

# Revealing Deaths of Massive Stars with High-Energy Neutrinos

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Neutrinos play important roles in revealing energetic astrophysical explosions such as gamma-ray bursts (GRBs) and supernovae (SNe). The large neutrino detector, IceCube has opened a new window of the multi-messenger astronomy.

I discuss neutrino emissions from GRBs in view of recent theoretical/observational progress, and emphasize the importance of sub-TeV neutrino astronomy. In particular, I show that neutron-loaded outflows lead to the promising signal from “subphotospheres”. On the other hand,  $\gg$ TeV neutrino production is largely prohibited inside stars for usual GRBs and jet-driven SNe, but possible for low-power GRBs. We stress the importance of dedicated searches for neutrinos from such low-power GRBs, which can also explain the PeV neutrino background observed by IceCube without violating GRB neutrino limits.

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