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Diverse Emission Patterns from Precessing Super-Eddington Disks Formed in Tidal Disruption Events

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A tidal disruption event (TDE) occurs when a star passes within the tidal radius of a supermassive black hole (SMBH). In TDEs it is expected that the orbital angular momentum of the disrupted star is generally misaligned with the SMBH spin axis, which should result in a misaligned super-Eddington disk precessing around the SMBH spin axis due to the Lense-Thirring effect. In this paper, we investigate the distinct observational signatures produced from such TDE disks, by performing radiative transfer calculations upon previous super-Eddington disk simulations. We demonstrate that the precession of the disk and wind drive time-dependent obscuration and reprocessing of X-ray radiation. Depending on the orientation of the viewing angle of the observer and the tilt angle of the disk, four main types of variability are induced:
1) The smooth-TDEs: The emissions from these TDEs show no fluctuations;
2) The dimmer: The main emission type (X-ray or optical) stays the same, with small to moderate modulations of brightness;
3) The blinker: X-ray and optical emissions take turns to dominate in one cycle of precession, with dramatic changes in the X-ray fluxes.
4) The siren: X-ray and optical emissions take over each other twice per cycle, possibly with two different peak X-ray fluxes within one cycle.
In all three scenarios, we observe an inverse correlation between X-ray and optical emissions.
Our model provides a unified physical framework for interpreting TDE multi-wavelength variability through disk precession dynamics and gives an alternative interpretation to the interesting case of J045650.3-203750 which was suggested to be a repeated partial TDE previously.

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