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Nuclear Transients from Star-Disk Interactions Near Black Holes

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Recently, multiple detections of repeating soft X-ray emissions from quiescent galaxies have suggested a potential new category of nuclear transient events: quasi-periodic eruptions (QPEs). These events are characterized by quasi-regular, large-amplitude X-ray flares detected at around ˜100 eV, with typical recurrence times ranging from hours to days, a connection to previous tidal disruption events (TDEs), and a lack of optical/UV counterparts. Several models have been proposed to explain their origin, including a class of models involving a star orbiting near a black hole and interacting with the relic accretion disk.
In this work, we perform two-dimensional multigroup radiation hydrodynamics simulations of a star colliding with an existing disk. We find that the collision is able to produce two plumes of ejecta from both sides of the disk, consistent with theoretical expectations. However, the ejecta are not symmetric in mass and velocity. As the ejecta expand and cool, the quasi-adiabatic cooling emission can potentially be connected to transient flares. The emission, however, is not always thermalized, which is essential to producing the emission in the soft X-ray band. We discuss the importance of capturing the multi-band radiation transfer physics in this problem

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