Poster Session #E
Astrophysics and Gravitational Waves

E05

The morphology of the X-ray afterglows and of the jetted GeV emission in long GRBs

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We recall evidence that all short and long gamma-ray bursts (GRBs) have binary progenitors and give new detailed examples. We focus on the binary progenitors of long GRBs, the binary-driven hypernovae (BdHNe), that consist of a carbon-oxygen core (CO core) and a binary neutron star (NS) companion. For binary periods of the order of 5 min, the energetic subclass BdHN I originates when the CO core collapses. They are characterized by: 1) an outstanding energetic supernova (the "SN-rise"); 2) a newborn black hole (BH) originating from the SN hypercritical accretion onto the NS companion. Only in some cases, the newborn BH via the "inner engine"' mechanism, is observed to lead to GeV emission characterized by an isotropic power-law luminosity $L_{GeV} = A_{GeV} \times t^{-\alpha_{GeV}}$. 3) The new NS ($\nu$NS), created at the SN center, accretes matter from the SN ejecta originating the X-ray afterglow with $L_X = A_X \times t^{-\alpha_X}$, always present in all BdHN I. We analyze 378 BdHN I and, among them, select four prototypes: GRB 130427A, GRB 160509A, GRB 180720B and GRB 190114C using a time-resolved spectral analysis and derive 1) the spectra, the luminosities and the duration of the SN-rise; 2) the amplitude A_X, the power-law index $\alpha_X = 1.48 \pm 0.32$ of their X-ray afterglows, 3) the time-evolution of the νNS spin, and 4) A_{GeV} and $\alpha_{GeV} = 1.19 \pm 0.04$. From the latter, we infer for the first time the mass and spin of the BH powering long GRBs. We also deduce that there is a special morphology which explains why the GeV emission is present only in some BdHN I, and it is confirmded by dedicated three-dimensional smoothed-particle-hydrodynamics simulations of BdHN I. We conclude that the GeV radiation is observed only when emitted within a cone of half-opening angle of nealry 60 degrees from the normal to the orbital plane. The mass and spin of the Kerr BHs are obtained based upon the GRB "inner engine" originating the GeV emission by extracting the BH rotational energy. We obtain initial BH masses $2.3 < M/M_{sun} < 8.9$ and spins $0.27 < a/M < 0.87$, and from their time evolution, we verify, for the first time, the validity of the BH mass-energy formula.