Distribution of the number of peaks within a long gamma-ray burst

R. Maccary[1], M. Maistrello[1], C. Guidorzi[1,2,3], M. Sartori[1], L. Amati[3], L.Bazzanini[1,3], M. Bulla[1,3,6], A.E. Camisasca[1], L. Ferro[1,3], F. Frontera[1,3], A. Tsvetkova[3,4,5].

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[1]Department of Physics and Earth Science, University of Ferrara, Via Saragat 1, 44122 Ferrara, Italy

[2]Istituto Nazionale di Fisica Nucleare, Sezione di Ferrara, Via G. Saragat 1, 44122 Ferrara, Italy

[3]Istituto Nazionale di Astrofisica, Osservatorio di Astrofisica e Scienza dello Spazio di Bologna, Via Piero Gobetti 101, 40129 Bologna, Italy

[4]Department of Physics, University of Cagliari, SP Monserrato-Sestu, km 0.7, 09042 Monserrato, Italy

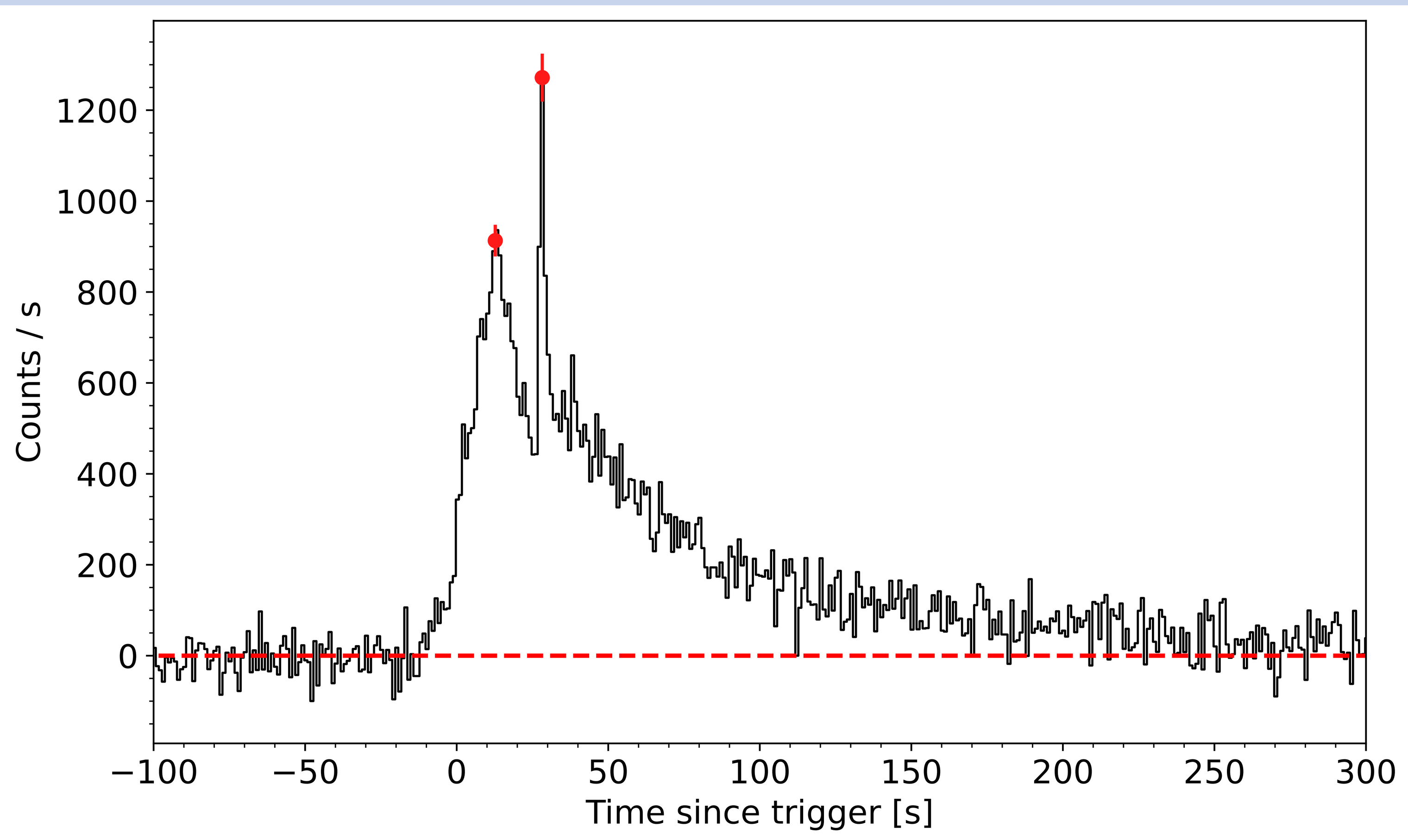
[5] Ioffe Institute, Politekhnicheskaya 26, 194021 St. Petersburg, Russia

[6]Istituto Nazionale di Astrofisica, Osservatorio Astronomico d'Abruzzo, Via Mentore Maggini snc, 64100 Teramo, Italy

ABSTRACT

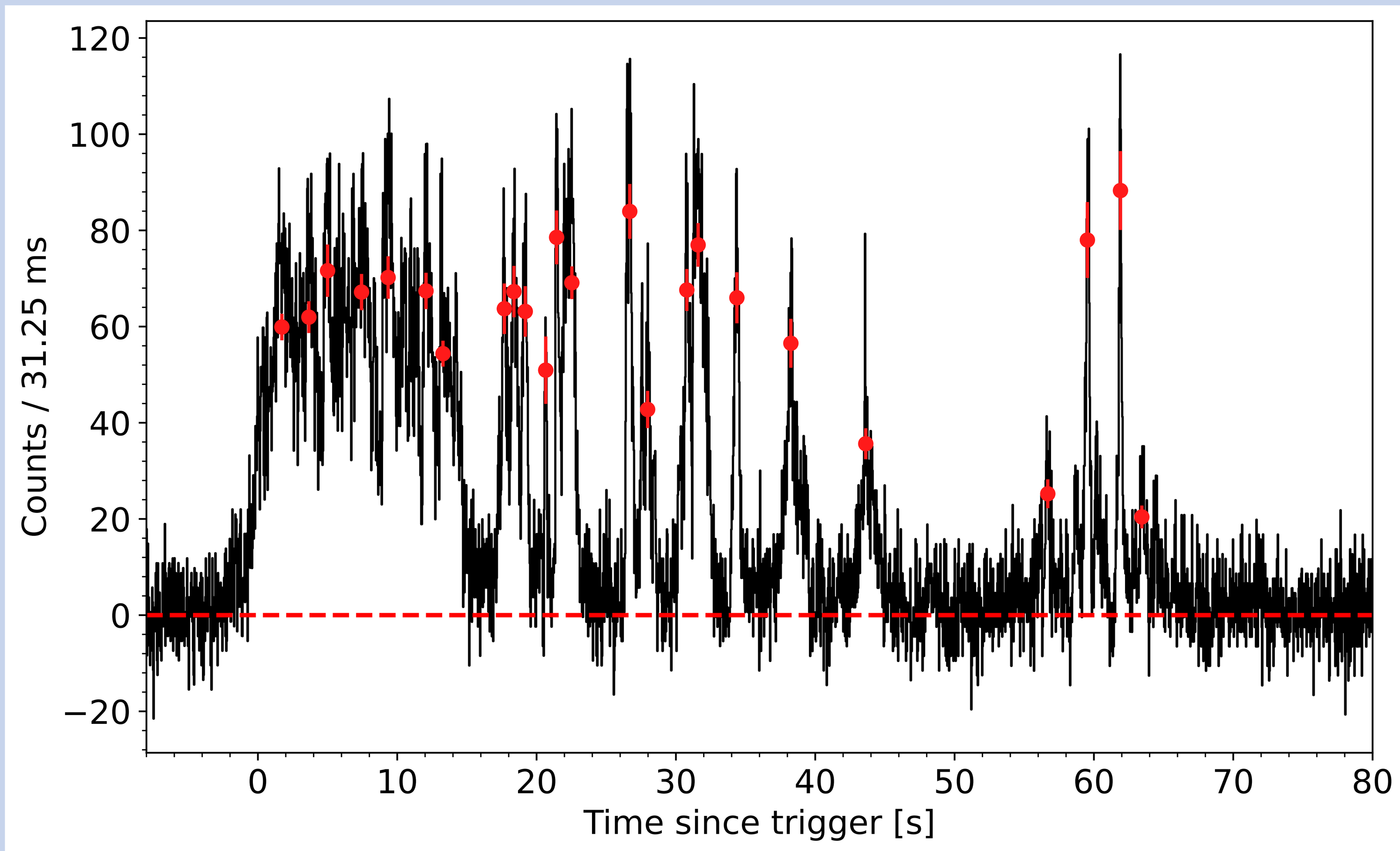
Time profiles of GRB prompt emission are still far from being understood, despite intensive efforts to characterise them in terms of duration, hardness ratio, minimum variability timescale, averaged and individual power density spectra. Surprisingly, **the number of peaks** that one could observe in a GRB light curve has mostly been overlooked. For the first time, we studied and modelled the distribution of the number of peaks within each GRB across four major GRB catalogues, namely **CGRO/BATSE, BeppoSAX/GRBM, Swift/BAT, Insight-HXMT, and Fermi/GBM** encompassing over **6000 GRBs** and **20,000 peaks**. We found that this distribution can be consistently modelled with **a mixture of two exponentials**, dividing GRBs in two classes, so-called **"peak-poor"** (80%) and **"peak-rich"** (20%) GRBs. Peak-rich GRBs exhibit **sub-second variability** on top of a slowly varying component, while peak-poor GRBs show only the latter. We discuss the implications on the theoretical models that have been proposed to explain the variety and properties of GRB time profiles.

PEAK-POOR GRBs



slow variability only

PEAK-RICH GRBs



slow and fast variability

MIXTURE MODEL OF TWO EXPONENTIALS

$$f(n) = k(\mathbf{e}^{-\mathbf{n}/\mathbf{n_1}} + \xi \mathbf{e}^{-\mathbf{n}/\mathbf{n_2}})$$

$$< n^{(i)} > = \frac{\sum_{n=1}^{\infty} n e^{-\frac{n}{n_i}}}{\sum_{n=1}^{\infty} e^{-\frac{n}{n_i}}} = \frac{1}{1-e^{-\frac{1}{n_i}}}$$

$< n^{(i)} >$ represents the averaged peak number of the i^{th} component

$$w_2 = k\xi \sum_{n=1}^{\infty} e^{-\frac{n}{n_2}}$$

w_2 represents the fraction of peak-rich GRBs.

RESULTS