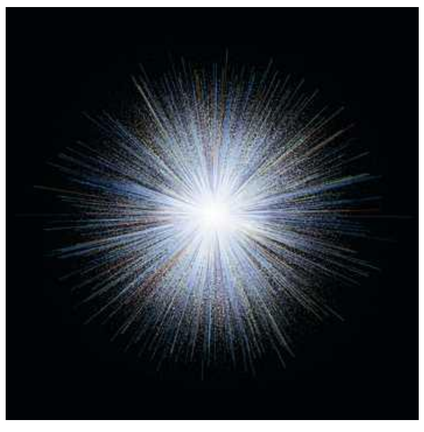

GRB200826A: a peculiar short burst with an associated SN

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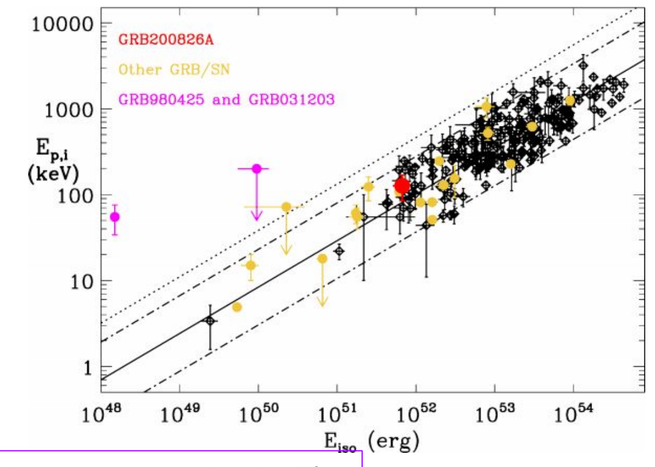
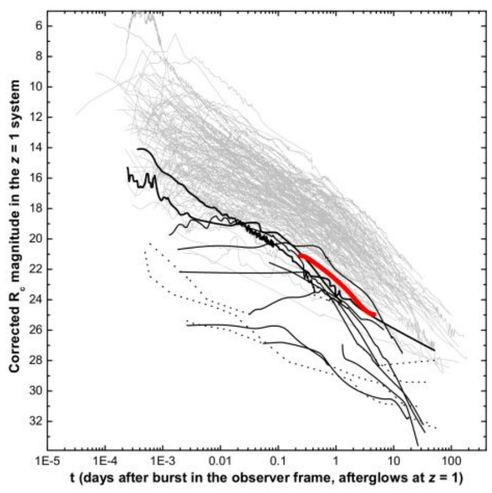
On behalf of a larger collaboration

ABSTRACT: Gamma-ray bursts (GRBs) are classified as long and short events. The short GRBs (SGRBs) are those lasting less that 2 s (from a few milliseconds to 2) and are thought to be connected with the merger of compact objects. The long GRBs (LGRBs) (from 2 s to a few hundreds of seconds) are typically associated with highly energetic broad-lined type Ic supernovae (SNe). **GRB 200826A was a peculiar event, because by definition it was a SGRB, with a duration T_{90}= 1.14s, but very energetic and soft, consistent with LGRBs.** Its relatively low redshift (z ~ 0.5) motivated a comprehensive, multi-wavelength follow-up campaign to characterize its host, search for a possible associated supernova (SN), and thus unveil its possible progenitor. The results of our analysis and observations show: an isotropic energy release and a peak energy of the prompt event (the $E_{p,i}$ – E_{iso} relation) more consistent with classical LGRBs; an afterglow light curve with a re-brightening compatible with a SN component contribution which resemble the LGRB-SNe; a low-mass and star-forming host galaxy, typical for LGRBs. We conclude that **GRB 200826A is a typical collapsar event** in the low tail of the duration distribution of LGRBs. This finding shows that **duration alone is not an efficient discriminator to unveil the progenitor class of a GRB.**

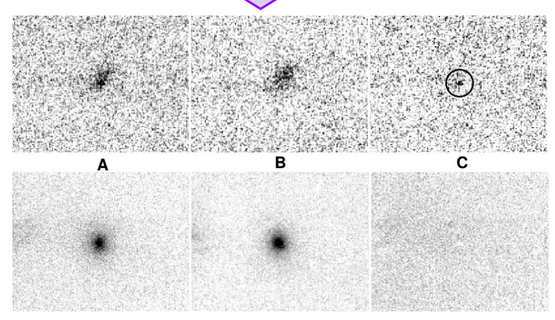
Prompt Event Analysis: A very useful tool to discriminate between LGRBs and SGRBs is the location of a GRB in the $E_{p,i}$ -E_{iso} where LGRBs follow a strong correlation known as "*Amati Relation*". In comparison SGRBs populate a different region in this plane (D'Avanzo et al 2014; Minaev & Pozanenko 2020a). In the figure on the right we show GRB 200826A (red) in the $E_{p,i}$ -E_{iso} plane. GRBs with an associated SN are highlighted in yellow, outliers in magenta. GRB data are from Amati et al. (2019). Despite its short duration, this event is clearly consistent with the "*Amati Relation*" followed by LGRBs.



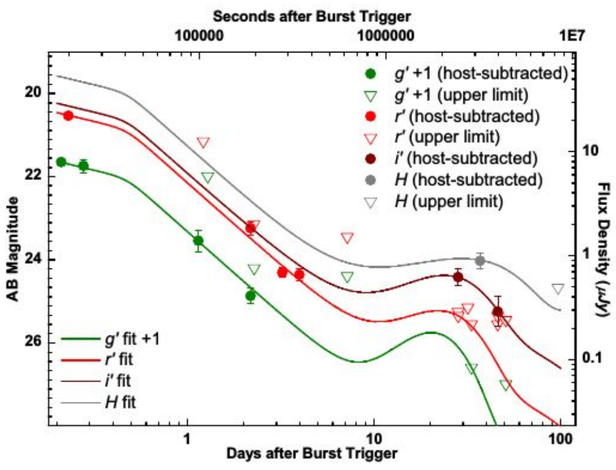


The GRB200826 afterglow light curve in the general afterglow light curves context. The comparison of the optical afterglow light curve of GRB 200826A (red line) with the sample of extinction-corrected afterglows shifted to z=1 (Kann et al. 2011, 2022a) shows a relatively faint optical afterglow with a luminosity that lies in between those of the afterglows of LGRB (light grey) and SGRB with secure redshift (thicker black lines, solid are detection, dashed are upper limits) afterglows.

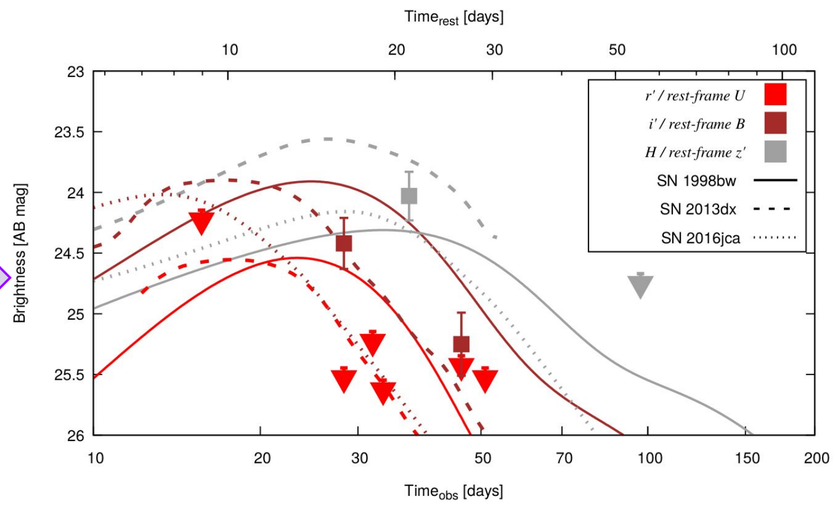
SN detection. We observed the GRB field in the H-band using the second generation SOUL Adaptive Optics with LUCI-1 at the 8m Large Binocular Telescope (LBT) in Arizona. In the figure the top row shows A) the H-band image obtained close to the peak of the SN; B) H-band image obtained four months later when only the host was visible; and C) the subtraction between these two epochs. For comparison the bottom row shows a random star in the field. The transient is highlighted with a circle.

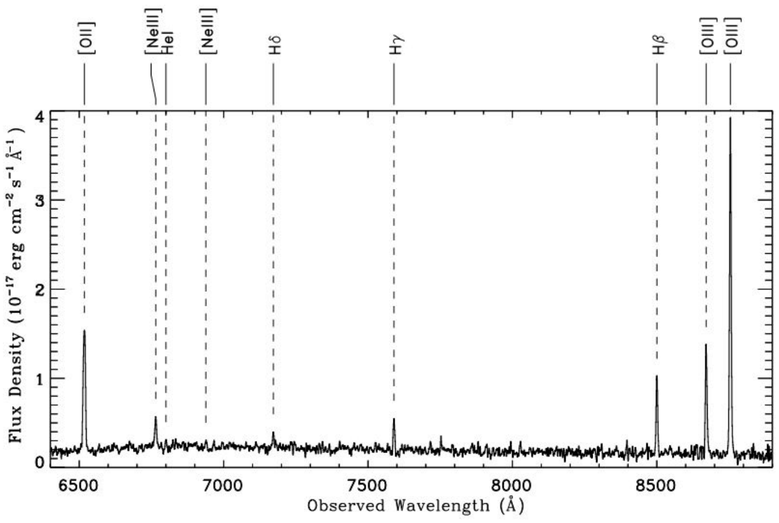


The afterglow light curve re-brightening. The multiband monitoring of the afterglow light curves allowed to detect the appearance of the SN component in the the observed bands (*griH*), after the subtraction of the constant host-galaxy contribution. The data are well modeled with a smoothly broken power-law for the afterglow, plus a SN 1998bw template (the first discovered GRB-SN) shifted to the GRB redshift. Note the *g'* band is offset by 1 mag for reasons of clarity.



SN light curves. We used late time images of the host galaxy in the r,i,H bands to remove, via image subtraction, the host contribution from the earlier images. A SN is clearly detect 20 days after the GRB trigger in the *i* and *H* bands as shown in the figure. The SN 1998bw light curve templates obtained are shown for comparison (solid lines) so as other GRB-SN light curves (dashed and dotted lines). The SN associated with GRB 200826A must have been more red and evolving faster than 98bw to explain the early optical limits indicated by downward red triangles.





The host galaxy. The spectrum and multiband images of the host of GRB200826A obtained with MODS and LBCs at LBT allowed us to characterise the galaxy. It is a small, star-forming galaxy as most LGRB hosts but with a relatively high metallicity and a sSFR among the highest within the LGRB host population (e.g. Savaglio et al. 2009, Hunt, et al. 2014, Japelj et al. 2016). In the figure the LBT/MODS observed spectrum is shown. The detected emission lines are marked.

Conclusions.

- Despite its short duration, this event is consistent with the $E_{p,i}$ -E_{iso} "*Amati Relation*" followed by LGRBs.
- It was followed by a relatively faint afterglow with a luminosity that lies in between those of LGRB and SGRB afterglows.
- The evolution and color of the late bump is in good agreement with other GRB-SNe. GRB 200826A is one of the cosmologically most remote GRB-SNe detected to date, close to the sensitivity limit of the present generation of 8 to 10 m class optical telescopes.
- The host galaxy of GRB 200826A is remarkable because it is typical of an LGRB host galaxy, but with higher SFR and sSFR rates than expected.

A complete analysis of our GRB 200826A observations is reported in **Rossi et al., 2022, ApJ in print, arXiv:2105.03829**

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