, which have higher radiation intensity than the average interstellar radiation field. Finally, we compare our predictions of the P850-Td relationship with Planck data and find that the observed decrease of P850 with Td can be explained when grain disruption by RATs is accounted for, suggesting that interstellar grains unlikely to have a compact structure but perhaps a composite one. The variation of the submm polarization with U (or Td)can provide a valuable constraint on the internal structures of cosmic dust.

Cosmic Reionization Seen in Local and Global Scales

Kyungjin Ahn (Chosun University)

Cosmic Reionization imprints its characteristics on the intergalactic medium in varying scales. We first present the CoDa (Cosmic Dawn) simulations, one of the leading projects on how the Local Group galaxy cluster undergoes cosmic reionization. Here, stellar- and galactic-scale physics shape the sources of radiation, whose birth and evolution are handled through star formation criterion and local physical properties. Their clustering and the growing H II regions, then, spand the scales of galaxies, galaxy clusters and beyond. We then present our effort in forecasting future observations to probe cosmic reionization, again from galactic scales to truly cosmological scales. This involves (1) high-redshift 21-cm intensity mapping, (2) single-dish observation of the global 21-cm signal, and (3) probing the signature of cosmic reionization through the polarization of the cosmic microwave background (CMB). We show our recent progress in forecasting these observational probes, with some focus on an almost ideal CMB probe for CMB polarization, LiteBIRD and how one may be able to probe the early onset of cosmic reionization beyond z=15.

Radiation burst from colliding beams

Min Sup Hur (UNIST)

Recently we've conducted a series of PIC simulations on radiation emission from colliding electron-beams. This research aims to propose a new physical model to explain the highly energetic cosmic radio bursts such as SRB (solar radio burst) or FRB (fast radio burst). With the assumption that FRB has a similar origin, i.e. the Langmuir wave, as the well-understood SRB, we studied the colliding beam cases to explain the high efficiency of the EM emission from the Langmuir wave. I present mostly the research background and motivation, the fundamental concept. Details of the simulation results will be presented in the following talk by Dr. Kumar.

Particle-in-cell simulations of THz emission from a plasma by oblique-collision of two electron beams

Manoj Kumar (UNIST)

A promising way for generating a powerful electromagnetic radiation in THz range by using electron beams rather than short laser pulses, because electron beam is able to transfer more energy into the plasma oscillations, which can enhance the efficiency compared to laser-based scheme. Here, we study the THz radiation generated by a beam-plasma system using two-dimensional particle-in-cell simulations. The Langmuir waves excited by two counter-propagating electron beams via two-stream instability, collide to each other at an oblique angle, which forms a high beam-density modulation near the colliding region, where the both beam electrons are trapped. As a result, spatially-localized Langmuir wave-packets with large amplitude of longitudinal electric field are formed, which give rise to the bursts of electromagnetic radiation. Our 2D-PIC simulations show that a strong THz emission is obtained at second-harmonic of plasma frequency with a narrow spectral-width (~0.80%) in vacuum, which is enhanced significantly compared to the head-on-collision case. The efficiency of power conversion from electron beams to THz wave in vacuum is reached around ~ 0.0289, for the continuous injection of beams into plasma, which makes it suitable for applications requiring high-power narrow-band THz radiation sources.

Magnetic effects on Plasma Dipole Oscillation

Hyung Seon Song (UNIST)

Plasma dipole oscillation (PDO) is a promising optical component in the plasma field. Particle trajectories are computed using a two-dimensional particle in cell code, and its spectra contain peaks at the right circular (R), left circular (L), and plasma frequency. PDO radiation is p-polarized and features two spectral peaks. Except for the plasma frequency, the radiation spectra are identical to the source spectra. The intensity curve of transverse radiation shows dipole. Upper hybrid mode is a resonance point that grows through a series of oscillations. We plan to explore the magnetized PDO merging process in the future, as it might be a kinetic micro-process in the creation of a large Alfven wave capable of producing astrophysical radio bursts.

1MeV Neutrino Detection

Bokkyun Shin (UNIST)

Low energy neutrino energy less than 2 MeV is key to investigate star evolution.
The lower energy limit is about 5 MeV with a Water Cherenkov detector such as Super Kamiokande.

So that, the Detection of low-energy neutrino is a challenge. In this presentation, We suggest the Cherenkov radiation and fluorescence emission hybrid detection method to detect low energy neutrino. And report the expected neutrino flux from carbon burning star at 1 kpc using the new method.

Towards the PAL-XFEL Experiment based on the Helium like Ar data with the UNIST EBIT

SungNam Park (UNIST)

Electron beam ion trap(EBIT) is an ideal tool for both producing and study highly charged ions. Thanks to CHEA(Center for High Energy Astrophysics), UNIST electron beam ion trap(EBIT) have successfully commissioned. Photon count with the X-ray detector by Sweeping the electron beam energy from 2keV to 3keV (with 10mA current) shows the signal of He-Like Ar state. With this experience, we are expecting to connect the EBIT with the accelerator facilities such as PAL-XFEL for further in-depth experiment. Here, we present Ar X-ray data with the progress of preparation for future PAL-XFEL experiment.

Identification of compact object in high mass X-ray binary Cygnus X-3 via VLBI

Jeong-Sook Kim (Chungbuk National University)

The determination of a mass and peculiar motion for the stellar mass black hole provide for information about the final stages of stellar evolution. Most mysterious high mass X-ray binary, Cyg X−3, is the radio-brightest, galactic X-ray binary, displaying frequent flares (up to 10 Jy), with relativistic jets identified with VLBI. It means that Cygnus X-3 is a microquasar. It is one of only a few microquasars detected in TeV γ-rays produced by interaction of jets with wind-active Wolf-Rayet(WR) companion. Cyg X−3 is an idealistic cosmic laboratory in stellar/interstellar scales from the radio to γ-rays, associated with jets, WR star, star formation, and gravitational waves from compact object pairs in the future. However, although there are lots of observational results from VLBI, infrared, X-ray and Gamma-ray, the nature of the compact object (mass) still remains in question whether it is a neutron star or black hole due to uncertain distance.

We have been VLBI observation with the East Asia VLBI Network (EAVN) from 2020. Therefore, I will introduce the progress of measuring the distance of Cygnus X-3 with EAVN at high frequency.

Accommodation and Meal Information

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(신라스테이 해운대)

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(1) Venue
- 3F Ballroom

(2) Check-in
- Place : 3F, Ballroom (CHEA staff)
- Time : After 3PM

(3) Check-out
- Place : 2F Lobby (Front desk)
- Time : by noon

(4) Breakfast
- Place : 2F, Modern & Delightful Cafe
- Time : 7AM ~ 10AM

<u>※ Room cards and breakfast coupons are provided together from CHEA staff.</u>