GW2025-HW2

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1 A simplified analysis to GRB240219A

The light curve (LC) derived from the raw data file is shown in Figure 1, with time bins set as 1 second. The original time series is filtered with a gaussian kernel function to primarily locate the peaks, which is also displayed in the same figure. Then the whole light curve is divided into two bands: The hard X-ray (HXR) band ($<$ 100 keV) and the gamma-ray band ($\geq$ 100 keV), which are shown in the two subplots in Figure 2 respectively. It is found that the major peak of the raw time series could be mainly contributed by the peak occurred in the HXR light curve, with only minor contributions from the gamma-ray one.

Next, the data set is detrended with a 3-order polynomial to filter the background and peak-detection methods are applied to detect signals of the burst in smoothed LCs. The results are shown in Figure 3 and 4: The major peak of the whole time series is identified around 456.5 seconds after the initial trigger time T_{ini}; For the LCs of HXR and gamma-ray bands, the peak time is around 458.5 and 453.5 seconds respectively. The full width and half maximum (FWHM) of the peaks are also noted in the figures, which can represent the duration of the signals coarsely. Assuming that the total photon counts in the FWHM range is N_{total} and the background photon counts in the same range is N_{bkg}, the significance can be calculated as $(N_{total} - N_{bkg})/\sqrt{N_{bkg}}$ (σ). With this method, the significance of the peaks are estimated as 10.22σ for the whole light curve, 9.86σ for the HXR data and 4.24σ for the gamma-ray data, indicating that the GRB signals detected in these bands are highly possible to be intrinsic. The value of T_{90} for the burst is further estimated as $\sim$ 123 seconds for the burst, which is shown in Figure 5.

Last but not least, the energy spectrum are also calculated, which are shown in Figure 6. The blue one represents the spectrum from the whole data set; The orange one represents the total spectrum in obtained T_{90} range; The green one is the background spectrum scaled to the same time span and the spectrum after background reduction is denoted by the red line. All of the spectrum take double power-law forms and their spectral index remains nearly identical, with a significant excess at $\sim$ 1 MeV, which requires further physical interpretations. The codes for the analysis above are available at Github.

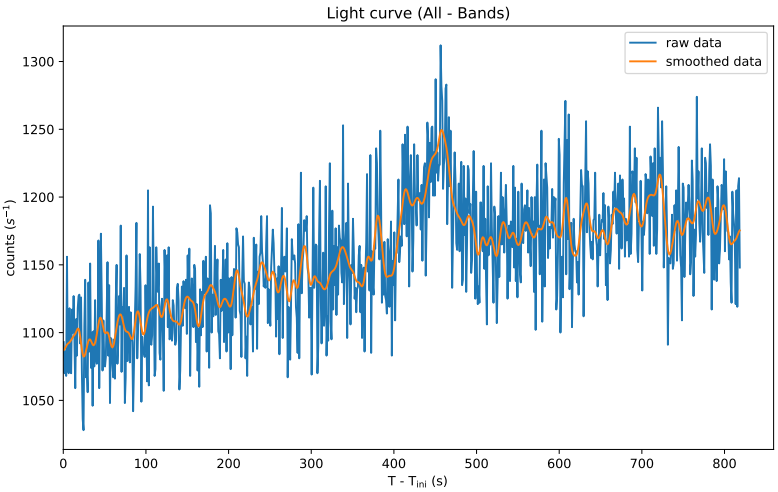

Figure 1: The raw light curve (LC) derived from Fermi_n9_GRB240219A.txt. The orange line represents the smoothed LC with gaussian filters.

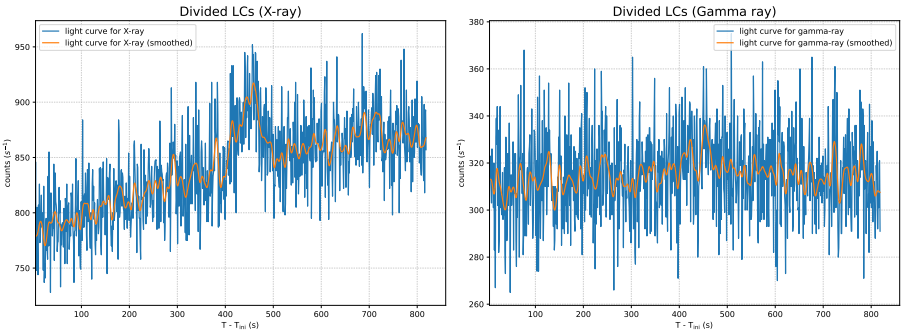

Figure 2: The raw LCs of X-ray band (the left panel) and Gamma-ray band (the right panel); The orange lines represent the smoothed LC with gaussian filters.

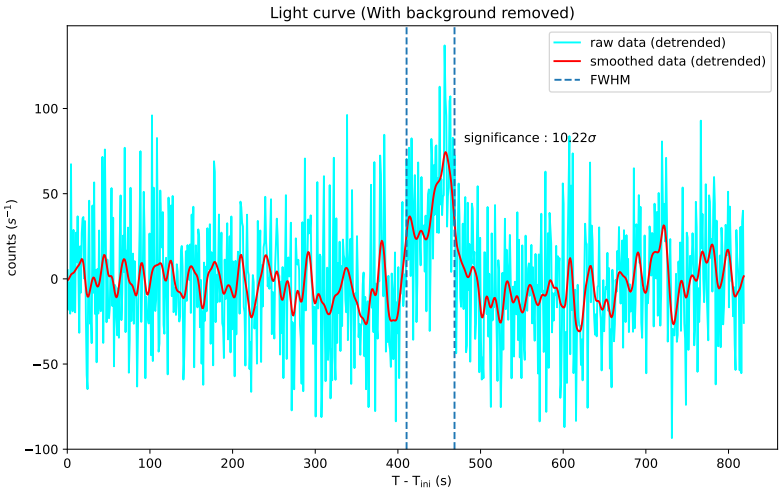

Figure 3: The detrended LC derived from Fermi_n9_GRB240219A.txt. The red line represents the smoothed LC with gaussian filters, and the significance of the GRB signal exceeds 10σ.

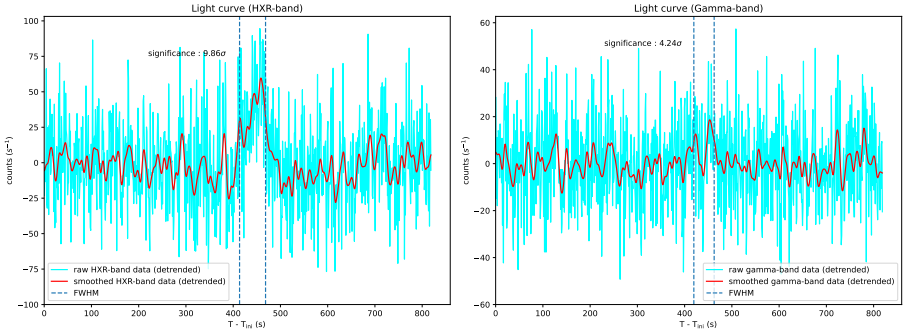

Figure 4: The detrended LCs of X-ray band (the left panel) and Gamma-ray band (the right panel); The red lines represent the smoothed LC with gaussian filters, and the significance of the HXR signal and the gamma-ray signal is $\sim 10\sigma$ and 4σ, respectively.

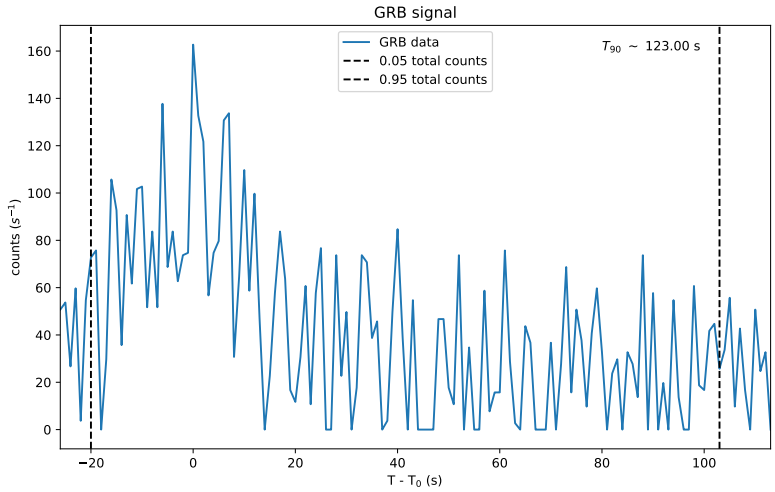

Figure 5: A section of the whole light curve to calculate the value of T_{90}, which is around 123 seconds. T_0 is the time where the burst reaches its maximum.

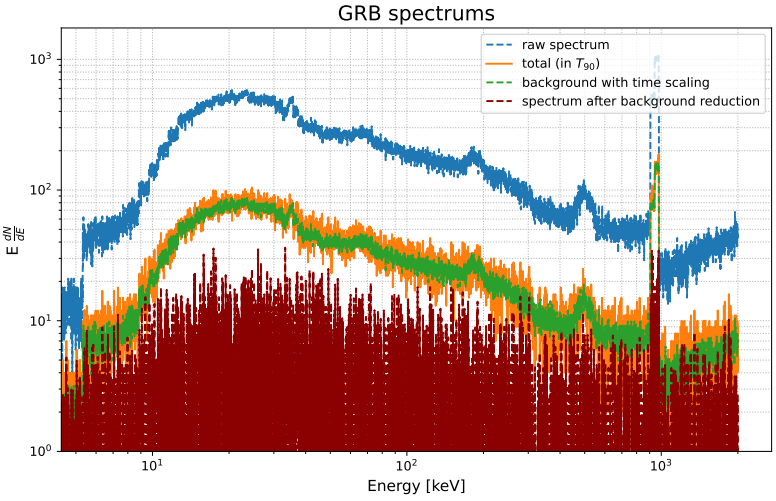

Figure 6: Energy spectrum of GRB240219A.