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Choked jets in expanding envelope as the origin of the neutrino emission associated with Tidal Disruption Events

Three tidal disruption event (TDE) candidates (AT2019dsg, AT2019fdr, AT2019aalc) have been found to be coincident with high energy astrophysical neutrinos in multi-messenger follow-ups. Recent studies suggest the presence of a quasi-spherical, optically thick envelope around the supermassive black holes in TDEs, resulted from stellar debris after the disruption. The envelope may expand outwardly with a velocity of $\sim 10^4\,\mathrm{km}^{-1}$, as indicated by the emission line widths. We study whether the neutrino signal can be explained by choked relativistic jets inside the expanding envelope. While powerful jets, such as that in Swift J1644+57, can successfully break out from the envelope, those with relatively weak power could be choked by the envelope. Choked jets can still accelerate cosmic rays and produce high-energy neutrinos via interaction with the thermal photons in the envelope. We explore the parameter space of the jets that can produce detectable neutrino flux while being choked in the expanding envelope.
We find that the cumulative neutrino numbers of AT2019fdr and AT2019aalc are consistent with the expected range imposed by observations, while the allowed parameter space for AT2019dsg is small.
The neutrino time delay relative to the optical peak time of TDEs can be explained as the jet propagation time in the envelope before being choked. The discovery of TDE-associated neutrino events may suggest that jets might have been commonly formed in TDEs, as expected from super-Eddington accretion, but most of them are too weak to break out of the expanding envelopes.

Summary

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