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Black Hole Hyperaccretion in Collapsars: GRB Timescale

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Gamma-ray bursts (GRBs) are classified into long and short populations (i.e., LGRBs and SGRBs) based on the observed bimodal distribution of duration T90. Multimessenger observations indicate that most SGRBs and LGRBs should be powered by ultrarelativistic jets launched from black hole (BH) hyperaccretion in compact-object mergers and massive collapsars, respectively. However, the duration criterion sometimes cannot correctly reflect the physical origin of a particular GRB. In the collapsar scenario, a GRB can be observed when the jet breaks out from the envelope and circumstellar medium successfully. The observed GRB duration reflects only the time the engine operates after the jet breaks out. This work studies the propagation of jets driven by the neutrino annihilation or Blandford–Znajek mechanism in massive collapsars. The signatures of the progenitors producing LGRBs, SGRBs, and failed GRBs in the collapsar scenario are exhibited. The competition between the mass supply onto the BH hyperaccretion and jet propagation into the envelope is definitely dependent on the density profiles of the collapsars. We show that duration and isotropic energy of GRBs can help constrain the density profiles of collapsars. Finally, we propose that a collapsar-origin SGRB, GRB 200826A, might originate from a neutrino-annihilation-dominated jet launched by a ˜10 solar mass collapsar whose progenitor ' s envelope has been stripped.

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