Co-Evolution of Central Black Holes and Galaxies
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Optical Flares from the Tidal Disruption of Stars by Massive Black Holes

Linda E. Strubbe[1] **and Eliot Quataert**[1]

[1]Department of Astronomy, University of California, Berkeley, CA, USA
Email: linda@astro.berkeley.edu

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A star that wanders too close to a massive black hole (BH) is shredded by the BH's tidal gravity. Stellar gas falls back to the BH, releasing a flare of energy. In anticipation of upcoming transient surveys, we predict the light curves and spectra of tidal flares as a function of time, highlighting the unique signatures of tidal flares in the optical and near-IR. Some of the gas initially bound to the BH is likely blown away when the fallback rate is super-Eddington at early times. This outflow produces an optical luminosity comparable to that of a supernova (Figure 1, left panel); such events have durations of $\sim$ 10 days and may have been missed in supernova searches that exclude the nuclear regions of galaxies. When the fallback rate subsides below Eddington, the gas accretes onto the BH via a thin disk whose emission peaks in the UV to soft X-rays. Some of this emission is reprocessed by the unbound stellar debris, producing a spectrum of very broad emission lines, with no corresponding narrow forbidden lines (center panel). These lines are strongest for BHs with $M_{\rm BH} \sim 10^5$–$10^6\,M_\odot$ and thus optical surveys are particularly sensitive to the lowest mass BHs in galactic nuclei. Calibrating our models to *ROSAT* and *GALEX* observations, we predict detection rates for Pan-STARRS, Palomar Transit Factory, and LSST (right panel) and highlight observational challenges in the optical. Pan-STARRS should detect at least several events per year — many more if current theoretical models of super-Eddington outflows are correct. These surveys will significantly improve our knowledge of stellar dynamics in galactic nuclei, the physics of super-Eddington accretion, the demography of intermediate mass BHs, and the role of tidal disruption in the growth of massive BHs.

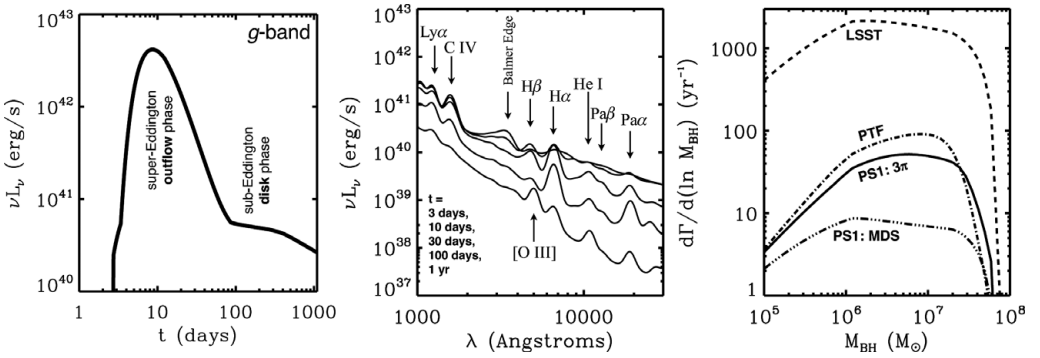

Figure 1. Predicted optical light curve (left) and spectrum (center) of a solar-type star tidally disrupted by a $10^6\,M_\odot$ BH. Right panel shows the predicted optical detection rates for LSST, Palomar Transient Factory, and the Pan-STARRS 3π and Medium Deep surveys.