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Studying Magnetic Fields near a Black Hole with the EHT using Polarized Geometric Models

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The Event Horizon Telescope (EHT) has imaged the black hole shadows of the supermassive black hole at the center of the galaxy M87 (M87*, [1]) and at the center of the Milky Way (Sgr A*, [2]). Polarimetric imaging of M87* with the EHT, probing the near-horizon magnetic field structure, enabled significantly stronger inferences on the black hole and accretion parameters than total intensity data alone [3, 4]. Geometric modeling was a central tool for studying the structure of M87* in total intensity and is especially effective for sparse arrays such as the EHT. However, few geometric models have been developed in polarized light, and there has been no analysis of EHT polarization data using geometric models.

The "m-ring" geometric model [5] has been particularly useful in analyzing EHT observations of Sgr A*. The parameters of this ring model, which has an angular profile parameterized by Fourier coefficients, directly map to parameters of interest that characterize the black hole system. We have extended this model to include both linear and circular polarization, making use of calibration-invariant polarimetric data products to derive results that are robust to atmospheric or instrumental data corruptions.

We will show tests of this model using simulated EHT datasets generated from general relativistic magnetohydrodynamics models of the black hole accretion flows, which demonstrate that this new approach is effective at studying the polarized emission on event horizon scales. We will also show the results of fitting this model to EHT observations of M87*. Our results are generally consistent with imaging methods, but they also enable studies of the black hole when imaging methods struggle, such as nights with sparse coverage or weak signals.

References

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