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Modelling of GRB 221009A through analytical description of VHE afterglow light curves

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In date 9th of October 2022, several ground-based and space-based detectors observed a Gamma-Ray Burst (GRB) then called GRB 221009A, which is recorded as the most energetic ever detected (with E_{iso} ~ 10^{55} erg, for this reason also known as the B.O.A.T., brightest of all time) spanning its emission over the whole electromagnetic spectrum, up to the very high energy (VHE) gamma-ray band. In particular the LHAASO observatory, in China, has been able to detect photons up to energies never detected before from a GRB, reaching ~ 10 TeV and so opening a new era for the observation of this kind of phenomena.
In the work we present here we describe the method we developed to model its VHE afterglow through an analytical description of the light curve behaviour, depending on four parameters driving the emission, followed by a Markov-Chain Monte Carlo (MCMC). The dependence on the physical parameters (electron energy fraction, magnetic energy fraction, initial bulk Lorentz fraction and ISM density) is inferred from the simulations produced with a numerical model based on temporal step-by-step calculation of the evolution of the blast wave and consequent GRB emission through the interaction with the ISM: by varying the parameters we extracted the behaviour of the light curves, and assuming a “modified” smoothed power law shape for the afterglow light curves we inferred a direct dependence on the parameters later used for the MCMC.

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