The Jet in the Galactic Center: An Ideal Laboratory for Magnetohydrodynamics and General Relativity

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In this paper we review and discuss some of the intriguing properties of the Galactic Center supermassive black hole candidate Sgr A*. Of all possible black hole sources, the event horizon of Sgr A*, subtends the largest angular scale on the sky. It is therefore a prime candidate to study and image plasma processes in strong gravity and it even allows imaging of the shadow cast by the event horizon. Recent mm-wave VLBI and radio timing observations as well as numerical GRMHD simulations now have provided several breakthroughs that put Sgr A* back into the focus. Firstly, VLBI observations have now measured the intrinsic size of Sgr A* at multiple frequencies, where the highest frequency measurements have approached the scale of the black hole shadow. Moreover, measurements of the radio variability show a clear time lag between 22 GHz and 43 GHz. The combination of size and timing measurements, allows one to actually measure the flow speed and direction of magnetized plasma at some tens of Schwarzschild radii. This data strongly support a moderately relativistic outflow, consistent with an accelerating jet model. This is compared to recent GRMHD simulation that show the presence of a moderately relativistic outflow coupled to an accretion flow Sgr A*. Further VLBI and timing observations coupled to simulations have the potential to map out the velocity profile from 5-40 Schwarzschild radii and to provide a first glimpse at the appearance of a jet-disk system near the event horizon. Future submm-VLBI experiments would even be able to directly image

those processes in strong gravity and directly confirm the presence of an event horizon.

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