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Onset of particle acceleration during the prompt phase in GRBs

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The physical processes of the gamma-ray emission and particle acceleration during the prompt phase in GRBs are still unsettled. In order to perform an unambiguous physical modelling of GRB observations, a clear identification of the emission mechanism is essential. The very strong flare in GRB160821A, that occurs during the prompt phase at 135s, has for instance been clearly identified as synchrotron emission. By using Fermi observations, we show that the distribution of the radiating electrons is initially very narrow, but later develops a power-law tail of accelerated electrons. We thus identify for the first time the onset of particle acceleration in a GRB jet. The flare is consistent with a late energy release from the central engine causing an external-shock as it encounters a preexisting ring nebula of a progenitor Wolf-Rayet star. Relativistic forward and reverese shocks develop, leading to two distinct emission zones with similar properties. The particle acceleration only occurs in the forward shock, moving into the dense nebula matter. Here the magnetisation decreases below the critical value which allows for Fermi acceleration to operate. The observation of the onset thus gives new and independent constraints on the properties of the flow as well as on theories of particle acceleration in collisionless astrophysical shocks. For the prompt flare in GRB160821A we find a bulk Lorentz factor of Gamma \sim 640 and an emission radius of R \sim 10^{18} cm, consistent with a Wolf-Rayet ring nebula with a hot, tenuous phase of its interior.

Track

GRBs

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