2020 4th CHEA WORKSHOP

Jan 15 – 16, 2020

The Westin Chosun Busan

4^{th} CHEA Workshop

1/15(WED)

Chair	Dongsu Ryu	
13:00-13:10	Opening Remark	
13:10-13:25	Kyungyuk Chae	Possible day-1 experiment at KoBRA: 18F(p,a)15O reaction
13:25-13:40	Soomi Cha	Astrophysical 18Ne(a,p) reaction study using radioactive 18Ne beam
13:40-13:55	Nguyen Kim Uye	Precise mass measurements for nuclear astrophysics using MR-TOF
13:55-14:10	Minsik Kwag	16O(6Li,t)19Ne reaction measurement for the astrophysical 18F + p system
14:10-14:25	Sungnam Park	Progress of the UNIST-EBIT and the commissioning plan
14:25-14:40	Chang-Kyu Sung	Experiments on phase space manipulation with electron beam at injector test facility of PAL
14:40-14:55	Bokkyun Shin	Air fluorescence yield measurement by 10^18 eV of artificial electron shower
14:55-15:10	Manoj Kumar	Terahertz generation by nonlinear mixing of two lasers in a magnetized plasma with density ripple
15:10-15:25	Teyoun Kang	Radiation reaction from a constantly accelerated charge
15:25-15:45	Coffee break	
Chair	Moses Chung	
15:45-16:00	Min Sup Hur	Laboratory astrophysics for understanding cosmic radio bursts
16:00-16:15	Salizhan Kylychbekov	Harmonic generation and density diagnostics from localized plasma dipole oscillations (PDO)
16:15-16:30	Hyungseon Song	Diagnostic method based on Plasma Dipole Oscillation
16:30-16:45	Young-Min Kim	Gravitational-wave Data Analysis for Neutron Stars
16:45-17:00	Yong-Beom Choi	Measurement errors in GW parameter estimation for spinning BNS mergers
17:00-17:15	Myungkuk Kim	Observational constraint on mass and radius of neutron star in low-mass x-ray binary by opacity Measurement
17:15-17:30	Maurice van Putten	Time-slide analysis of Extended Emission to the double neutron star merger GW170817
17:30-17:45	Kyujin Kwak	Solar Neutrinos
17:45-18:00	Seonho Kim	Prediction for Ruthenium isotopes abundances in presolar system using the NuGrid Project
18:00-18:15	Gwangeon Seong	Nuclear reactions with non-maxwellian statistics in the stellar evolution
19:00-	Banquet	

4^{th} CHEA Workshop

1/16(THU)

Chair	**Min Sup Hur**	
08:30-08:45	David Hui	Treasure hunting from the unidentified hard gamma-ray sources with machine learning techniques
08:45-09:00	Kwangmin Oh	Adopting machine learning for identifying X-ray sources in globular cluster
09:00-09:15	Jongsu Lee	Investigation for X-ray emitting MSPs in Globular clusters and comparing with MSPs in the Galactic field
09:15-09:30	Sangin Kim	Deep X-ray Spectral Imaging of the Bow-shock Nebula associated with PSR B1929+10
09:30-09:45	Chun-Che Lin	PSR J1420-6048, another variable gamma-ray pulsar?
09:45-10:00	Jeongkwan Yoon	Understanding Correlations between Observed Interstellar Molecules with Numerical Simulations
10:00-10:15	Jongheun Kim	Atomic Spectra of Iron at Black Hole Accretion Disk
10:15-10:30	Jungyeon Cho	Measuring properties of magnetic fields in astrophysical fluids
10:30-10:45	Kyungjin Ahn	Critical View of the Interpretation of the EDGES Observation under Variance in Reionization Scenarios
10:45-11:00	Coffee break	
Chair	**Jungyeon Cho**	
11:00-11:15	Hyunjin Cho	Magnetohydrodynamic Turbulence in ISM and ICM
11:15-11:30	Jeongbhin Seo	A simulation study of ultra-relativistic jets
11:30-11:45	seungwoo Ha	Identification and analysis of filaments of galaxies in the large-scale structure of the universe using deep learning
11:45-12:00	Ji-Hoon Ha	Gamma-ray and Neutrino Emissions due to Cosmic-Ray Protons in Starburst Galaxies
12:00-12:15	Sunjung Kim	Electron Firehose Instabilities in High-β Intracluster Medium
12:15-12:30	Hyesung Kang	A Diffusive Shock Acceleration Model for CR Protons in ICM shocks
12:30-12:45	Dongsu Ryu	Gamma-ray and Neutrino Emissions from Clusters of Galaxies
12:45-13:00	Closing Remark & Best Presentation Awards	

Possible day-1 experiment at KoBRA at RAON facility: $^{18}F(a,p)15O$

Kyungyuk Chae (Sungkyunkwan University)

The $^{18}F(p,a)^{15}O$ reaction plays a crucial role in understanding both gamma-ray emission from novae during the first several hours after the expansion and heavy element production in the higher temperature environments of x-ray bursts. Because of the importance of understanding the $^{18}F+p$ reactions, a number of studies of the A=19 isobars have been made using both stable and exotic beams. Many aspects of the quantum system have been studied through the previous works. There are, however, yet to be answered questions such as the resonance parameters for the astrophysical $E_{c.m.}$ = 330 keV resonance. We propose to measure the $^{18}F(a,p)^{15}O$ reaction in inverse kinematics using radioactive ^{18}F beams from the ISOL facility of RAON.

Astrophysical $^{18}Ne(\alpha,p)^{21}Na$ reaction study using radioactive ^{18}Ne beam

Soomi Cha (Sungkyunkwan University)

The $^{18}Ne(\alpha,p)^{21}Na$ reaction, one of the breakout reactions from hot-CNO cycle, plays a crucial role in understanding the X-ray bursts and the nucleosynthesis in the rp-process. Because this reaction rate is dominated by the energy levels of ^{22}Mg above the α-threshold at 8.14 MeV, studying the ^{22}Mg nuclide may improve our understanding of the X-ray burst. In order to study the energy level properties of the radionuclide ^{22}Mg, the ^{18}Ne $(\alpha,\alpha)^{18}Ne$ scattering measurement was performed at CRIB, a radioactive-ion beam separator of Center for Nuclear Study of the university of Tokyo in inverse kinematics. By adopting a thick target method, energy levels at Ex = 9.5 - 17 MeV in ^{22}Mg were populated in a single run. Details of the experimental setup and preliminary results will be discussed in this presentation.

Precise mass measurements for nuclear astrophysics using MR-TOF

Nguyen Kim Uye (Sungkyunkwan University)

Utilizing X-ray astronomical satellite Suzaku's capability, we have, so far, demonstrated a systematic X-ray investigation of galaxies clusters hosting diffuse radio emissions (so called radio relics/radio shocks). Among these investigations, CIZA J2242.8+5301 shows a remarkably narrow radio relic with a width of 55 kpc in the northern part. The relic is strongly polarized at the 50 to 60% level, indicating a well-ordered magnetic field, and polarization magnetic field vectors are aligned with the relic. Our Suzaku observations of CIZA J2242.8+5301 showed a remarkable temperature jump across the northern relic. The Mach number MX estimated from the Rankine-Hugoniot condition is MX 2.3-3.4. These results definitely show that radio relics are an excellent tracer of shock structure.

In this talk, I will report recent progress on X-ray inventions of shock structures at cluster outskirts and related subjects.

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^{16}O(^{6}Li,t)^{19}Ne reaction measurement for the astrophysical ^{18}F + p system

Minsik Kwag (Sungkyunkwan University)

The flux of 511 keV γ-ray line emitted during a nova explosion depends on the decay rate of ^{18}F. Therefore, understanding the ^{18}F(p,γ)^{19}Ne and the ^{18}F(p,α)^{15}O reaction rates is very important for the γ-ray emission, because those reactions are the main destruction mechanisms of radionuclide ^{18}F. Since the reactions proceed through the resonances in the ^{18}F + p system above the proton threshold located at 6.41 MeV in the ^{19}Ne, the properties of the resonances determine the reaction rates at the nova temperatures. Because of its importance, those properties have been investigated many times. Although our understandings of the reaction rates have been improved by those studies, many spins and parities of the resonances are not constrained yet. Therefore, the ^{16}O(^{6}Li,t)^{19}Ne reaction measurement was performed by using the 26 MeV ^{16}O beams at the 8 MV tandem accelerator complex of Kyushu University in Japan. The experimental setup and the preliminary result will be presented.

Progress of the UNIST-EBIT and the commissioning plan

Sungnam Park (UNIST)

For the purpose of studying highly charged ions(HCIs), UNIST IBAL(intense beam and accelerator laboratory) is developing an electron beam ion trap(EBIT) in collaboration with Max Planck institute of nuclear physics(MPIK). The EBIT with an on-axis electron gun which generates up to 8 keV energy-tunable electron beam, and 0.84 T room-temp permanent magnets, allows us to do the X-ray spectroscopy of the HCIs in a cost effective and low maintenance way.

We will present the status of our EBIT construction, performance, and research plans; all parts of our EBIT components are ready and remaining tasks are careful conditioning and assembling. Our device performance to generate HCI is estimated with the CBSIM simulation package. In this work, we will share our primary and first target for spectroscopy of HCIs.

Experiments on phase space manipulation with electron beam at injector test facility of PAL

Chang-Kyu Sung (UNIST)

As the beam is highly accelerated, it requires a stable control of phase space parameters such as transverse emittance, beam size, and so on. Besides, (x, x'), (y, y') planes could be correlated with each other by the solenoidal fields, tilted magnets. In such cases, it needs a reconstruction of 4-dimensional transverse phase space.

We are developing the beam diagnostic systems to achieve the purpose of figuring out phase space. They are a noninterceptive monitor consists of multiple number of capacitive pickups and an interceptive one with a configuration of slit-screen, so-called pepper-pot. These will be experimentally demonstrated with electron beam at the injector test facility (ITF) of PAL. In this talk, the principle of monitors, characteristic of ITF electron beam, and the plan for experiments will be presented. Additionally, it will be followed by the brief introduction to experiment of the beam-plasma interaction with characteristic of plasma source.

Air fluorescence yield measurement by 10^18 eV of artificial electron shower

Bokkyun Shin (UNIST)

The sFLASH experiment is a measurement air fluorescence yield (AFY) using ~10^18 eV artificial electron showers. The beam was provided from End Station A of the Stanford Linear Accelerator Center (SLAC) and the showers were generated by the electron beam interaction with the various depth of alumina targets from 0 to 10 RL or 30 inches. The definition of AFY is a number of emission photons per unit energy deposition. The photons were measured using photomultiplier and energy deposition was estimated by physics simulation package Geant4 and FLUKA. We will report instruments and preliminary results of sFLASH experiment.

Terahertz generation by nonlinear mixing of two lasers in a magnetized plasma with density ripple

Manoj Kumar (UNIST)

A theoretical model for THz generation by nonlinear mixing of two lasers in a rippled density magnetized plasma is developed. The lasers exert ponderomotive force on the plasma electrons and impart them oscillatory velocity at the difference frequency. The latter couples with density ripple and produces a nonlinear current that drives the THz radiation. The static magnetic field (tranverse to the direction of laser propagation) provides the transverse component to the current density, while density ripple (along the direction of laser propagation) provides the phase matching when ripple wave vector kq equals $(k_1-k_2)-k_{THz}$, where k1 and k_2 are the laser wave vectors and k_{THz} is the THz wave vector. A strong enhancement in the efficiency of THz radiation (about an order of magnitude higher than without ripple) is investigated from 1D particle-in-cell (PIC) simulation.

Radiation reaction from a constantly accelerated charge

Teyoun Kang (UNIST)

It is well-known that an accelerated charge radiates photons, which induce reaction force based on Newton's third law. Although it seems to be trivial, in fact this force (called radiation reaction) has never been successfully described even by quantum electrodynamics (QED). The problem is that recent construction of ultra-intense laser facilities and observation of supermassive stars are deeply related to radiation reaction, as the strong fields lead to strongly accelerated particles. Hence, an uncontroversial theory model describing radiation reaction is now required for upcoming advanced experiments and observations. In this talk we revisit some well-known equations to explain classical radiation reaction, and their problems are discussed. To modify them, new particle model and its equation of motion will be suggested. As a result, it will be presented that the mass can increase as the particle accelerates, and this increased mass corresponds to radiation reaction.

Laboratory astrophysics for understanding cosmic radio bursts

Min Sup Hur (UNIST)

Coherent and incoherent cosmic radio bursts are abundant both in our solar system and in the deep space. One commonly-favored explanation of the cosmic radio emission is that the electromagnetic is emitted from Langmuir waves driven by energetic electrons in space plasmas. This scenario has been widely verified for solar radio bursts (SRB). Another interesting radio emission is the fast-radio-burst (FRB), which is believed to be originating from a point-like (i.e. in the astrophysical scale) source in the deep space. Its exact mechanism has not been disclosed yet. In our study, we address the problems of SRB and FRB by exploring the parametrically rescaled, laboratory plasma systems, driven by laser pulses or electron beams. In this talk, I introduce the several interesting issues in this laboratory astrophysics; Langmuir wave collapse, trapping of the Langmuir wave, laser or beam driven plasma dipole oscillation, and relevant second harmonic generation.

Harmonic generation and density diagnostics from localized plasma dipole oscillations (PDO)

Salizhan Kylychbekov (UNIST)

It was reported by Kwon K et al in 2018 that the cross-focusing of slightly detuned, ultrashort laser pulses in preformed plasma can generate a local dipole of ensembled electrons oscillating at plasma frequency, ωp. Recently, utilizing the radiation from dipole oscillations, we proposed a novel technique to measure local plasma density (Kylychbekov S et al, 2019). Investigations by 1D, 2D, and 3D PIC simulations have shown that the dipole of oscillating electrons behaves in a non-trivial manner, leading to the harmonic generation and much more interesting physics yet to be unfolded. In this presentation, I will report the second harmonic generation, possibly the source of type II and type III solar radio bursts.

Diagnostic method based on Plasma Dipole Oscillation

Hyungseon Song (UNIST)

The new diagnostic method is developed for measurement of plasma density. Collision of detuned lasers generates embedded Plasma Dipole Oscillation(PDO) in the plasma. PDO can radiate outward from the collision spot, the radiation has not averaged but local point information. New method can obtain more specific information than conventional method. Plasma density can be measured by transforming spectral information from radiation of PDO. Measured results well fit various density profile of plasmas.

Gravitational-wave Data Analysis for Neutron Stars

Young-Min Kim (UNIST)

The 3rd Observing run of LIGO and Virgo has started since Aril 1st, 2019, and about 40 GW candidates were detected. Among those candidates, several BNS candidates were detected and the properties of those BNS candidates are currently being estimated. In this presentation, I will briefly introduce the contribution of the LIGO observation as well as KAGRA collaboration. In addition, I will present preliminary study on Bayesian analysis of NS EoS to be applied into GWDA for NSs.

Measurement errors in GW parameter estimation for spinning BNS mergers

Young-Beom Choi (Pusan National University)

In our presentation, we will introduce TaylorF2 post-Newtonian gravitational waveform model and Fisher matrix (FM) method with which one can calculate measurement errors of parameters much faster than with Markov Chain Monte-Carlo method. By using TaylorF2 model and FM, we will show measurement errors related to mass and tidal deformability in spinning binary neutron star (BNS) mergers.

Observational constraint on mass and radius of neutron star in low-mass x-ray binary by opacity Measurement

Myungkuk Kim (Pusan National University)

X-ray bursts (XRBs) are energetic explosive events which have been observed in the low-mass X-ray binaries (LMXBs). Some Type-I XRBs show photospheric radius expansion (PRE) and these PRE XRBs are used to simultaneously estimate the mass and radius of the neutron star in LMXB. Opacity during PRE affects the mass and radius estimation and it is possible to constrain the current uncertainty in opacity better by identifying the low-mass companions in LMXBs because the composition of the accreted material is determined by the type of the companion star. Considering the possibility that future observatories equipped with high spatial and spectral resolution can identify the low-mass companions more accurately, we re-analyze four LMXBs studied in the previous works with fixed values of hydrogen mass fraction X that determines the opacity in PRE XRBs. Our Monte Carlo calculations show that the most probable values of mass (radius) increase (decrease) as X increases, which is consistent with the expected trend from the algebraic solutions if they exist. For the four LMXBs, we summarize and review the past observational efforts to identify the low-mass companions and show that future observations will be able to improve the current uncertainty in the opacity not only for these four targets but also for many other targets that show PRE XRBs.

Time-slide analysis of Extended Emission to the double neutron star merger GW170817

Maurice van Putten (Sejong University)

We report on accurate parameter estimation of the post-merger Extended Emission to GW170817 against a 100hr background of blindly selected H1-L1 data using a novel two-time scale time-slide correlation analysis. We observe a time-of-onset of Extended Emission t_s = 0.8pm0.1 s post-merger at a level of Gaussian equivalent level of confidence better than 5 sigma. Identified with black hole spin-down against high-density debris from dynamical mass-ejecta, this result identifies t_s with the maximal lifetime of the hyper-massive neutron star formed in the immediate aftermath of the merger. (After the Nico van Kampen Colloquium, Utrecht, The Netherlands, https://zenodo.org/record/3528005)

Solar Neutrinos

Kyujin Kwak (UNIST)

Solar neutrinos have been detected experimentally. Measured flux of solar neutrinos constrains the standard solar model and provides the information on the neutrino oscillation. Previous, current, and future experiments for solar neutrinos are reviewed briefly in this presentation. Solar neutrinos predicted from the standard solar model can be modified with non-standard particle distributions. By using uncertainties in the measured flux of solar neutrinos, the deviation from the standard particle distribution can be constrained quantitatively. Some ideas on the possibility of the non-standard particle distributions inside the Sun are discussed.

Prediction for Ruthenium isotopes abundances in SiC grains using NuGrid project

Seonho Kim (UNIST)

^{99}Tc is an important isotope to form ^{99}Ru abcundance in stardust grains. That has been discussed under the only AGB stars with s-process. We calculated ^{99}Tc and Ru isotopes yields related to initial mass and metallicity using the NuGrid project. Our results give more detailed information like Ru yields in full stellar evolution than previous results.

Nuclear reactions with non-maxwellian statistics in the stellar evolution

Gwangeon Seong (UNIST)

The main energy generation of stellar evolution is caused by thermonuclear reactions. Thermonuclear reaction rate depends on the distribution function of the particle and the reaction cross section. In the stellar evolution simulation, since the previous model assumes thermodynamic equilibrium, the particle distribution is described by the Maxwell-Boltzmann distributions in any situation. However, the interior of the star consists of a complex plasma state, which can potentially escape thermodynamic equilibrium. So here we present the thermonuclear reaction rate obtained using Tsallis statistics and solar model to study the effect of non-equilibrium state on the stellar evolution.

Treasure hunting from the unidentified hard gamma-ray sources with machine learning techniques

David Hui (Chungnam National University)

We report the results of searching pulsar-like candidates from the unidentified objects in the 3rd Catalog of Hard Fermi-LAT sources (3FHL). Using a machine-learning based classification scheme with a nominal accuracy of ~98%, we have selected 27 pulsar-like objects from 200 unidentified 3FHL sources for an identification campaign, in which we have identified a new globular cluster has significant emission at energies > 10 GeV and a new gamma-ray binary which apparently associated with an extended X-ray feature.

Adopting machine learning for identifying X-ray sources in globular cluster

Kwangmin Oh (Chungnam National University)

Globular cluster is the densest stellar system in the universe. Due to its high density, many compact objects and dynamic events have been emerged from globular clusters. The emission of X-ray from these compact objects have revealed many things (e.g. emission mechanism, evolution, formation mechanism and binary system, etc). However, it is still difficult to identify the classes from the single X-ray observation. I found the drawbacks of current classification method from previous study and suggest new method which the machine learning technique is adopted.

Investigation for X-ray emitting MSPs in Globular clusters and comparing with MSPs in the Galactic field

Jongsu Lee (Chungnam National University)

We have performed a systematic survey for the X-ray detected MSPs in GC. Currently, 43 MSPs in GC were confirmed the detection of X-ray counterparts. To be enable to carry out a statistical analysis, we have normalized their X-ray luminosities and photon indices into a homogeneous data set. Based on our censored sample, we have done for the investigation of relationship between Lx and various parameters, 1/P^2, Porb, Edot, Blc, Bs, and age. Also we have further divided the sample into four sub-populations: (1) Redbacks, (2) Black-Widow, (3) Isolated MSPs, and (4) other MSP binaries, and compare the properties among them or MSPs in galactic field.

Deep X-ray Spectral Imaging of The Bow-shock Nebula Associated with PSR B1929+10

Sangin Kim (Chungnam National University)

We have studied the X-ray bow-shock nebula powered by the old non-recycled pulsar PSR B1929+10 with XMMNewton data of an effective exposure ~ 300 ks, which provides the deepest investigation of this system so far. We found the X-ray axial tail has a length of ~ 8 arcmin, which is a factor of two longer than that reported in previous study. We found the another feature of arc-like tails which is could not seen before. Evidence for spectral hardening along the axial tail has been found which suggests certain acceleration processes occur along the nebular emission. With multi-epoch data with a time span > 15 years, we have also placed constraints on the spatial and spectral variabilities of the nebula.

PSR J1420-6048, another variable gamma-ray pulsar?

Chun-Che Lin (UNIST)

Pulsars are usually thought as steady sources in their long-term emission behavior although they are featured with pulsations in a short rotational/spin cycle. Recent studies suggest that pulsars with strong magnetic field can also have changeable flux caused by the twisting of the magnetosphere or the reconnection of the magnetic field lines. Since most of the gamma-ray pulsars are young and do not have such strong magnetic field, we do not expect the scenario of twisted pulsar magnetosphere can occur to lead the flux change.

However, the change of the flux and the spin-down rate detected for PSR J2021+4026 brought us the new understandings of gamma-ray pulsars.
PSR J2021+4026 is the first known variable gamma-ray pulsar; it showed a sudden flux drop and a glitch occurred in 2018 mid-Oct. while the recovery of the flux and spin-down rate can be detected after 2014 early Dec.
In 2018 Feb. 1st, PSR J2021+4026 enter a new low gamma-ray flux/high spin-down rate state (LGF/HSD) again, and it may repeat such an abrupt state change with an interval of 6-7 years. The timing anomaly event with a flux change of PSR J2021+4026 might closely relate to the neutron star's quake, and a state change of one acceleration region caused by the quake may affect to global current and hence to the global magnetosphere structure. Since PSR J2021+4026 has typical spin-down parameters among all the gamma-ray pulsars, we should expect more variable gamma-ray pulsars, if the physical process around the light cylinder could trigger the state switching.

Here we investigate the long-term Fermi data of PSR J1420-6048, which had at least 4 obvious glitches between Jun. of 2009 and 2019. Except for the obvious glitches, we also detected some small timing anomaly events with the gamma-ray flux drop before the pulsar experienced new glitches, and these events also lead the structure change and phase shift of the pulsation. Different from PSR J2021+4026, PSR J1420-6028 did not stay in a specific state of the gamma-ray flux or the spin-down rate for several years, and the spin-down rate of the pulsar gradually increased before experiencing a new glitch. The long-term monitoring of timing and emission behaviors for PSR J1420-6048 provides us a new viewpoint to search for other variable Fermi-LAT pulsar candidates. The state change of the global magnetosphere may not be a unique feature, and gamma-ray pulsars may not be as steady as we understood.

Understanding Correlations between Observed Interstellar Molecules with Numerical Simulations

Jeongkwan Yoon (UNIST)

Through observations and researches of interstellar absorption lines, it is known that there is a correlation between the column densities of the interstellar molecules. For example, the column densities of H2, CO, and CH molecules have a strong correlation with each other. The correlation between molecules is thought to be related to the origin and the nature of the molecular cloud. We suggest a method to reproduce the correlation between molecules using a simulation of the interstellar molecular cloud.

Atomic Spectra of Iron at Black Hole Accretion Disk

Jongheun Kim (UNIST)

The black hole accretion disks contain highly ionized Fe, including Civ, Nv, and Ovi at a temperature of about 10^8K. The relatively hot accretion disk (10^8K) and the relatively cool surrounding medium (10^6K) are mixed and the iron is ionized and recombined to release the X-ray. This paper investigates the physical properties of turbulent mixing layers and the production of highly ionized irons, by using hydrodynamic simulations with radiative cooling and non-equilibrium ionization (NEI) calculations.

Measuring properties of magnetic fields in astrophysical fluids

Jungyeon Cho (Chungnam National University)

Many astrophysical fluids are strongly magnetized and in turbulent state. Since magnetic fields affect many physical processes, measuring their properties is of great importance. First, I will briefly talk about physics of Alfvenic MHD turbulence in strongly magnetized media, which will be starting point of further discussions. Second, I will talk about techniques to measure properties of magnetic fields from observations. I will focus on techniques that utilize observations of synchrotron emission and dust polarization. It is well known that synchrotron emission is polarized in the direction perpendicular to magnetic field. On the other hand, interstellar dust grains tend to be aligned with magnetic field and thermal emission from aligned grains is also polarized in the direction perpendicular to magnetic field. Therefore, if we observe polarization of synchrotron emission or thermal radiation from dust grains, we can derive information about magnetic field. Third, I will discuss various issues related measurement of magnetic field from observations.

Critical View of the Interpretation of the EDGES Observation under Variance in Reionization Scenarios

Kyungjin Ahn (Chosun University)

We present out critical view of the interpretation of the EDGES observation that claims the detection of ~500 mK absorption signal from the epoch of reionization. We briefly review the original interpretation and its possible implication for strong dark matter-baryon interaction. As a counter-claim, we introduce the criticism by Hills et al. and our own analysis, and conclude that it is still premature to claim such a detection. Even if the detection were real, we show that the variance in reionization scenarios would change the quantitative estimation of the dark matter-baryon interaction.

Magnetohydrodynamic Turbulence in ISM and ICM

Hyunjin Cho (Pusan National University)

Observations indicate that turbulence in molecular clouds of the interstellar medium (ISM) is highly supersonic ($M_{turb} \gg 1$) and strongly magnetized ($\beta \approx 0.1$), while in the intracluster medium (ICM) it is subsonic ($M_{turb} \leq 1$) and weakly magnetized ($\beta \approx 10^6$). Here, M_{turb} is the turbulent Mach number and β is the ratio of the gas to magnetic pressures. We report a study of magnetohydrodynamic (MHD) turbulence in molecular clouds and the ICM using a newly developed code based the high-order accurate, WENO (Weighted Essentially Non-Oscillatory) scheme. While the simulation results using the WENO code are generally in agreement with those presented in the previous studies with, for instance, a TVD code (Park & Ryu 2019), the WENO code reveals more structures on smaller scales, effectively resulting in a higher resolution. We present the populations of MHD shocks and the energy dissipation at the shocks as well as the density PDF and the power spectrum, and describe and compare the properties of simulated turbulences in the ISM and ICM environments. We also discuss the dependence on different forcing mode such as solenoidal, compressive, and mixed forcing.

A simulation study of ultra-relativistic jets

Jeongbhin Seo (Pusan National University)

We have recently developed a new code, based on the high-order WENO-Z scheme, for relativistic hydrodynamics with a realistic equation of state. It has been specifically optimized for the study of ultra-relativistic jets. In this talk, we present the early results of simulations of ultra-relativistic jets using the code. The morphology of radio jets is primarily determined by the jet power, that is, either FR type I for low power or FR type II for high power (FR stands for Fanaroff-Riley). We show the shape of simulated jets for different jet powers. We also discuss the dependence of the jet morphology for the secondary parameters, such as the momentum injection rate.

Identification and analysis of filaments of galaxies in the large-scale structure of the universe using deep learning

Seungwoo Ha (UNIST)

The cosmic web of the large-scale structure of the universe consists of clusters of galaxies, filaments of galaxies, and voids. Among the components, we study filaments and their characteristics, specifically their shape, using the data of cosmological simulations. Due to the vast amount of the data and the complex structures of mass distribution, however, it is not trivial to identify filaments in the three-dimensional space. Hence, we recently initiated a new project to employ an approach based on deep learning, rather than convectional algorithm. Our first goal is to find filaments around clusters of $T \sim 2 - 3$ keV and compare their properties to those observed around the Virgo cluster. We hear present the progress of this project.

Gamma-ray and Neutrino Emissions due to Cosmic-Ray Protons in Starburst Galaxies

Ji-Hoon Ha (UNIST)

Starburst galaxies (SBGs) are efficient producers of cosmic-ray protons (CRp) due to high star formation rate (SFR) and supernova (SN) explosion rate. In this talk, we present an improved model for CRp production, and also improved estimations of gamma-ray/neutrino emissions, from nearby SBGs (M82, NGC253, Arp220). We first consider the CRp produced by supernova remnant (SNR) shocks and stellar wind (SW) termination shocks. The contribution of SW termination shocks is in the range of ~ 15 - 50 %, depending on SFR. In addition, we consider the distribution of SNR-produced CRp, fitted to a broken power-law form. With the power-law slope of ~ 3.95 - 4.1 in the range of E_{CRp} > ~100 GeV, the high-energy gamma-ray observations in the range of E_{gamma} > ~1 TeV (i.e., Veritas, HESS) are well reproduced. We then estimate neutrino fluxes from nearby SBGs using our CRp model. The predicted neutrino fluxes are smaller than < ~10^{-3} of the atmospheric neutrino flux in the energy range of $E_{neutrino}$ < ~1 TeV. Our results indicate that the chance to isolate neutrinos from nearby SBGs with neutrino telescopes would be slim.

Electron Firehose Instabilities in High-β Intracluster Medium

Sunjung Kim (UNIST)

In a magnetized plasma the firehose instability is driven when the plasma temperature along the magnetic field is higher than the perpendicular temperature. Such condition occurs commonly in astrophysical and space environments, for instance, when there are beams aligned with the background magnetic field. Recently, it was argued that around weak quasi-perpendicular shocks in high-β plasmas of the intracluster medium, shock-reflected electrons propagating upstream cause the temperature anisotropy of $T_{\parallel} > T_{\perp}$. This electron temperature anisotropy can trigger the electron firehose instability (EFI), which excites oblique nonpropagating waves in the shock foot. In the study, we investigate, through a linear analysis and particle-in-cell (PIC) simulations, the firehose instabilities driven by an electron temperature anisotropy (ETAFI) and also by a drifting electron beam (EBFI) in high-β (β~100) ICM plasmas. We find that the basic properties of the two instabilities, such as the growth rate, γ, and the wavenumber of fast-growing oblique modes are similar in the ICM environment, with one exception; while the waves excited by the ETAFI are nonpropagating (ω_r =0), those excited by the EBFI have a non-zero frequency ($\omega_r \neq 0$). However, the frequency is small with $\omega_r < \gamma$.

A Diffusive Shock Acceleration Model for CR Protons in ICM shocks

Hyesung Kang (Pusan National University)

Low sonic Mach number shocks form in the intracluster medium (ICM) during the formation of the large-scale structure of the universe. Nonthermal cosmic-ray (CR) protons are expected to be accelerated via diffusive shock acceleration (DSA) in those ICM shocks, although observational evidence for the gamma-ray emission of hadronic origin from galaxy clusters has yet to be established. Considering the results obtained from recent plasma simulations, we improve the analytic test-particle DSA model for weak quasi-parallel shocks, previously suggested by Kang & Ryu (2010). In the model CR spectrum, the transition from the postshock thermal to CR populations occurs at the injection momentum, p_{inj}, above which protons can undergo the full DSA process. As the shock energy is transferred to CR protons, the postshock gas temperature should decrease accordingly and the subshock strength weakens due to the dynamical feed of the CR pressure to the shock structure. This results in the reduction of the injection fraction, although the postshock CR pressure approaches an asymptotic value when the CR spectrum extends to the relativistic regime. Our new DSA model self-consistently accounts for such behaviors and adopts better estimations for p_{inj}. With our model DSA spectrum, the CR acceleration efficiency ranges $\eta \sim 10^{-3} - 10^{-2}$ for supercritical, quasi-parallel shocks with sonic Mach number $2.25 \leq M_s \leq 5$ in the ICM. Based on Ha et al. 2018, on the other hand, we argue that proton acceleration would be negligible in subcritical shocks with $M_s < 2.25$.

Gamma-ray and Neutrino Emissions due to Cosmic-Ray Protons Accelerated at Intracluster Shocks in Galaxy Clusters

Dongsu Ryu (UNIST)

We examine the cosmic-ray protons (CRp) accelerated at collisionless shocks in galaxy clusters through cosmological structure formation simulations. We find that in the intracluster medium (ICM) within the virial radius of simulated sample clusters, only ~7 % of the shock kinetic energy flux is dissipated by the shocks that are expected to accelerate CRp, that is, supercritcal, quasi-parallel shocks with sonic Mach number M_s > ~ 2.25. The rest is dissipated at subcritical shocks and quasi-perpendicular shocks, both of which may not accelerate CRp. Adopting the model of diffusive shock acceleration (DSA) recently presented in Ryu et al (2019), we estimate the production of CRp in simulated clusters. The average fraction of the shock kinetic energy transferred to CRp through DSA is assessed at ~ (1 – 2) x 10^{-4}. We also estimate the boost due to the reacceleration of CRp with a model in the test-particle regime. Assuming that the gas passes through ICM shocks about three times on average through the history of the universe, the reacceleration increases the CR energy by a factor of ~ 1.4 - 1.8. We then calculate diffuse gamma-ray emissions from simulated clusters, resulting from inelastic collisions between CRp and thermal protons. The predicted gamma-ray emissions lie mostly below the upper limits set by Fermi-LAT for observed clusters. We also estimate neutrino emission due to the same process. The predicted neutrino fluxes towards nearby clusters are < ~ 10^{-4} of the IceCube flux at E = 1 PeV and < ~ 10^{-6} of the atmospheric neutrino flux in the energy range of E <= 1 TeV.

Accommodation and Meal Information

The Westin Chosun Busan, Orchid(2F)

(1) Check-in / Check-out: 1F, Lobby

- Check-in : after 3pm, Check-out : by noon

(2) Banquet

-Location: 2F, Orchid hall

-Date & Time: Jan 15, 7:00PM (Western course dishes)

-Western Menu

: Grilled Shrimps and Scallop with yuzu Dressing and Seasonal Salad, Wild Mushroom Cream Soup with Roasted Almond, Char-grilled Rib-Eye of Australian Beef with Mashed Potato And Chasseur Sauce, Almond Parfait with Cinnamon Wafer, Amaretto Cream, Coffee or Tea

-Vegetarian Menu (Only Manoj Kumar, Salizhan Kylychbekov, Hyunjin Cho)

: Avocado Timbal with Baby Salad, Sun dried Tomato and Balsamic Sauce, Wild Mushroom Cream Soup with Roasted Almond, Pan-fried Bean cured Steak with Teriyaki Sauce and Seasonal Vegetables, Almon Parfait with Cinnamon Wafer, Amaretto Cream, Coffee or Tea

(3) Breakfast

-Location: 1F, Camellia (Buffet Restaurant)

-Date & Time: Jan 16, 6:30AM ~ 10:00AM

Participants List & Roommate information

Double room
Min Sup Hur
Moses Jung
Lupin Chun-Che Lin
Kyungyuk Chae
David Hui
Jungyeon Cho
Kyungjin Ahn
Maurice van Putten
Twin room
Dongsu Ryu / Hyesung Kang
Jayoon Um / Jua Jin
Sunjung Kim / Seungwoo Ha
Ji-Hoon Ha / Jeongbhin Seo
Eunyu Lee / Minjung Son
Seonho Kim / Jongheun Kim
Gwangeon Seong / Jeongkwan Yoon
Bokkyun Shin / Young-Min Kim
Teyoun Kang / Jeongyoon Choi
Maoj Kumar / Salizhan Kylychbekov
Sungnam Park / Chang-Kyu Sung
Myungkuk Kim / Yong-Beom Choi
Minsik Kwag / Minju Kim
Soomi Cha / Kim Uyen Nguyen
Kwangmin Oh / Jongsu Lee
Sangin Kim / Moon Hyeonjin
No accommodation
Kyujin Kwak / Hyungseon Song / Hyunjin Cho / Heesuk Cho