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Towards a unified model for the gamma-ray burst prompt emission & a new luminosity-hardness relation for cosmology

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The Gamma Ray Bursts (GRBs) are the most intense explosions in the universe and the footprints of stellar-mass black hole formation. Their initial phase, called prompt emission, lasts from a few ms to several tens of s. We suggest here to replace the historical spectral model (Band function) for the GRB prompt emission (keV-MeV energy regime) with a new one. We show that the complex GRB spectro-temporal shapes are well described with a combination of three separate components: (i) a thermal-like component that we interpret as emission from a non-dissipative GRB jet photosphere, (ii) a non-thermal component that we interpret either as synchrotron radiation from charged particles propagating and accelerated within the GRB jet or as a dissipative photosphere, and (iii) a second non-thermal component that is not always present or detectable and which is most likely of inverse Compton origin. The smooth evolution of all three components during the burst duration reinforces the validity of this new model. Detailed studies of the evolution of these components provide insights on the nature and composition of GRB jets as well as on their magnetic fields. Moreover, this new model enables a new luminosity-hardness relation based on the first non-thermal component showing that GRBs may be standard candles. If statistically confirmed, this relation will be used to (i) constrain the mechanisms powering GRB jets, (ii) estimate GRB distances, (iii) probe the early Universe, and (iv) constrain the cosmological parameters in complement to the Type Ia SNe sample. I will present this new model using analysis of GRBs detected with various observatories and instruments such as Fermi, CGRO/BATSE and more recently Swift. I will discuss here the striking similarities of GRB spectral shapes as well as the possible universality of the proposed luminosity-hardness relation in the context of the new model.

Author: GUIRIEC, Sylvain (NASA Goddard Space Flight Center / UMD / CRESST)

Presenter: GUIRIEC, Sylvain (NASA Goddard Space Flight Center / UMD / CRESST)

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