TIME STRETCHING OF THE GEV EMISSION OF GRBS: FERMI LAT DATA VS GEOMETRICAL MODEL

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Numerous observations confirm that the high energy ($> 100\,\mathrm{MeV}$) emission of gamma ray bursts is delayed with respect to the low energy emission. However, the difference of light curves in various high energy bands has not been studied properly.

In this paper we consider all the bursts observed by Fermi-LAT since 2008 August 4 to 2011 August 1, for which at least 10 events with energies $1\,\mathrm{GeV}$ or higher were observed. There are 4 of them: 080916C, 090510, 090902B, and 090926A. We study their light curves in two bands, $(100\,\mathrm{MeV}, 1\,\mathrm{GeV})$ and $(1\,\mathrm{GeV}, 300\,\mathrm{GeV})$. The Kolmogorov-Smirnov test is used to check whether the light curves for these two bands are the same. No significant difference was found for 080916C and 090510. However, we observed with statistical significance of 3.3σ, that the higher energy light curve of 090926A is stretched with respect to the lower-energy one, and with statistical significance of 2.2σ, that the lower energy light curve of 090902B is stretched with respect to the higher-energy one.

We suggest a simple geometrical model to explain this result. The main assumption is the jet opening angle dependence on radiation energy – the most energetic photons are emitted near the axis of the jet. To test this model, we compute the total energy of the burst, and confirm that it is below the constraint. We also compute the fraction of observable bursts in $(100\,\mathrm{MeV}, 1\,\mathrm{GeV})$ band, which can also be observed in higher energies. This fraction matches the observations. Finally, we predict the distribution of observable stretching factors, which may be tested in the future when more observational data will be available.

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1. INTRODUCTION

For the purposes of this review, by anomalies one can understand violations of the Ehrenfest theorem according to which all matrix elements of the classical equations of motion (considered as operators) vanish. Thus, anomaly is established if we find, for example, a nonvanishing matrix element of the Dirac equation for a charged particle:

$$\langle\bar{\psi}(\hat{D}+im)\psi\rangle \neq 0, \tag{1}$$

where $\hat{D}=\gamma_{\mu}D_{\mu}$ and D_{μ} is the covariant derivative and m is the mass of the charged particle.

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АНОМАЛИИ (ИЗБРАННЫЕ ТЕМЫ)

В. И. Захаров

Данный обзор имеет образовательный характер и посвящен киральным аномалиям и их наиболее существенным приложениям. Также рассматриваются современные вопросы решеточных измерений.

Figure captions

Fig. 1. Anomalous triangle graph. Momenta q, k_1, k_2 are carried by the axial current a^5_μ and two photons, respectively. The triangle corresponds to a fermion of small mass m.

Fig. 2. Imaginary part of the anomalous triangle graph. The intermediate fermions are on mass shell. (The signs are the same as in Fig. 1)

Fig. 3. Three-body intermediate state in the imaginary part. (The signs are the same as in Fig. 1)

Fig. 4. Radiative correction to the two-body contribution to the imaginary part. (The signs are the same as in Fig. 1)

Fig. 5. Graphic representation of the Banks–Casher evaluation of the quark condensate $\langle \bar{q} q \rangle$. Dashed lines with crosses represent external (vacuum) gluonic fields.