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Probing stellar mass black hole orbits deep in galactic nuclei with quasi-periodic eruptions

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Quasi-periodic eruptions (QPEs) are intense repeating soft X-ray bursts with recurrence times about a few hours from nearby galactic nuclei. The origin of QPEs is still unclear. Though many models have been proposed for explaining the QPE observations, most of them can only recover
a portion of diverse features of different QPEs. In this work, we revised the extreme mass ratio inspiral (EMRI) + accretion disk model, where the disk is formed from a previous tidal disruption event (TDE). In this EMRI+TDE disk model, the QPEs are the result of collisions between a TDE disk and a stellar mass black hole (sBH) orbiting around a supermassive black hole (SMBH) in galactic nuclei. This model is flexible and comprehensive in recovering different aspects of QPE observations, especially fitting the QPE light curves and spectral evolution with high precision that alternative models hardly reach. In the framework EMRI+TDE disk, we find that all the observed QPEs are produced by EMRIs of low eccentricity and semi-major axis about $O(10^2)$ times gravitational radius of the central SMBH.
If this interpretation is correct, QPEs will be invaluable in probing the formation channels of EMRIs, which is one the primary targets of spaceborne gravitational wave missions.

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