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Jet structure and variability studies of GRBs with 3D GRMHD simulations of magnetically arrested disks

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We study the structure and temporal variabilty properties of the GRB jets considering a magnetically arrested disk as their central engine. We numerically evolve the accretion disk around a Kerr black hole using 3D general relativistic magnetohydrodynamic simulations. We consider two analytical equillibrium disk configurations, the Fishbone-Moncrief and Chakrabarti solutions, as the initial conditions and impose poloidal magnetic fields upon them. The disk starts accreting due to the development of the magnetorotational instability and eventually develops to a magnetically arrested accretion disk state. We consider these models as central engines of short and long-GRBs, based on our initial conditions, and investigate the properties of the jets launched from these models. Our models self-consistently produce structured jets with a hollow core up to ~ 5 degrees. The jets from our simulations have an opening angle up to ~ 11 degrees for the long-GRB model and up to ~ 25 degrees for the short-GRB model. We also do the time variabilty studies of the jets and provide an estimate of their minimum variabilty timescales. Our models can be applied to the GRB jets in the binary neutron star post-merger system or to the ultra-relativistic jets launched from collapsing stars.

Presenter(s) : JAMES, Bestin (Center for Theoretical Physics PAS)