Peculiar prompt emission and afterglow in H.E.S.S. detected GRB 190829A

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Abstract

Aim: We present the results of a detailed investigation of the prompt and afterglow emission of GRB 190829A (z = 0.0785). This burst was detected by Fermi and Swift with two emission episodes separated by a quiescent gap of ~ 40 s, was also observed by the H.E.S.S. telescopes at Very-High Energy (VHE).

Methods: We present multi-band photometric data along with spectroscopic follow-up observations taken with the 10.4m GTC telescope. Together with the data from the prompt emission, the 10.4m GTC data are used to understand the emission mechanisms and possible progenitor. We also analyzed the late-time Fermi-LAT emission that encapsulates the HESS detection.

Results: The first episode, which has a higher spectral peak ~ 120 keV and a low isotropic energy ~ 10^{50} erg is an outlier to the Amati correlation and marginally satisfies the Yonetoku correlation. However, the energetically dominant second episode has lower peak energy and is consistent with the above correlations. A detailed analysis of multi-band data of the afterglow demands cooling frequency to pass between the optical and X-ray bands at early epochs and dominant with underlying SN 2019oyw later on.

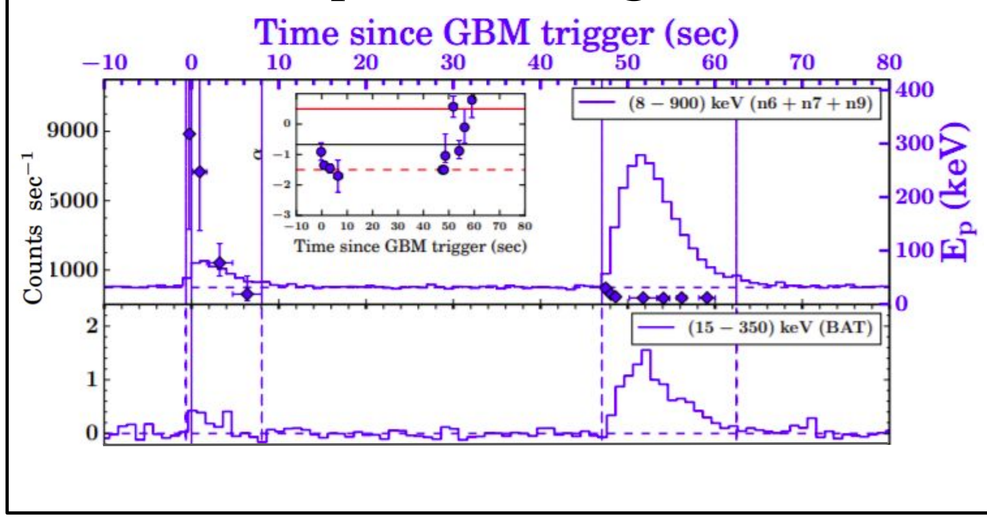
Conclusions: Some of the LAT photons are likely to be associated with the source. All above observational facts suggest GRB 190829A is a peculiar low luminosity GRB that is not powered by a shock breakout, and with an unusual rebrightening due to a patchy emission or a refreshed shock during the afterglow. Furthermore, our results show that TeV energy photons seem common in both high luminosity GRBs and LLGRBs.

Introduction

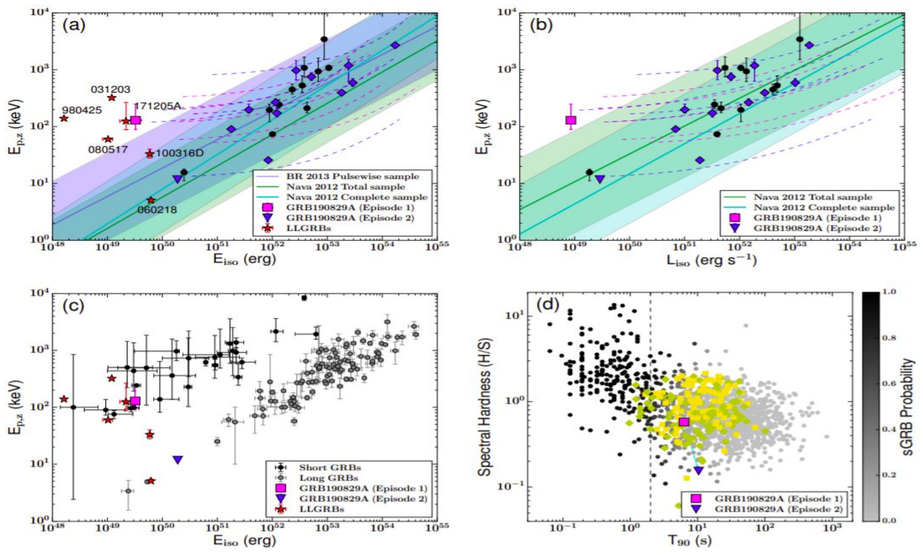
The recent detections of GRB afterglow in TeV energies by H.E.S.S. and MAGIC Cerenkov telescopes have provided new insights in the study of GRBs

For example, GRB 190114C, in its multifrequency spectral energy density (SED) showed evidence for a double-peaked distribution with the first peak being the synchrotron emission. The second peak shows a very high energy (VHE) emission in TeV energies and is explained by the synchrotron self-Comptonisation process, theoretically predicted in a standard afterglow model.

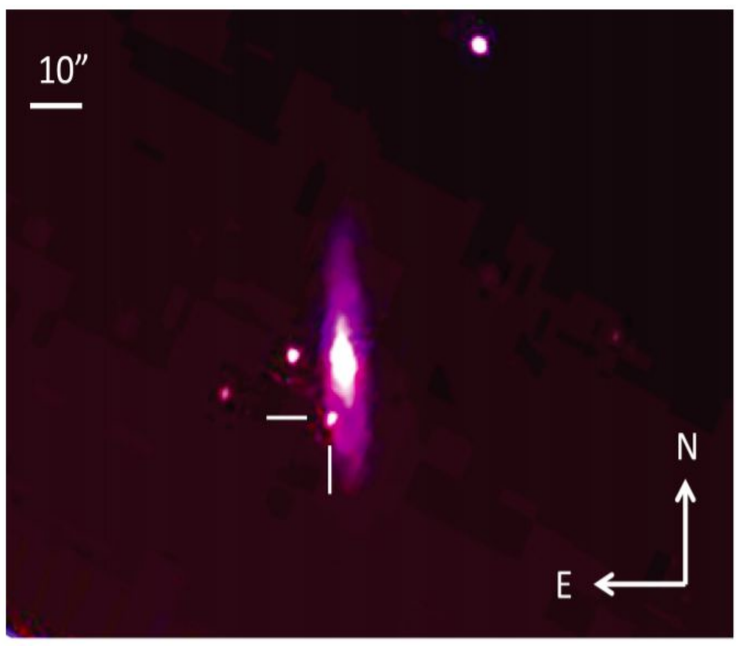
Prompt emission light curve

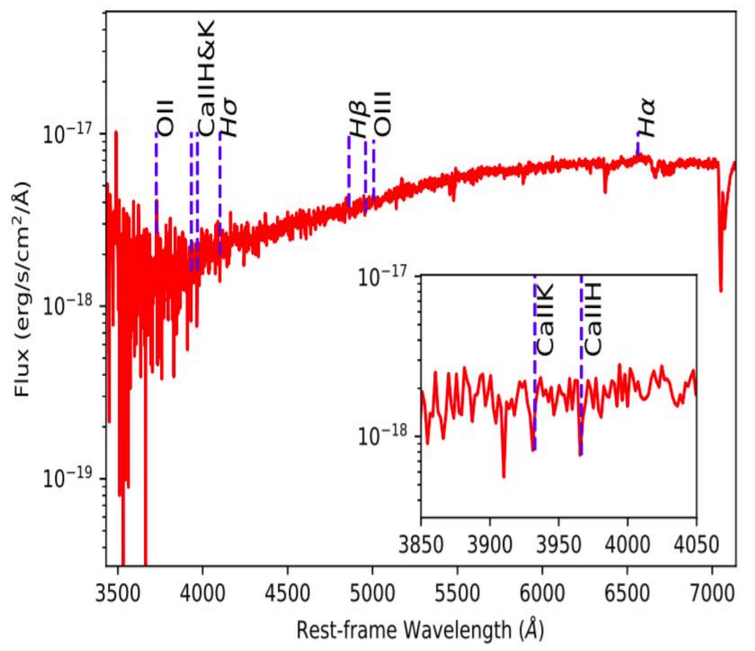


Correlations for two-episode GRBs



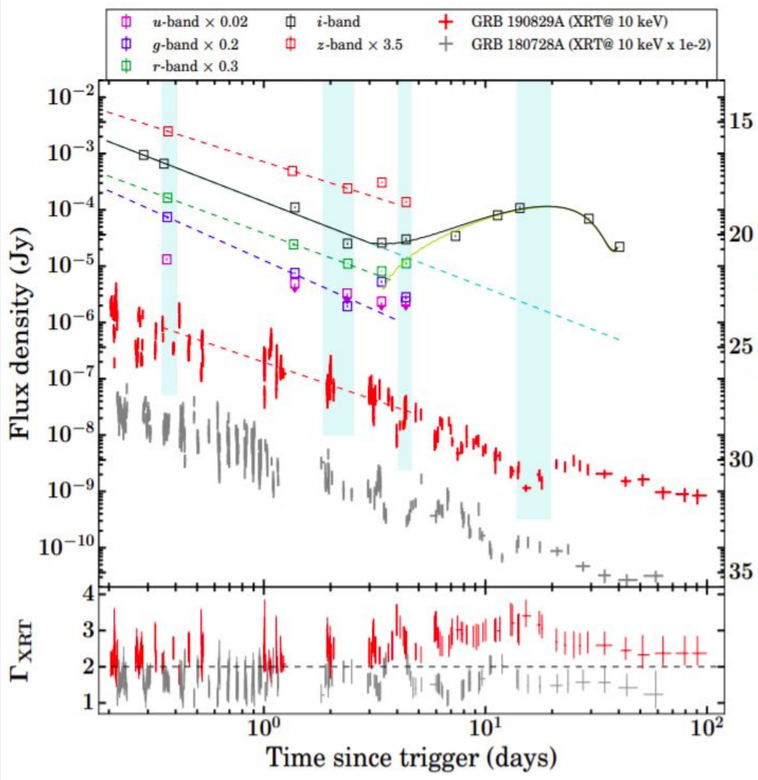
Redshift determination using 10.4m GTC observations



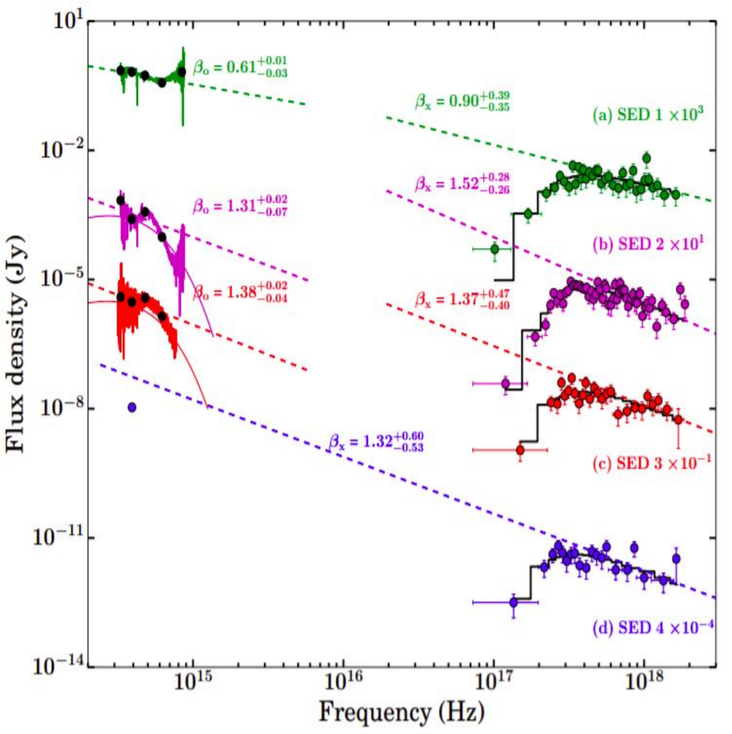


z = 0.0785

Multiwavelength light curve



Spectral energy distributions



SUMMARY AND DISCUSSION

1. We highlighted the unusual spectral features of episodic activities in GRB 190829A from the prompt emission to afterglows.

2. The prompt emission light curve of GRB 190829A, with the two emission episodes separated by a quiescent gap, is found to be very much similar to that exhibited by another nearby GRB 180728A consisting of a fainter precursor followed by the brighter main pulse.

3. We found that Amati and Yonetoku relations are satisfied for GRBs with multiple episodes separated by quiescent phases. But, the first episode of GRB 190829A is the only outlier. It also does not satisfy the pulse-wise Amati correlation known for well-separated individual pulses of GRBs.

4. In the near future, with more such observed events, it would be very interesting to know if such nearby GRBs having two emission episodes in their prompt emission phase have underlying SN features.

References: Hu et al. 2020, Chand et al. 2020, Misra et al. 2019, Joshi et al. 2019, MAGIC Collaboration et al. 2019.