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First M87 Event Horizon Telescope Results: The Shadow of the Supermassive Black Hole

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The Event Horizon Telescope (EHT) has mapped the central compact radio source of the elliptical galaxy M87 at 1.3 mm with unprecedented angular resolution. These images show a prominent ring with a diameter of ~40 micro-arcsecond, consistent with the size and shape of the lensed photon orbit encircling the "shadow" of a supermassive black hole. The ring is persistent across four observing nights and shows enhanced brightness in the south. Here we consider the physical implications of the asymmetric ring seen in the 2017 EHT data. To this end, we construct a large library of models based on general relativistic magnetohydrodynamic simulations and synthetic images produced by general relativistic ray tracing. We compare the observed visibilities with this library and confirm that the asymmetric ring is consistent with earlier predictions of strong gravitational lensing of synchrotron emission from a hot plasma orbiting near the black hole event horizon. Overall, the observed image is consistent with expectations for the shadow of a spinning Kerr black hole as predicted by general relativity. If the black hole spin and M87's large scale jet are aligned, then the black hole spin vector is pointed away from Earth. Models in our library of non-spinning black holes are inconsistent with the observations as they do not produce sufficiently powerful jets. We also briefly discuss the possibility of the alternatives to a black hole for the central compact object.

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