Astrophysics Seminar Presentations Agenda
Wednesday, October 3, 2018

Reinhard Friedel, CSES 5min 1:00-1:05pm
Introduction to CSES Astro Focus Area Presentations

Kirk Flippo, P-24 20min 1:05-1:30pm (5 min Q&A)
CSES Student Fellow Project
Title: Self-Generated Magnetic Fields in High Energy Density Laboratory Experiments

Przemek Wozniak, ISR-2 20 min 1:30-1:50pm (5 min Q&A)
CSES Emerging Ideas R&D project
Title: Automated Selection and Characterization of Explosive Astrophysical Transients

Andrey Sadofyev, T-2 20min 1:50-2:15pm (5 min Q&A)
CSES Emerging Ideas R&D project (J. Robert Oppenheimer Fellow)
Title: An Axion-Like Particle from the Chiral Anomaly and TeV Gamma-rays from Extragalactic Sources

Platon Karpov, T-5 20min 2:15-2:40 (5 min Q&A)
CSES Emerging Ideas R&D project (Student presenting under Chengkun Huang project, T-5)
Title: Autonomic MHD closure for the turbulent plasmas in Astrophysics

Self-Generated Magnetic Fields in High Energy Density Laboratory Experiments

Kirk Flippo, P-24, LANL

High Energy Density (HED) laboratory experiments to study hydrodynamic instabilities have been developed over the last several years on Omega and NIF. We model these experiments with multi-physics hydro-dynamic codes under the assumption that any magnetic fields produced in these plasmas will not affect the bulk hydro. In many cases this is likely a valid assumption; however, as we try to ever focus our understanding on smaller and smaller scale phenomena in HED experiments we begin to see more and more discrepancies with our pure hydro models. Our project aims to create and diagnose self-generated fields in platforms similar to our HED hydro experiments to quantify how large these fields can become and how these fields can affect the small scale hydro evolution of these platforms. Namely, when the energy density of phenomena are on par with the magnetic energy density, as can be in turbulence, how are small vortices affected, how do B fields change the dissipation scales, and how do changes in heat conduction change the distribution of modes?

Automated Selection and Characterization of Explosive Astrophysical Transients

Przemek Wozniak (ISR-2), Thomas Vestrand (ISR-2), Chris Fryer (CCS-2), Carola Ellinger (CCS-7)

Photometric sky surveys on a massive scale such as the Zwicky Transient Facility (ZTF) and Large Synoptic Survey Telescope (LSST) are stimulating exponential growth in studies of cosmic explosions. Much of what we know today about extreme physical conditions in exotic environments such as gamma-ray bursts (GRBs) and supernovae (SN) relies on early identification capabilities and rapid follow-up observations that enable detailed spectroscopic, multi-wavelength, and now, multi-messenger (gravitational wave) studies of the most interesting events. While a variety of machine learning (ML) algorithms and tools have been deployed to help observers with transient selection and classification in specific contexts (e.g. finding supernovae), there is no comprehensive approach that can automatically parse a complete data stream from a modern sky survey. It is also not clear how to incorporate model predictions, e.g. where a purely data driven approach lacks sufficient examples. The necessary algorithms and software tools that can bridge this gap have been slow to emerge. Here we explore the potential utility of ML tools for extracting interesting features and correlations from collections of computational models such as time-resolved spectra of core collapse supernovae from the theoretical astrophysics group at LANL. The results of this pilot study will be used to establish the most promising directions for further research and development needed to fully utilize the science potential of current and emerging sky surveys.

An Axion-Like Particle from the Chiral Anomaly and TeV Gamma-rays from Extragalactic Sources

Emil Mottola and Andrey Sadofyev (T-2), LANL

High-energy gamma-ray observations have the potential to probe fundamental physics at energy scales not accessible by earthbound accelerators. We have shown that the axial anomaly of QED in the high energy limit in which the electron mass can be neglected implies the existence of a massless bosonic excitation that can propagate over very large distances. Its two-photon interaction from the anomaly is similar to that of the hypothetical axion. If a fraction of Tev γ-rays from distant AGN sources oscillate into this Axion-Like Particle (ALP) through interaction with magnetic fields, CMB microwave photons or extragalactic background light, and then reconvert to gamma-rays nearer the earth, they could lead to a possible increase in the γ-ray flux at earth compared to the expected EBL absorption, and indirect detection by high energy γ-ray experiments such as HAWC. I will describe the fundamental physics of this emerging idea based on our recent preprint LA-UR.

Autonomic MHD closure for the turbulent plasmas in astrophysics

Platon Karpov, T-5, LANL
University of California Santa Cruz

Turbulence plays a significant role in many different phenomena in astrophysics, such as the Core-Collapse Supernovae (CCSN). Unfortunately, current state-of-the-art simulations have to resort to using subgrid models for turbulence treatment, as direct numerical simulations (DNS) are too expensive to run for full scale simulation. However, said subgrid models, such as used in large eddy simulation (LES), lack accuracy when compared to DNS results. Recently, there has been a new trend of utilizing Machine Learning (ML) technique, with impressive prediction capability for the turbulence closure [1]. We've applied Kernel Ridge Regression to investigate the accuracy and applicability of these algorithms in regards to magnetohydrodynamic (MHD) turbulence subgrid modeling. Our future goal is to ready and apply our ML methodology within the multi-D MHD CCSN framework to investigate the effects of accurately-modeled turbulence on the explosion rate of these events.

[1] R.N.King, P.E.Hamlington, and W.J.A.Dahm, *Autonomic closure for turbulence simulations*, Phys. Rev. E 93, 031301 (2016)