8th East-Asia School and Workshop on Laboratory, Space, and Astrophysical Plasmas

July 30 (Mon) ~ August 03 (Fri), 2018

DaeDeok Hall,
Jeongsimhwa International Cultural Center
Chungnam National University,
Daejeon, Korea

CNU 충남대학교 CHUNGNAM NATIONAL UNIVERSITY
BK21플러스 Department of Astronomy, Space Science and Geology
APCTP Asia Pacific Center for Theoretical Physics
DIME 대전마케팅공사

PROGRAM

MONDAY (July 30) : Modeling, Simulations, and Experiments in Plasmas

TIME	NAME	TITLE
08:10 –		Resistration
09:00 – 09:05	Jungyeon Cho	Opening Remarks
09:05 – 09:15	Deog-Seong Oh (President of CNU)	Congratulatory Remarks

Morning Session — **Chair: Chang Hee Nam**

TIME	NAME	TITLE	INDEX
09:15 – 10:35	Ethan Vishniac	Symmetry, Self-Organization, and the Large Scale Dynamo	1-1
10:35 – 10:50		Coffee Break	
10:50 – 12:10	Taik Soo Hahm	Introduction to tokamak core plasma turbulence and transport	1-2
12:10 – 13:40		Lunch	

Afternoon Session I — **Chair: Jungyeon Cho**

TIME	NAME	TITLE	INDEX
13:40 – 15:00	Jae-Min Kwon	Introduction to kinetic simulation of magnetized plasma	1-3
15:00 – 15:20	Dong-Ho Park	Magnetic island structure effect on runaway electron confinement	1-4
15:20 – 15:40	Chang-Mo Ryu	FLASH simulations of magnetic generation and amplification in plasma jets for laboratory astrophysics	1-5
15:40 – 15:55		Coffee Break	

Afternoon Session II — **Chair: Chang-Mo Ryu**

TIME	NAME	TITLE	INDEX
15:55 – 16:20	Chang Hee Nam	Relativistic Laser Plasma Explored with PW lasers	1-6
16:20 – 16:45	Young-chul Ghim	Critically balanced turbulence in fusion-grade plasmas	1-7
16:45 – 17:10	Gunsu Yun	Ion cyclotron harmonic waves in the boundary of magnetized plasmas	1-8
17:10 – 17:35	Makoto Sasaki	Dynamics of turbulence interacting with zonal flows	1-9
17:35 – 17:55	Chul Min Kim	Strong gamma rays from a double-layer target irradiated by an ultra-intense laser pulse and their use for producting pair plasmas	1-10

TUESDAY (July 31) : Waves, Particles, and Magnetic Fields in Plasmas

Morning Session — Chair: Quanming Lu

TIME	NAME	TITLE	INDEX
09:00 – 10:20	Masahiro Hoshino	Plasma Heating and Particle Acceleration during Magnetic Reconnection	2-1
10:20 – 10:35	Coffee Break		
10:35 – 11:55	Hui Li	Particle Energization in Different Turbulent Environments	2-2
11:55 – 12:05	Group Photo		
12:05 – 13:40	Lunch		

Afternoon Session I — Chair: Masahiro Hoshino

TIME	NAME	TITLE	INDEX
13:40 – 15:00	Yoshiharu Omura	Nonlinear Wave-Particle Interactions in Earth's Inner Magnetosphere	2-3
15:00 – 15:25	Xinliang Gao	Nonlinear processes related to whistler waves in the Earth's magnetosphere	2-4
15:25 – 15:45	Mijie Shi	The parametric decay instability of Alfven waves in turbulent plasmas	2-5
15:45 – 16:00	Coffee Break		

Afternoon Session II — Chair: Hui Li

TIME	NAME	TITLE	INDEX
16:00 – 16:25	Quanming Lu	Energetic electrons during multiple X line reconnection	2-6
16:25 – 16:50	Shinji Saito	The influence of intermittent nature of magnetosonic-whistler turbulence on ion dynamics	2-7
16:50 – 17:15	Bo Li	Seismological applications of sausage waves for inferring the physical parameters in solar coronal structures	2-8

WEDNESDAY (Aug. 1) : Particles, Turbulence, and Magnetic Fields in Plasmas

Morning Session — Chair: Dongsu Ryu

TIME	NAME	TITLE	INDEX
09:00 – 10:20	Tom Jones	TBD	3-1
10:20 – 10:35	Coffee Break		
10:35 – 11:55	Gianfranco Brunetti	Turbulent acceleration and the physics of extragalactic radio sources	3-2
11:55 – 12:15	Thiem Hoang	Acceleration of Charged Dust Grains in Magnetized Turbulent Plasma	3-3
12:15 – 13:40	Lunch		

Afternoon Session I — Chair: Ryoji Matsumoto

TIME	NAME	TITLE	INDEX
13:40 – 15:00	Alex Lazarian	Studying 3D Distribution of Magnetic Fields in Diffuse Media and Molecular Clouds	3-4
15:00 – 15:20	Hyeseung Lee	Study of MHD turbulence using synchrotron polarization	3-5
15:20 – 15:40	Diego F Gonzalez-Casanova	The VGT in proto-stellar disk environments	3-6
15:40 – 15:55	Coffee Break		

Afternoon Session II — Chair: Xueshang Feng

TIME	NAME	TITLE	INDEX
15:55 – 16:20	Ryoji Matsumoto	Radiation Magnetohydrodynamic Simulations of Black Hole Accretion Disks	3-7
16:20 – 16:45	Dongsu Ryu	Turbulence and Magnetic Fields in the Outskirts of Clusters of Galaxies	3-8
16:45 – 17:10	Hyesung Kang	Proton Injection and Acceleration in Weak ICM shocks	3-9
17:10 – 17:35	Takanobu Amano	Stochastic shock drift acceleration for electrons	3-10
17:35 – 17:55	Jungyeon Cho	Removing Large-scale Variations in Observations	3-11
19:00 –	Conference Dinner (Intercity Hotel)		

THURSDAY (Aug. 2) : Particles, Turbulence, and Magnetic Fields in Plasmas

Morning Session — Chair: Yoshiharu Omura

TIME	NAME	TITLE	INDEX
09:00 – 10:20	Discussion		
10:20 – 10:35	Coffee Break		
10:35 – 11:55	Yao Chen	Initiation and Energy Release of Solar Coronal Mass Ejections and Relevant Solar Radio Bursts	4-2
11:55 – 12:15	Jeongwoo Lee	The Onset of Solar Magnetic Eruptions	4-3
12:15 – 13:40	Lunch		

Afternoon Session I — Chair: Siming Liu

TIME	NAME	TITLE	INDEX
13:40 – 15:00	Joerg Buechner	TBD	4-4
15:00 – 15:20	Hongyu Liu	A Solar Stationary Type IV Radio Burst and Its Radiation Mechanism	4-5
15:20 – 15:40	Veluchamy Vasanth	Coronal Signatures of a Flare Generated Type-II Solar Radio Burst	4-6
15:40 – 15:55	Coffee Break		

Afternoon Session II — Chair: Takanobu Amano

TIME	NAME	TITLE	INDEX
15:55 – 16:20	Jongchul Chae	Observations and Theory of Three-minute Oscillations in the Solar Chromosphere	4-7
16:20 – 16:45	Siming Liu	Evolution of high-energy particle distribution in SNRs	4-8
16:45 – 17:10	Shuta Tanaka	The Crab Nebula with tangled magnetic field: its radio emission and confinement by its supernova remnant	4-9
17:10 – 17:35	Siyao Xu	TBD	4-10
17:35 – 18:00	Yong-Joo Rhee	Kerr metric and quadratic curvature invariant of rotating black hole	4-11

FRIDAY (Aug. 3) : Particles, Turbulence, and Magnetic Fields in Plasmas

Morning Session **Chair: Jongchul Chae**

TIME	NAME	TITLE	INDEX
09:00 – 10:20	Peter H Yoon	Kinetic space plasma turbulence	5-1
10:20 – 10:45	Kanya Kusano	Toward the solar flare prediction based on the critical condition of MHD instability	5-2
10:45 – 11:00	Jungyeon Cho	Closing Remarks	
11:00 –	Lunch and/or Excursion		

POSTERS

NAME	TITLE	INDEX
LongLong Sang	Quadrupolar and sextupolar Hall magnetic field during asymmetric magnetic reconnection without a guide field	P1
Heesu Yang	Observation of the Kelvin–Helmholtz Instability in a Solar Prominence	P2
Isaac Habumugisha	The Effect of Pressure Gradient Force on an Accretion Disk Surrounding a Magnetized Neutron Star	P3
Li-Hsin Chen	Formation of the First Galaxies	P4
Ruo-Yu Liu	Two-dimensional simulations of circumstellar material collisions from exploding stars	P5
Lochan Khanal	Study of ambient environment around Asymptotic Giant Branch Carbon Star using IRAS survey	P6
Yudong Luo	Big Bang Nucleosynthesis with an Inhomogeneous Primordial Magnetic Field Strength	P7
Junho Shin	Off-Axis Characteristics of Japanese Grazing Incidence Mirror Telescopes for X-Ray Solar Physics	P8
Heesun Yoon	Density and Magnetic Field Correlation in MHD Turbulence	P9
Jongkil Lee	Space Weather Operation at KASI with Van Allen	P10

[1-1]

Symmetry, Self-Organization, and the Large Scale Dynamo

Ethan Vishniac

American Astronomical Society/Johns Hopkins University

Magnetic helicity is a robustly conserved local variable in magnetized turbulence. I will discuss how this conservation law can be used to understand large scale dynamo theory. Simple scaling arguments can be used to show that galactic dynamos can generate large scale fields in a few rotational periods, that stellar magnetic fields scale inversely with the Rossby number for slowly rotating stars and saturate for rapidly rotating ones, and that accretion disks can sustain MRI turbulence self-consistently. I will also show that kinematic dynamo theory is never applicable to realistic astrophysical systems.

[1-2]

Introduction to tokamak core plasma turbulence and transport

Taik Soo Hahm

Seoul National University

[1-3]

Introduction to kinetic simulation of magnetized plasma

Jae-Min Kwon

National Fusion Research Institute

In this lecture, we introduce some basic materials for kinetic simulation of strongly magnetized plasma. Fusion plasma confined by strong toroidal magnetic field is a prime such example.

In the first part of the lecture, staring from the complete 6-dimensional Boltzmann equation, we present the hierarchy of reduced kinetic models and explain how the reduced models are derived and what kinds of physical assumptions are made during the derivations. Since kinetic simulations require huge computing costs in most cases, it is critical to choose proper reduced models for practical simulations. In this lecture, we present some examples of kinetic simulations employing a set of reduced kinetic models. It is shown that with a proper choice of models, key target kinetic physics can be accurately captured with greatly reduced computing costs.

In the second part of the lecture, we briefly introduce some numerical aspects of kinetic simulation. Choosing the Particle-in-Cell (PIC) method as an example, we discuss numerical issues in solving the kinetic equations. Particular emphasis is given to the issues of numerical noises caused by the discrete particles used in simulation. We introduce a basic framework to understand and analyze the noises.

[1-4]

Magnetic island structure effect on runaway electron confinement

Dong-Ho Park

NFRI

Dong-Ho Park, Tongnyeol Rhee and Hogun Jhang

In tokamaks, relativistic runaway electrons (REs) are generated during the current ramp-up phase and/or plasma disruptions. The loss of REs can cause severe damage in plasma facing components in the device. Therefore, the study of RE confinement and transport is of significant importance in contemporary fusion plasma research, especially for ITER. In this work, we develop a set of singularity-free relativistic RE guiding-center equations of motion based on the recently reported coordinate transformation technique [1]. To study RE confinement in toroidal geometry, we develop a code which solves the system of relativistic guiding-center equations. Using this code, we perform a computational analysis of the characteristics of RE orbits and confinement in the KSTAR tokamak. Specifically, we perform numerical simulations of RE confinement in the presence of prescribed magnetic islands to investigate the impact of equilibrium magnetic topology on RE confinement.

References

[1] Burby, J. W. and Ellison, C. L., 2017, Phys. Plasmas 24, 110703.

[1-5]

FLASH simulations of magnetic generation and amplification in plasma jets for laboratory astrophysic

Chang-Mo Ryu

GIST, IBS, CoRels

C.M. Ryu[1], C.M. Kim[1,2], H.C. Tong[1], S.M. Kim[1,3] and C.H. Nam[1,3]

[1] Center for Relativistic Laser Science, IBS, Gwangju, Korea
[2] Advanced Photonics Research Institute, GIST, Gwangju, Korea
[3] Department of Physics and Photon Science, GIST, Gwangju, Korea

Recently, laboratory astrophysics has drawn much interest. Along this line, magnetic field generation and amplification in plasma jets produced by high power lasers have been intensively studied. In this paper, we present our FLASH simulation results of magnetic generation and amplification by Kelvin-Helmholz, Reyleigh Taylor instabilities, Biermann battery, and turbulence in plasma jets produced by a high power laser.

Relativistic Laser Plasma Explored with PW lasers

Chang Hee Nam

Institute for Basic Science

Petawatt lasers have been developed for the exploration of strong field physics in a number of institutes around the world. At Center for Relativistic Laser Science of Institute for Basic Science two PW laser beamlines have been utilized for investigating relativistic laser-matter interactions. One of the PW laser beamlines has been upgraded recently to a 20 fs, 4 PW laser [1]. With the PW lasers we succeeded in generating multi-GeV electron beams. We plan to carry out the Compton backscattering to generate MeV gamma-rays from the interaction of a GeV electron beam and another laser beam, offering an opportunity to measure strong field QED effects, such as nonlinear Compton scattering, radiation reaction, and Breit-Wheeler electron-positron pairs.

[1] J. H. Sung et al., "4.2 PW, 20 fs Ti:Sapphire Laser at 0.1 Hz," Opt. Lett. 42, 2058 (2017).

[1-7]

Critically balanced turbulence in fusion-grade plasmas

Young-chul Ghim

KAIST

[1-8]

Ion cyclotron harmonic waves in the boundary of magnetized plasmas

Gunsu Yun

Pohang University of Science and Technology (POSTECH)

The existence of ion cyclotron harmonic waves (ICHW) triggered by fast relaxation event at the boundary of magnetized plasmas is confirmed thanks to high-resolution RF detection technique developed on the KSTAR tokamak. ICHW is an interesting example of particle-wave interaction, which offers a useful diagnostic potential for energetic ions. Instability mechanisms which can drive ICHW are reviewed along with examples of measured ICHW spectra.

Dynamics of turbulence interacting with zonal flows

Makoto Sasaki

Kyushu University

Prediction of the spatial distribution of the turbulence is one of important subjects in the research of magnetically confined plasmas. Micro-scale turbulence driven by the spatial inhomogeneities of the temperature and density excites meso/ macro scale flows, such as zonal flows and mean sheared flows. Due to the Interaction of the turbulence with such flows, the turbulence is strongly affected, and the spatial distribution of the turbulence and turbulence transport is determined. In this talk, we investigate the spatiotemporal dynamics of the turbulence interacting with the zonal flows, focusing on the phase-space dynamics: the turbulence trapping. Here, the phase-space consists of the real space and wavenumber space. Based on the wave-kinetic theory, we show that the turbulence trapping plays a key role for determining the spatial profile and the propagation of the turbulence.

Strong gamma rays from a double-layer target irradiated by an ultra-intense laser pulse and their use for producting pair plasmas

Chul Min Kim

Gwangju Institute of Science and Technology

Chul Min Kim[1,2], Taiwu Huang[1,3], Jong Ho Jeon[1], Kazuhisa Nakajima[1,] Chang-Mo Ryu[1], Chang Hee Nam[1,4]

[1]Center for Relativistic Laser Science, IBS, Gwangju, Korea
[2]Advanced Photonics Research Institute, GIST, Gwangju, Korea
[3]College of Optoelectronic Engineering, Shenzhen Univ., Shenzhen, China
[4]Dept. of Physics and Photon Science, GIST, Gwangju, Korea

Generation of strong gamma rays via nonlinear Compton scattering has been a fascinating topic in ultra-intense laser physics both as a manifestation of strong-field quantum electrodynamics and as a potential mechanism for intense gamma ray sources. In this regard, we propose a scheme based on double-layer targets for efficiently realizing nonlinear Compton scattering and thus generating strong gamma rays [1]. In this scheme, an ultra-intense laser pulse propagates through a near-critical-density layer, becoming stronger by relativistic self-focusing and accelerating copious ambient electrons by direct laser acceleration mechanism [2]. Then the laser pulse is reflected by a solid-density layer and collides with the accelerated electrons, resulting in a strong nonlinear Compton scattering. From 3D simulations with a particle-in-cell code including strong-field quantum electrodynamics modules [3], we found that 2.6×10^12 gamma-ray photons (energy > 1 MeV) can be generated with a 28-fs laser pulse with a peak intensity of 5.3×10^21 W/cm^2, achieving a high conversion efficiency of 0.01. In addition, we estimated the number of electron-positron pairs that can be produced by the gamma rays via Bethe-Heitler process. Such electron-positron pair plasmas may enable us to study astrophysical plasma processes in the lab.

[1] T. Huang et al., arXiv:1803.08237[physics.plasm-ph]
[2]. A. Pukhov, Z. -M. sheng, and J. Meyer-ter-Vehn, Phys. Plasmas 6, 2847 (1999).
[3]. T. D. Arber et al., Plasma Phys. Control. Fusion 57, 113001 (2015).

[2-1]

Plasma Heating and Particle Acceleration during Magnetic Reconnection

Masahiro Hoshino

University of Tokyo

We review the general background and recent progress on collisionless magnetic reconnection by paying a special attention to energy partition between ions and electrons as well as energy partition between thermal and non-thermal particles.

Particle Energization in Different Turbulent Environments

Hui Li

LANL

We will give an overview of particle energization processes in different turbulent environments. We will emphasize how different free energy will lead to different turbulence and its associated structures. These structures will affect the particle energization processes.

[2-3]

Nonlinear Wave-Particle Interactions in Earth's Inner Magnetosphere

Yoshiharu Omura

Research Institute for Sustainable Humanosphere, Kyoto University

In recent years, a series of spacecraft, Cluster, THEMIS, Van Allen Probes, and ERG have been launched into the Earth's inner magnetosphere, and they have functions to record wave forms with high time resolutions, enabling us to understand coherent structures in waves such as whistler mode chorus, hiss, and electromagnetic ion cyclotron (EMIC) emissions frequently observed in the radiation belts. Successful reproductions of these waves by particle simulations have resulted in significant progress in theory on their generation mechanisms and associated acceleration and precipitations of energetic particles. We give a brief account of the nonlinear theory of the generation mechanism of chorus emissions. We describe the nonlinear dynamics of resonant electrons, and the formation of the electromagnetic electron "hole" that results in resonant currents generating rising-tone emissions. We have theoretically derived threshold and optimum wave amplitudes for the nonlinear wave growth of rising-tone emissions. The profiles of these wave amplitudes as functions of frequencies agree well with those from observations and simulations. In contrast, falling-tone emissions are generated through the formation of electron "hills." We also describe the mechanism of nonlinear wave damping due to quasi-oblique propagation, which results in the formation of a gap at half the electron cyclotron frequency. The nonlinear wave growth theory of chorus emissions can be applied to the generation mechanism of electromagnetic ion cyclotron emissions. Hybrid code simulations have confirmed that coherent rising-tone emissions are generated by energetic protons at frequencies below the proton cyclotron frequency through formation of electromagnetic ion holes. Electromagnetic ion cyclotron waves can also interact with relativistic electrons. Both chorus emissions and electromagnetic ion cyclotron rising-tone emissions play important roles in controlling radiation-belt particle dynamics. Coherent structures recently found in the plasmaspheric hiss emissions are also interpreted by the nonlinear wave growth theory. Good agreement between the observation and the theory confirms local generation of the hiss emissions in the equatorial region just inside the plasmapause.

[2-4]

Nonlinear processes related to whistler waves in the Earth's magnetosphere

Xinliang Gao

University of Science and Technology of China

In this talk, I will present our latest works about nonlinear wave-wave interactions related to whistler-mode waves in the Earth’s magnetosphere. First, I will talk about the series of works about multiband chorus waves, in which the upper-band waves are showing up at the harmonics of lower-band waves. Based on the case study, PIC simulations, and theoretical analysis, multiband chorus waves are well explained by the lower band cascade mechanism. In this scenario, the upper-band wave is driven by the coupling between the magnetic and electrostatic components of the nonparallel lower-band whistler-mode wave. A statistical study about multiband chorus events is performed to show that this is a very common phenomenon in the magnetosphere. Then, I will also illustrate several interesting chorus events, which involves the three-wave resonance. Our results reveal the large diversity of the evolution of whistler-mode waves in the Earth’s magnetosphere.

[2-5]

The parametric decay instability of Alfven waves in turbulent plasmas

Mijie Shi

Shandong University, Weihai

Coauthors: Hui Li, Shengtai Li, Liping Yang, Bo Li

The parametric decay instability (PDI) of Alfven waves is an important mechanism in low beta plasmas, in which an Alfven wave decays into a backward Alfven wave and a forward slow wave. In this talk, I will first summarize some recent studies on PDI in the community, and then present our preliminary results of PDI in driven turbulent plasmas. At last, possible applications of PDI are proposed for coronal heating as well as the solar wind acceleration.

[2-6]

Energetic electrons during multiple X line reconnection

Quanming Lu

University of Science and Technology of China

Multiple X line reconnection usually occurs in a long current sheet. Magnetic islands are formed in such a process, and then these islands will interact each other. In this talk, two-dimensional particle-in-cell simulations are performed to study the production of energetic electrons during the evolution of multiple X line reconnection with a guide field.We analyze the contributions of the parallel electric field and Fermi mechanism to electron acceleration during the evolution of magnetic reconnection. The results show that with the magnetic reconnection proceeding, magnetic islands are formed and interact in the simulation domain. Electrons can be accelerated by the parallel electric field in the vicinity of the X lines during the formation and coalescense of magnetic islands, and Fermi acceleration takes place when magnetic islands are contracted. We also investigate how a power-law spectrum of energetic electrons can be formed.

[2-7]

The influence of intermittent nature of magnetosonic-whistler turbulence on ion dynamics

Shinji Saito

Nagoya University

Solar wind turbulence contains fluctuations with a broad range of frequency and wavenumber. Nonlinear cascade process in the solar wind turbulence transports fluctuation energy from MHD to ion/electron kinetic scales. At the kinetic scales, kinetic Alfven and whistler mode waves are observed at kinetic scales where the MHD approximation is broken. Turbulent fluctuations at kinetic scales can interact with ions and electrons. The wave-particle interactions cause particle acceleration and heating through the dissipation of the kinetic turbulence. In this study we demonstrate the influence of magnetosonic-whistler turbulence on ion acceleration and heating by using a two-dimensional particle-in-cell simulation of plasma turbulence. It is shown that probability distribution functions of the magnetosonic-whistsler turbulence indicate intermittent nature of compressible magnetic fluctuations propagating to the quasi-perpendicular direction of the mean magnetic field. The intermittent magnetic fluctuations make steep magnetic gradients, whose electrostatic potential field is expected to be a source of the perpendicular ion heating and acceleration. The fully kinetic particle-in-cell simulation suggests that ions and electrons in magnetosonic-whistler mode turbulence are accelerated/heated by not only Landau and cyclotron resonance by linear modes at electron kinetic scales but also nonlinear scattering related to ion kinetic scales.

Seismological applications of sausage waves for inferring the physical parameters in solar coronal structures

Bo Li

Shandong University Weihai

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[2] Centre for Mathematical Plasma Astrophysics (CmPA), KU Leuven, Celestijnenlaan 200B bus 2400, B-3001 Leuven, Belgium
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[4] Yunnan Key Laboratory of Computer Technology Application, Kunming University of Science and Technology, Kunming 650500, China

Low-frequency waves and oscillations in the magneto-hydrodynamic (MHD) regime abound in the highly structured atmosphere of the Sun. Their detailed measurements, in conjunction with a continuous refinement of their theories, can help yield atmospheric parameters that prove difficult to directly measure. The magnetic field strength often tops this list of desired parameters. However, the structuring transverse to magnetic structures is also important both for understanding the fundamental properties of solar atmospheric structures and from the perspective of atmospheric heating. This talk will present some of our recent results on the theoretical understanding of both kink and sausage waves in coronal structures for which the physical parameters are transversely structured in a continuous manner. We will examine how this

continuous transverse structuring influences the wave properties. Conversely, we will also address how the measurements of low-frequency waves and oscillations can help constrain the information on the transverse structuring. Included in this talk will be: 1) standing sausage modes in flare loops and their seismological applications for inverting the measured quasi-periodic pulsations (QPPs) in solar flare lightcurves; 2) impulsively generated sausage wave trains in both coronal tubes and coronal slabs together with their applications for inferring the information on sub-resolution density structuring.

[3-1]

TBD

Tom Jones

[3-2]

Turbulent acceleration and the physics of extragalactic radio sources

Gianfranco Brunetti

National Institute of Astrophysics

Turbulence and the electromagnetic fluctuations in astrophysical plasmas induce pitch angle scattering of particles governing their spatial diffusion and inducing stochanstic acceleartion mechanisms. In the first part of the lecture I will review the basis of particle spatial diffusion and turbulent acceleration and the formalism that we use to describe the interplay between turbulence and particles. In the second part I will describe more detailed modellings of turbulent acceleration in extragalactic radio sources and the comparison with observations. In particular I will focus on turbulent acceleration and non-thermal emission in galaxy clusters and on evidences for turbulent acceleration in the radio galaxies. Future observational plans to constrain turbulent acceleration physics in these environments will also be discussed.

Acceleration of Charged Dust Grains in Magnetized Turbulent Plasma

Thiem Hoang

KASI/UST

Dust grain coagulation is widely believed to be the first step in the process of planetesimal and planet formation. The coagulation efficiency depends on relative velocities of grains. I will present our refined study of acceleration mechanisms of charged grains by MHD turbulence using non-linear theory, including gyroresonant acceleration by fast MHD modes and transit-time damping. I will also discuss the new acceleration mechanism of dust nanoparticles due to fluctuating electric fields that originate from grain charge fluctuations. Both analytical theory and numerical simulations will be presented.

Studying 3D Distribution of Magnetic Fields in Diffuse Media and Molecular Clouds

Alex Lazarian

University of Wisconsin-Madison

I shall discuss and compare existing techniques to study magnetic fields. I shall both polarimetry, Zeeman measurements and statistical techniques for tracing magnetic fields and probing media magnetization. The emphasis will be on getting the 3D distribution of magnetic field in the diffuse interstellar medium and molecular clouds. Apart from the traditional techniques, I shall describe the new technique that employs gradients of velocities and synchrotron intensity and polarization. I shall discuss the synergetic use of different techniques.

[3-5]

Study of MHD turbulence using synchrotron polarization

Hyeseung Lee[1], Jungyeon Cho[1], and Alex Lazarian[2]

[1]Chungnam National University
[2]University of Wisconsin, USA

We study statistical properties of synchrotron polarization emitted from media with MHD turbulence. First, we obtain the spatial spectrum and its derivative with respect to wavelength of synchrotron polarization arising from both synchrotron radiation and Faraday rotation fluctuations. Second, we provide statistical description of anisotropy of polarized synchrotron intensity. Since Faraday rotation,, which depends on wavelength, can change the structure of polarized intensity and result in depolarization, we study how the structure changes with wavelength. We consider polarized synchrotron emission arising from two spatially separated regions as well as one spatial region, in which synchrotron emission and Faraday rotation occur simultaneously.

[3-6]

The VGT in proto-stellar disk environments

Diego F Gonzalez-Casanova

UW-Madison

We use the Velocity Gradient Technique (VGT) in the form of Velocity Channel Gradients (VChG) and Reduce Velocity Centroid Gradients (RVCG) in early stages of proto-stellar disk formation to trace the magnetic field surrounding young stellar objects. We applied the VChG and the RVCG on a MHD simulation post-processed to include ^{13}CO 2-1 emission to mimic observational type data. This two different gradients gives the plane of the sky (POS) magnetic field as a function of the line-of-sight velocity producing a three-dimensional information about the magnetic field (in PPV). We find that using the VGT we are able to understand the structure of the POS magnetic field providing a second tool to dust polarization to understand their environment.

[3-7]

Radiation Magnetohydrodynamic Simulations of Black Hole Accretion Disks

Ryoji Matsumoto

Chiba University

We present the results of global three-dimensional radiation magnetohydrodynamic simulations of black hole accretion flows carried out by applying a code CANS+R which adopts 5th order scheme for MHD and M1-closure scheme for radiation. We show that during the hard-to-soft transition, hot optically thin disk near the black hole co-exists with an optically thick, cool disk in the outer region. Quasi-periodic oscillations and mass ejections generated during the transition will be compared with observations.

[3-8]

Turbulence and Magnetic Fields in the Outskirts of Clusters of Galaxies

Dongsu Ryu

UNIST

Magnetic fields in galaxy clusters, at least in their outskirts, are conjectured to be originated by small-scale dynamo due to turbulence in the intracluster medium (ICM). The so-called Sausage relic, one of giant radio relics in a cluster outskirt, on the other hand, posses magnetic fields of a few microG strength and a Mpc scale, so challenges the turbulence origin of cluster magnetic fields. The turbulence in the ICM is induced in highly stratified backgrounds due to the cluster gravity, and also it is driven sporadically by major mergers during the hierarchical formation of clusters. To get quantitative measures for turbulence and magnetic fields in such environments, we performed a series of simulations using a newly developed, high-accurate MHD code, and followed the development of turbulence and the amplification of magnetic fields. We here present early results, trying to answer whether turbulence dynamo could explain observed magnetic fields in cluster outskirts or other mechanisms need to be invoked.

[3-9]

Proton Injection and Acceleration in Weak ICM shocks

Hyesung Kang

Pusan National University

[3-10]

Stochastic shock drift acceleration for electrons

Takanobu Amano

University of Tokyo

We present a new theory of energetic electron acceleration at a quasi-perpendicular collisionless shock. The new model is essentially an extension of the classical shock drift acceleration (SDA) for electrons. The SDA as seen in the Hoffmann-Teller Frame (HTF) may be understood as an adiabatic mirror reflection by a fast-mode shock or a moving magnetic mirror. We introduce the effect of pitch-angle scattering during the particle interaction with the shock. In contrast to the adiabatic SDA, the scattering tends to confine the particles within the shock transition region, which enables much more significant energy gain than would be expected from the adiabatic theory. We show that the theory naturally obtains a power-law energy spectrum with its exponent independent of the scattering properties. We compare the proposed model with recent three-dimensional particle-in-cell simulations as well as MMS (Magnetospheric MultiScale) observations.

[3-11]

Removing Large-scale Variations in Observations

Jungyeon Cho

Chungnam National University

Magnetic fields play important roles in astrophysical fluids. There are several techniques to measure the strength of the magnetic fields. In this talk I will focus on techniques of measuring magnetic field strengths in interstellar space. 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 dust polarization. Interstellar dust grains tend to be aligned with magnetic field and thermal emission from the aligned grains is polarized in the direction perpendicular to magnetic field. Therefore, if we observe polarization of thermal radiation from dust grains, we can derive information about magnetic field. Third, I will discuss various issues related to measurements of magnetic fields from observations.

Initiation and Energy Release of Solar Coronal Mass Ejections and Relevant Solar Radio Bursts

Yao Chen

Institute of Space Sciences, Shandong University, Weihai China

Solar coronal mass ejections (CMEs) and flares are the two most important energy release phenomena occurring in the solar system. CMEs result in large-scale fast-speed ejection of magnetized plasmas into the heliosphere, and flares cause abruptly enhanced radiations across almost the whole electro-magnetic spectrum. Both phenomena also generate significant amounts of energetic particles. These particles, along with the greatly-enhanced radiations and the huge magnetized ejecta, pose potential catastrophic threats to some human's activities and assets in the space as well as on the ground.
In this lecture, I will try to focus on the initiation and subsequent energy-release mechanisms of CMEs. The big picture and some important elements of this magnificent sudden release of energy will be presented. I will also discuss solar radio bursts relevant to CMEs, which are emitted by those energetic electrons accelerated during the eruption. In particular, the metric type- II and IV solar radio bursts are most relevant, they carry valuable diagnostics information on the emitting source and the eruptive process. The lecture is designed to elucidate the overall physical concepts and to introduce some relevant unresolved issues in this very-dynamic field.

[4-3]

The Onset of Solar Magnetic Eruptions

Jeongwoo Lee

Kyung Hee University

Solar magnetic eruptions represent the most powerful class of the magnetohydrodynamic (MHD) instabilities in the solar system. Efforts to understand the underlying physics have continued often based on the two types of the ideal processes: the kink instability (KI) represented by the magnetic twist number at the edge of the flux rope and the torus instability (TI) subject to the external field variation with height. Another recent development in this line is the Double Arc Instability (DAI), which depends on both the magnetic twist number and the flux ratio of the flux rope to the external field. We present a detailed study of these three instabilities with an exceptionally well-observed event of a solar erupting sigmoid structure. It is demonstrated that the time-dependent enhancement of the flux rope via magnetic reconnection should properly be incorporated into the evaluation of the instabilities in order to make an accurate prediction of the onset time. Our result also explains why solar eruptions occur only sporadically.

[4-4]

TBD

Joerg Buechner

A Solar Stationary Type IV Radio Burst and Its Radiation Mechanism

Hongyu Liu

KASI/UST

A stationary Type IV (IVs) radio burst was observed on September 24, 2011. Observations from the Nançay RadioHeliograph (NRH) show that the brightness temperature (TB) of this burst is extremely high, over 10^{11} K at 150 MHz and over 10^{8} K in general. The degree of circular polarization (q) is between $-60\% \sim -100\%$, which means that it is highly left-handed circularly polarized. The flux–frequency spectrum follows a power-law distribution, and the spectral index is considered to be roughly $-3 \sim -4$ throughout the IVs. Radio sources of this event are located in the wake of the coronal mass ejection and are spatially dispersed. They line up to present a formation in which lower-frequency sources are higher. Based on these observations, it is suggested that the IVs was generated through electron cyclotron maser emission.

[4-6]

Coronal Signatures of a Flare Generated Type-II Solar Radio Burst

Veluchamy Vasanth

Kyung Hee University

We present a detailed case study of a type-II radio burst occurred on 6th march 2014 using multi-wavelength observations. The type-II burst is observed with both fundamental (harmonic) branches in the frequency range between 120 – 60 MHz (235 – 130 MHz) with a life time of 5 mins. The estimated speed of type-II radio burst is found to be 650 km/s. An EUV wave is observed in AIA images, their closest temporal onset association with flare energy release indicates that the EUV wave is likely produced by flare pulse. There is a weak CME observed in STEREO-B (LASCO) FOV with sky plane speed of 252 (280) km/s. The observed CME is independent of the shock wave, which is confirmed by the NRH radio source located below the CME-frontal structures. Therefore the type-II radio burst is possibly ignited by flares.

Observations and Theory of Three-minute Oscillations in the Solar Chromosphere

Jongchul Chae

Seoul National University

The three-minute oscillations are the most prominent dynamic activity in the chromosphere of an apparently quiescent sunspot. They are interesting to us because they may be in charge of heating the chromosphere and driving jets in the upper solar atsmophere, and they can be expoited for the inference of the atmospheric structure. In this talk, by combining our observations using the Fast Imaging Solar Spectrograph of the Goode Solar Telescope, and our theoretical works that are mostly anlaytical, I will present several important results on this phenomenon. First, the three-minute oscillations represent long-wavelength slow magneto-acoustic waves upwardly-propagating in a gravitationally stratified medium. They are dispersive waves and have very low group velocities, and high phase speeds. Second, the frequncy the oscillations is determined by the temperature and magnetic inclinationof the temperature minimum egion. Third, they can be generated by impulsive disturbances somewhere in or below the atmosphere. The most dominant source may be magneto-convection beneath the photosphere. Fourth, the three-minute oscillations develop into shock waves as they propagate upward. Since they form shock waves, however, at larger heights than short wavelength waves do, they can play a potential role in the heating of plasma in the upper atmosphere. The nonlinearity can be measured by the growth of the second order harmonic component. Finally, the longer-period shock waves can be produced by the successive merging of three-minute shocks. These shock waves seem to be in charge of the driving of plasma jets in the chromosphere.

[4-8]

Evolution of high-energy particle distribution in SNRs

Siming Liu

Purple Mountain Observatory

Siming Liu and Houdun Zeng

Supernova remnants (SNRs) have been considered the dominant contributors to galactic cosmic rays. However, the relation between high-energy particles trapped in SNRs and cosmic rays observed at the Earth remains obscure. In this paper, we fit the spectral energy distributions of 35 SNRs with a simple one-zone emission model and analyze correlations of model parameters to uncover the evolution of high-energy particle distribution in SNRs. We find that (1) the particle distribution can be described by a broken power-law function with a high-energy cutoff; (2) the low-energy spectra become harder and the break energy decreases with aging of SNRs, (3) for most middle-age SNRs, the energy loss timescale of electrons at the high-energy cutoff is approximately equal to the age of the corresponding remnant; for young SNRs, this energy loss timescale is shorter than the age of SNRs implying continuous particle acceleration; and for a few old age SNRs, the energy loss timescale are longer than the age of SNRs which may suggest escaping of highest energy particles from SNRs.

[4-9]

The Crab Nebula with tangled magnetic field: its radio emission and confinement by its supernova rem

Shuta Tanaka

Aoyama Gakuin University

The Crab Nebula is powered by its central pulsar, the Crab pulsar. The relativistic magnetized plasmas supplied from the Crab pulsar, called pulsar wind, is Poynting-dominated at its base. Based on the standard ideal magnetohydrodynamic model of pulsar wind nebulae, the observed dynamical and spectral features of the Crab Nebula indicate that the pulsar wind is dominated by particle energy at the upstream of its termination shock. This is so-called sigma problem. Although the standard model considered pulsar wind nebulae as the laminar flow, the recent 3-dimensional simulations show that pulsar wind nebulae are highly turbulent state. Here, we will discuss that the introduction of the turbulence to the standard model resolves this problem.

[4-10]

TBD

Siyao Xu

Kerr metric and quadratic curvature invariant of rotating black hole

Yong-Joo Rhee

Center for Relativistic Laser Science, IBS

Astrophysical phenomena such as high speed jet, large scale magnetic reconnection, collision of stellar objects, spectroscopy of compact objects and so on are attracting more and more attention of many laser plasma scientists since the availability of high power and/or high energy laser systems which can generate extreme plasma conditions comparable with the astrophysical situation came true. In order to study the astrophysical phenomena suitably implementable with our highly energetic laser system which can generate higher than 10^{22} W/cm^2 of laser intensity we started to investigate the physics of stellar objects such as rotating black holes and neutron stars on the basis of Einstein's field equation. Quadratic curvature invariant (Kretschmann scalar, K) is calculated symbolically with Mathematica program for the Kerr-Newman metric in the Riemannian manifold. For some stellar-mass black holes and neutron stars the K's are analyzed and compared.

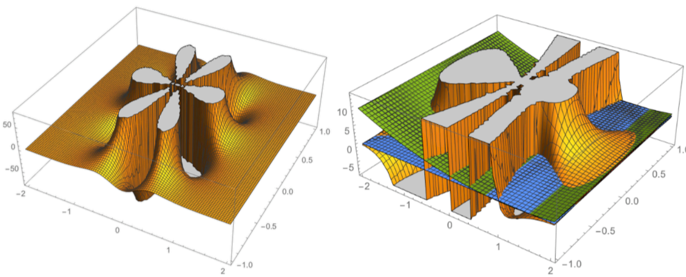

Figure 1. Kretschmann scalar vs r and cos(theta). Depending on the values of mass, angular momentum and charge of the black hole the curvature structure of space-time is changing.

[5-1]

Kinetic space plasma turbulence

Peter H Yoon

Kyung Hee University, KASI, and University of Maryland

[5-2]

Toward the solar flare prediction based on the critical condition of MHD instability

Kanya Kusano

Nagoya University

Solar flares and coronal mass ejections (CMEs) are believed to be the explosive liberation of magnetic energy in the solar corona. However, the critical condition for their onset is not yet well understood, and thus the accurate prediction of their onset is still difficult. Which kind of instability determines the critical condition is a key question of this problem, because magnetohydrodynamic (MHD) instabilities, e.g., the kink and torus modes of instabilities, may cause the explosive energy liberation in the solar corona. Recently, Ishiguro and Kusano (2017) proposed that a new instability called double-arc instability (DAI) may work as the initial driver of solar flares and it can trigger the onset of the solar eruption. We are building a new scheme for predicting solar flares based on the critical condition of this instability. In this talk, I will report the result of an event study for the solar active region NOAA 11158 (Muhamad, Kusano et al., in press), and the preliminary result of statistical analysis for the predictability of flare activity based on the new scheme.

[P1]

Quadrupolar and sextupolar Hall magnetic field during asymmetric magnetic reconnection without a guide field

LongLong Sang

University of Science and Technology of China

Co-authors: Quanming Lu and Rongsheng Wang

In this paper, taking advantage of a two-dimensional (2-D) particle-in-cell (PIC) simulation model, we study the structure of the out-of-plane magnetic field (Hall magnetic field) during asymmetric magnetic reconnection without a guide field, and the associated in-plane current system is also analyzed. The evolution of asymmetric reconnection have two stages: the Hall magnetic field at first has a quadrupolar structure, and then it evolves into a sextupolar structure. At the first stage, the electrons moves toward the X line along the separatrix in the magnetosheath side, and depart from the X line along the separatrix in the magnetosphere side. Another electron flow toward the X line exists above the separatrix in the magnetosphere side. The resulted in-plane current system, which is mainly determined by electron dynamics, generates the quadrupolar structure of the Hall magnetic field, where the two quadrants in the magnetosheath side is much larger than those in the magnetosphere side. At the second stage, besides these electron flows, an additional electron flow away from the X line is formed along the magnetic field below the separatrix in the magnetosheath side. A sextupolar structure of the Hall magnetic field is then generated by such a current system.

[P2]

Observation of the Kelvin–Helmholtz Instability in a Solar Prominence

Heesu Yang

Korea Astronomy and Space Science Institute

Authors : Heesu Yang, Zhi Xu, Eun-Kyung Lim, Sujin Kim, Kyung-Suk Cho, Yeon-Han Kim, Jongchul Chae, Kyuhyoun Cho, Kaifan Ji

Many solar prominences end their lives in eruptions or abrupt disappearances that are associated with dynamical or thermal instabilities. Such instabilities are important because they may be responsible for energy transport and conversion. We present a clear observation of a streaming kink-mode Kelvin–Helmholtz Instability (KHI) taking place in a solar prominence using the Hα Lyot filter installed at the New Vacuum Solar Telescope, Fuxian-lake Solar Observatory in Yunnan, China. On one side of the prominence, a series of plasma blobs floated up from the chromosphere and streamed parallel to the limb. The plasma stream was accelerated to about 20–60 km/s and then undulated. We found that 2″- and 5″-size vortices formed, floated along the stream, and then broke up. After the 5″-size vortex, a plasma ejection out of the stream was detected in the Solar Dynamics Observatory/ Atmospheric Imaging Assembly images. Just before the formation of the 5″-size vortex, the stream displayed an oscillatory transverse motion with a period of 255 s with the amplitude growing at the rate of 0.001/s. We attribute this oscillation of the stream and the subsequent formation of the vortex to the KHI triggered by velocity shear between the stream, guided by the magnetic field and the surrounding media. The plasma ejection suggests the transport of prominence material into the upper layer by the KHI in its nonlinear stage.

[P3]

The Effect of Pressure Gradient Force on an Accretion Disk Surrounding a Magnetized Neutron Star

Isaac Habumugisha

Kabale University

Isaac Habumugisha[1,2,3], Edward Jurua[1], Solomon B. Tessema[4] and Anguma K. Simon[5]

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In this study, we investigate the effect of pressure gradient force (PGF) on a stationary thinorbiting accretion disk surrounding a magnetized neutron star. In this model, the azimuthal velocity is formulated to deviate from the Keplerian fashion by a factor say ξ ($0 < \xi < 2$) that is close to unity. Using the usual assumptions about viscous stress, for a relatively high β plasma, we have found that for a typical binary X-ray source the disk is largely modified (position of corotation radius, PGF-torque) when the pressure gradient force is taken into account. Thus, this result can provide explanation of observed spin-down/up state in several astronomical environments.

[P4]

Formation of the First Galaxies

Li-Hsin Chen

National Taiwan University

Co-authors: Ke-Jung (Ken) Chen (ASIAA/NAOJ)

Modern cosmological simulations suggest that the hierarchical assembly of dark matter halos provided the gravitational wells that allowed the primordial gases to form stars and galaxies inside them. The first galaxies comprised of the first systems of stars gravitationally bound in dark matter halos are naturally recognized as the building blocks of early Universe. To understand the formation of the first galaxies, we use an adaptive mesh refinement cosmological code, ENZO to simulate the formation and evolution of the first galaxies. We first model an isolated galaxy by considering much microphysics such as star formation, stellar feedback, and primordial gas cooling. To examine the effect of Pop III stellar feedback to the first galaxy formation, we adjust the initial temperature and metallicity distributions based on the IMF of the first stars. Our results suggest that star formation in the first galaxies is sensitive to the initial metallicity/density/temperature distribution from the first supernovae. Our study can help to correlate the populations of the first stars and supernovae to star formation inside these first galaxies which may be soon observed by the JWST.

[P5]

Two-dimensional simulations of circumstellar material collisions from exploding stars

Ruo-Yu Liu

National Taiwan University

We present the 2D simulations of circumstellar material (CSM) interactions with supernovae (SNe) by using CASTRO code. During the evolution of a massive star, a vast amount of mass is ejected by stellar winds and leads to form an inhomogeneous CSM, which consists of numerous dense clumps, around the parent star. When the star eventually explodes as an SN, its shockwaves and ejecta start violently interacting with these clumps. We simulate the collisions to identify the fluid instabilities and its resulting mixing. Our results suggest strong radiation may be emitted from such collisions and it affects the SN observables significantly. Besides, the mass-loss history of a massive star can be reconstructed based on our models.

[P6]

Study of ambient environment around Asymptotic Giant Branch Carbon Star using IRAS survey.

Lochan Khanal

Tribhuwan University, Amrit Campus, Kathmandu

We studied dust environment such as flux, temperature, mass and inclination angle of the cavity structure around the C-rich Asymptotic giant branch star in 60 μm and 100 μm wavelengths band using Infrared Astronomical Survey. We observed the data of AGB star having IRAS name 01142+6306 corresponding to R.A.(J2000)= 01h 17m 33.504s and Dec. (J2000)= 630 22' 4.98'. Flexible image transport system image was downloaded from Sky View Observatory; we obtained the surrounding flux density using software Aladinv2.5. The dust color average temperature and mass are found to be 25.08 K and 4.73×10^{26} kg (0.00024 $M_\odot$) respectively. The dust color temperature ranges from 18.76 ± 3.16 K to 33.21 ± 4.07 K. The isolated cavity like structure around AGB star has extension 45.67 parsec and contraction 17.02 parsec was observed using detailed calculation. The core region is found to be edge-on having inclination angle 79.46 degree.

[P7]

Big Bang Nucleosynthesis with an Inhomogeneous Primordial Magnetic Field Strength

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National Astronomical Observatory of Japan

Co-authors:
Toshitaka Kajino, Motohiko Kusakabe and Grant J. Mathews

Big Bang Nucleosynthesis (BBN) agrees well with the observationally inferred abundances of light elements D, ^{3}He, ^{4}He and ^{7}Li in the early universe except for ^{7}Li. We investigate the effect on the abundances of these elements from the presence of a stochastic primordial magnetic field (PMF) whose strength is spatially inhomogeneous. We assume a uniform total energy density and a large-scale stochastic PMF with a power law (PL) correlation function and a gaussian distribution of field strength. In this case, domains of different temperatures exist in the BBN epoch due to variations in the local PMF. We show that in such case, the effective distribution function of particle velocities averaged over domains of different temperatures deviates from the Maxwell-Boltzmann (MB) distribution. We perform BBN network calculations taking into account the PMF strength distribution and find that the fluctuation of the PMF reduces the ^{7}Be production and enhances D production. We analyze the averaged thermonuclear reaction rates compared with those of a single temperature, and find that the charged-particle reaction rates

are very different. Finally, we constrain the parameters for our fluctuating PMF model from observed abundances of ^{4}He and D. In this model, the ^{7}Li abundance is significantly reduced. We also discuss the possibility that the baryon-to-photon ratio decreased after the BBN epoch. In this case, we find that if the η value during BBN was larger than the present-day value, all produced light elements are consistent with observational constraints.

[P8]

Off-Axis Characteristics of Japanese Grazing Incidence Mirror Telescopes for X-Ray Solar Physics

Junho Shin

Kyung Hee University

Junho Shin [1,2], Takashi Sakurai [2], Ryouhei Kano [2]

[1] Kyung Hee University

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Coronal hole has an important meaning not only in the field of solar physics but also in relation to the space weather because it is known as a birthplace of solar winds. The detailed mechanism of coronal heating leading to the solar wind acceleration is, however, still unknown. To theoretically model the three-dimensional coronal structures is sensitive to the values of plasma properties at the base of solar corona and thus requires beforehand accurate empirical description of those properties. Therefore, the detailed study on the physical conditions of solar plasma in the coronal holes and also at the off-the-limb areas will give us a clue to understand the boundary conditions and constraints on the theoretical mechanisms of heating the coronal plasma. Two Japanese grazing incidence mirror telescopes, the Yohkoh Soft X-ray Telescope (SXT) and the Hinode X-Ray Telescope (XRT), have provided solar X-ray images for more than a couple of decades and contributed to the progress in our understanding of coronal physics. An astronomical telescope is, in general, designed

such that the best-focused image of an object is achieved at or very close to the optical axis and inevitably the optical performance deteriorates away from the center. The Sun is, however, a large object of about half a degree in diameter and targets near the limb area are placed in the off-axis region of full-disk (synoptic) images. The optical design of a solar X-ray telescope should thus consider the uniformity of imaging quality over a wide field-of-view. Even after such a design effort, the off-axis performance such as the effects due to vignetting and the scattered light should be characterized carefully in order for the data to be properly interpreted. This presentation will explain the importance of accurate calibration of these effects, especially for the data taken in the off-axis region, which have been studied so far and also should be done in the near future.

[P9]

Density and Magnetic Field Correlation in MHD Turbulence

Heesun Yoon and Jungyeon Cho

Chungnam National University

Turbulent motions produce density and magnetic field fluctuations in astrophysical systems. The correlation between the two fluctuations is important for determining the magnetic field strength from the rotation measure (RM) and the dispersion measure (DM) observations. However, it is not clear what factors affect the correlation between two.
In this presentation, we discuss the factors affect correlation. We numerically investigate how the correlation time of driving affects the correlation between them. We consider two types of driving : a finite-correlated driving and a delta-correlated driving. We also consider solenoidal and compressive driving. Our results show that drivings produce clear differences in density-magnetic field correlation.

[P10]

Space Weather Operation at KASI with Van Allen

Jongkil Lee

KASI

The Van Allen Probes (VAPs) are the only modern NASA spacecraft broadcasting real-time data on the Earth's radiation belts for space weather operations. Since 2012, the Korea Astronomy and Space Science Institute (KASI) has contributed to the receipt of this data via a 7-m satellite tracking antenna and used these data for space weather operations. An approximately 15-min period is required from measurement to acquisition of Level-1 data. In this paper, we demonstrate the use of VAP data for monitoring space weather conditions at geostationary orbit (GEO) by highlighting the Saint Patrick's Day storm of 2015. During that storm, Probe-A observed a significant increase in the relativistic electron flux at 3 RE. Those electrons diffused outward resulting in a large increase of the electron flux > 2 MeV at GEO, which potentially threatened satellite operations. Based on this study, we conclude that the combination of VAP data and National Oceanic and Atmospheric Administration-Geostationary Operational Environmental Satellite (NOAA-GOES) data can provide improved space environment information to geostationary satellite operators. In addition, the findings obtained indicate that more data-receiving sites would be necessary and data connections improved if this or a similar system were to be used as an operational data service.