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Jets, Blobs, and Circular Polarization: Using PLUTO & RADMC-3D to Model Time Domain Variability in Blazars

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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 (VLBI) arrays (such as phased ALMA & The Event Horizon Telescope) 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 shock-in-jet/turbulence models, to relativistic magneto-hydrodynamic (RMHD) and particle-in-cell (PIC) plasma simulations. In this talk, I will present a new suite of relativistic jet simulations which study the variability in the circular polarization produced by a blob of relativistic plasma passing through a standing recollimation shock within a jet. This is accomplished through the use of the PLUTO code in concert with polarized radiative transfer ray-tracing calculations computed using the RADMC-3D code. The physical implications of this polarization variability will be discussed and direct comparisons will be made to full-Stokes light curves obtained with the Polarimetric Monitoring of AGN at mm-Wavelengths (POLAMI) Program.

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