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Microlensing Black Hole Shadows

A detailed analysis is presented of the gravitational microlensing by intervening compact objects of the black hole shadows imaged by the Event Horizon Telescope (EHT). We show how the center, size, and shape of the shadow depend on the Einstein angle relative to the true/unlensed shadow size, and how the location of the lens affects the shift, size, and asymmetry of the black hole shadow due to microlensing. Assuming a supermassive black hole (SMBH) casts a circular-shaped true shadow, microlensing can create an asymmetry of up to approximately 8\%, which is twice the asymmetry caused by the SMBH's spin and its tilt relative to us. Furthermore, the size can be enhanced by ∼50\% of the true shadow. Currently, the terrestrial baselines of EHT lack the resolution to detect microlensing signatures in the shadows. However, future expansions of EHT including space-based baselines at the Moon and L_2, could potentially enable the detection of microlensing events. For Sgr˜A*, an event rate of 0.0014 per year makes the microlensing phenomena difficult to observe even with space-based baselines for the stellar population in the stellar bulge and stellar disk for lens mass $\sim M_\odot$. However, continuously monitoring the shadow of Sgr˜A* could offer novel insights into the compact object population surrounding the galactic center.

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