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Black Hole Imaging: Radiative transfer in extreme gravity

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The GRAVITY instrument made a remarkable observation during the Near-Infrared flares of 2018, detecting a fast-moving hot spot in what seemed to be a circular orbit around SgrA*, the supermassive black hole in our Galactic Center. These profound observations have motivated the development of an advanced Python code for General-Relativistic Radiative Transfer calculations within the framework of Kerr spacetime. We provide a deeper understanding of the inner workings of ray tracing schemes in general and offer detailed insights into the challenges encountered during the development process. Moreover, we present rigorous tests to evaluate the accuracy of the code's results and highlight the importance of implementing high performance computing techniques in general relativistic numerical simulations. This work investigates how General Relativity and the spin of a black hole shape photon geodesics and studies the effect of parameters such as the hot spot' s angular velocity and the observer's inclination on the resulting trajectory. More specifically, we employ our radiative transfer algorithm to interpret the observed flaring events in the vicinity of our Galactic Center and seek out the optimal orbital parameters for modeling similar phenomena. In accordance with the latest state-of-the-art GRMHD simulations, our research scope encompasses physically motivated ejected hot spot models, such as helical and conical configurations, that represent the most suitable candidates for replicating the observed flares.

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