An expanding hadronic supercritical model for γ-ray burst emission

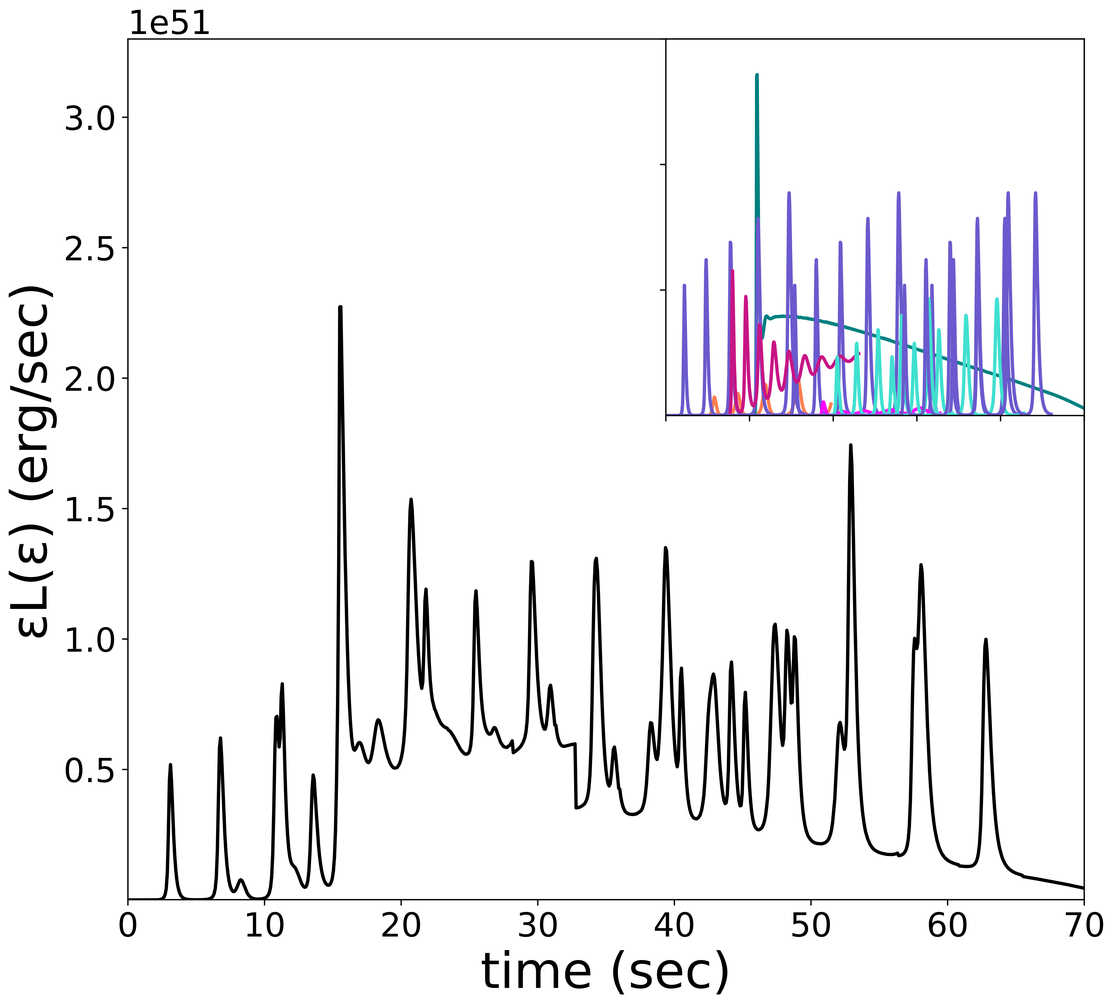
Ioulia Florou, Apostolos Mastichiadis and Maria Petropoulou

Department of Physics, National & Kapodistrian University of Athens

Summary

Gamma-Ray Bursts (GRBs) have been discovered in the late sixties, however their origin is still an open issue. Many models have been proposed during the past decades in order to explain the GRB production. A possible candidate are the hadronic models, implying that the particles that radiate are relativistic protons.

In this project we adopt **a hadronic scenario** in order to reproduce a GRB prompt emission. Specifically, we work on **hadronic supercriticality**, a property of hadronic systems, according to which, under certain conditions, protons release abruptly and efficiently all their radiative output to photons. The photon flares that are produced are highly variable and thus have a direct analogy to the GRB phenomenology.



Central plot: The superposition of the supercritical lightcurves produced by ten expanding blobs that are emitted from a central region every two seconds (black line). The Bulk Lorentz factor and the redshift are assumed $\Gamma = 100$ and $z = 2.27$ respectively.

Inset plot: The lightcurve produced from each expanding supercritical blob shown in colour. Both axis are the same as in the central plot

Here we assume, **for the first time, a spherically expanding one zone model** and seek the initial parameters that lead the system to the manifestation of supercriticality. We then simulate a variable GRB engine, by assuming that a discrete number of blobs are produced at the base of the GRB jet due to an episodic energy injection.

We perform a Monte Carlo simulation and randomly select the physical parameters of each expanding blob which also ensure the onset of hadronic supercriticality. We numerically calculate the time-dependent electromagnetic signals from each blob and compute their superposition in order to construct the total observed light curve. We also compute the broadband photon and neutrino spectra from each blob and present a physical picture of a typical long GRB prompt emission.