# The gamma-ray afterglows of tidal disruption events

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**Abstract**

A star wandering too close to a supermassive black hole (SMBH) will be tidally disrupted. Previous studies of such ‘tidal disruption event’ (TDE) mostly focus on the stellar debris that are bound to the system, because they give rise to luminous flares. On the other hand, half of the stellar debris in principle are unbound and can stream to a great distance, but so far there is no clear evidence that this ‘unbound debris stream’ (UDS) exists. Motivated by the fact that the circum-nuclear region around SMBHs is usually filled with dense molecular clouds (MCs), here we investigate the observational signatures resulting from the collision between an UDS and an MC, which is likely to happen hundreds of years after a TDE. We focus on ? -ray emission (0.1–105 GeV), which comes from the encounter of shock-accelerated cosmic rays with background protons and, more importantly, is not subject to extinction. We show that because of the high proton density inside an MC, the peak ? -ray luminosity, about 1039 erg s-1, is at least 100 times greater than that in the case without an MC (only with a smooth interstellar medium). The luminosity decays on a time-scale of decades, depending on the distance of the MC, and about a dozen of these ‘TDE afterglows’ could be detected within a distance of about 16 Mpc by the future Cherenkov Telescope Array. Without careful discrimination, these sources potentially could contaminate the searches for starburst galaxies, galactic nuclei containing millisecond pulsars or dark matter annihilation signals..

**Keywords**

Acceleration of particles, Cosmic rays, Galaxies: active, Local Group, Gamma rays: galaxies.