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M2FINDERS: Testing the event horizon paradigm with multiband VLBI measurements

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The most convincing experimental tests for the existence of cosmic black holes involve measuring the enclosed mass, observing relativistic effects near the event horizon, and detecting gravitational waves from black hole mergers. The observations of stellar motions near Sgr A* by GRAVITY [1] and the imaging of M87 and Sgr A* by EHT [2, 3] demonstrate the effectiveness of these methods in testing the black hole/event horizon paradigm. Effective tests of the event horizon paradigm can be further conducted using high-resolution VLBI probes of the magnetic fields around black holes on scales below several thousand gravitational radii. Our project M2FINDERS recognizes and explores this possibility through multi-frequency polarization VLBI imaging of compact radio emission in selected AGN. This allows for probing of linear scales below about 10000 gravitational radii. The sensitivity and positional accuracy of global VLBI observations at frequencies above 22 GHz are expected to improve by more than an order of magnitude with the advent of frequency phase transfer.

As part of its effort, the Faraday Rotation (FR) MOJAVE project presents resolved polarimetric images of 25 AGN. These images were derived from 15/24/43 GHz observations using the Very Long Baseline Array (VLBA) and span twenty-three epochs between August 2019 to June 2021. The images provide a unique view into both the spatial and temporal evolution of the magneto-ionic media of AGN. The project also derives FR, intrinsic electric vector position angle (EVPA), spectral index, and depolarisation maps. Quasar jets exhibit longitudinal magnetic fields, while BL Lac objects exhibit transverse jet magnetic fields. AGN cores have large and highly variable FR values. At variable times, core regions also display evidence of non-linear FR, suggesting internal FR within the source's emission. By combining depolarization and Faraday rotation (FR) information, we found additional evidence of internal FR and identified a collection of sources that exhibit a transition between internal and external FR between the core and jet regions. This transition changes over time, enabling us to better understand the nature of their magneto-ionic environments.

This paper presents the current progress and first results from the M2FINDERS measurements.

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