Department of Physics and Materials Science

SEMINAR

Multimessenger Sirens: Modeling & Monitoring
Blazar Jets Across the Electromagnetic Spectrum

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The University of Mississippi

Abstract: Blazars are an extreme subclass of active galactic nuclei (AGN), in which an accreting supermassive black hole launches a powerful relativistic jet of magnetized plasma that is closely aligned to our line-of-sight. Blazar jets: (i) shine across the entire electromagnetic spectrum (from low-frequency radio waves to high-energy gamma-rays), (ii) exhibit dramatic flares (on time scales ranging from days to minutes), and (iii) dominate the high-energy extragalactic sky. Very long baseline interferometric arrays (such as phased ALMA and the EHT) are capable of imaging the polarized synchrotron emission emanating from the innermost regions of relativistic blazar jets with unprecedented angular resolution and sensitivity. In particular, the linearly and circularly polarized synchrotron emission from blazar jets carry imprints of both the strength and orientation of the collimating magnetic field as well as the plasma content of the jet environment. In parallel to these advances in VLBI imaging, modern computational resources now support the execution of increasingly sophisticated 3D numerical jet simulations, from semi-analytic shock-injet and turbulence models, to relativistic magneto-hydrodynamic and particle-in-cell jet plasma simulations. In this talk, I will present a new suite of relativistic jet simulations which study the synchrotron polarization produced by blobs of relativistic plasma passing through standing recollimation shocks in the jet. This is accomplished using the PLUTO code in concert with polarized radiative transfer ray-tracing calculations computed using the RADMC-3D code. The physical implications of this synchrotron emission will be discussed and direct comparisons will be made to actual observations of relativistic blazar jets. By attempting to bridge the gap between plasma simulations and blazar observations, we aim to advance our understanding of the jet's intrinsic plasma nature in 3D.

Bio: Dr. MacDonald received his PhD from Boston University in 2017. He then joined the Max Planck Institute for Radio Astronomy (in Bonn, Germany) first as a postdoctoral researcher and then as a staff scientist. He then moved to Oxford, Mississippi in 2023, where he joined the Department of Physics and Astronomy at UM as an Assistant Professor. He specializes in the study of plasma physics and radio emission from relativistic black hole jets.

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