

**THE UNIVERSITY OF HONG KONG**

*DEPARTMENT OF PHYSICS*

*RESEARCH SEMINAR*

**Are Pulsar Halos Truly symmetric? Insights  
from 3D Magnetic Turbulence Simulations**

**Mr. Yuan LI**

*Shanghai Jiao Tong University / Tsung-Dao Lee Institute*

Abstract:

The diffuse gamma-ray emission from the Geminga halo has been suggested to exhibit asymmetric features, though the existence and origin of such asymmetry remain debated. We perform three-dimensional test-particle simulations of cosmic-ray (CR) electrons propagating in turbulent magnetic fields characterized by Kolmogorov and Bohm spectra. Particle trajectories are computed under the Lorentz force, with radiative energy losses from synchrotron emission and inverse Compton scattering included self-consistently. We further incorporate a regular magnetic field component and explore different inclinations between the magnetic field direction and the line of sight, computing the resulting gamma-ray surface brightness and comparing it with HAWC observations. Our results constrain the magnetic coherence length to several parsecs and statistically favor the presence of a regular magnetic field in the Geminga region. Compared to Kolmogorov turbulence, Bohm turbulence produces more tangled magnetic field lines and a nearly isotropic CR distribution, failing to reproduce the observed halo morphology. The simulations indicate that filamentary substructures are intrinsically present within the Geminga halo. Although current very-high-energy instruments cannot resolve these internal asymmetries, projection effects do not erase them: even in the extreme case of a large coherence length combined with a strong regular field aligned with the line of sight, filamentary structures persist internally despite an apparently isotropic overall morphology.

Biography:

Yuan Li is a PhD candidate at Shanghai Jiao Tong University / Tsung-Dao Lee Institute and is expected to graduate in summer 2026. His research focuses on cosmic-ray transport in turbulent magnetic fields and gamma-ray observations of pulsar halos, supernova remnants, and young massive star clusters. He combines test-particle simulations with multi-wavelength data analysis to investigate high-energy particle propagation in the Galaxy.

**Thursday, March 5, 2026, 4:00pm**

Room 522, 5/F, Chong Yuet Ming Physics Building, The University of Hong Kong

Department of Physics, Chong Yuet Ming Physics Building, The University of Hong Kong

*Phone: 39172360 Fax: 25599152. Anyone interested is welcome to attend.*