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Testing the Kerr model and investigating supermassive black holes space times with SKA

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1 Extended Abstract

We propose using synchrotron radiation and radio observations to test General Relativity (GR) in strong gravitational fields. Although GR, developed over a century ago, has been successfully tested in weak-field regimes, precise tests in strong-field conditions remain challenging. Astrophysical black holes are generally assumed to follow the Kerr solution of GR, but their true geometries have yet to be fully confirmed. Existing tests of strong gravity in X-ray wavelengths often suffer from a degeneracy between measuring spin and detecting deviations from GR, making it difficult to distinguish between the two effects. Current black hole spin measurements rely on methods that introduce this degeneracy. However, combining different observational techniques across multiple wavelengths can help break this degeneracy and provide more robust constraints. Nonthermal synchrotron radiation is produced by cosmic ray electrons interacting with magnetic fields. The Event Horizon Telescope (EHT) has detected significant synchrotron emission near the event horizons of supermassive black holes (SMBHs) in M87 and the Milky Way. In this study, we use synchrotron radiation to probe the strong gravity regime by comparing Kerr and non-Kerr spacetime models. We analyze how variations in spin, inclination angle, magnetic field strength, and nonthermal spectral index affect the observed flux density in both Kerr and non-Kerr spacetimes. Additionally, we simulate observations for multiple objects and compare the resulting data products. At this stage, we perform these comparisons using a Bayesian inference approach, exploring different priors to assess their impact on the results. Furthermore, we investigate the potential of the Square Kilometre Array (SKA) to test strong-field gravity through synchrotron and radio observations.