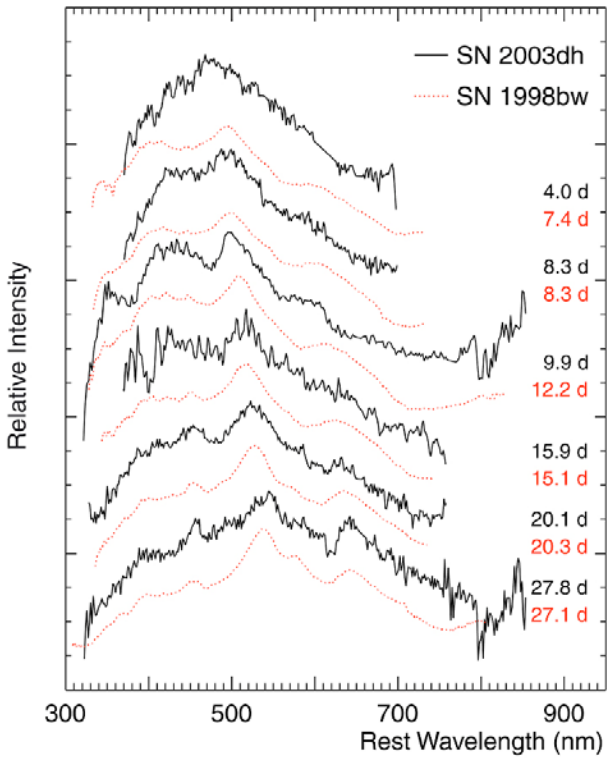
GRB 030329: Jets and Supernova connection

GRB 030329 had the brightest optical/IR afterglow of all localized GRBs so far, and allowed very detailed ground-based observations, e.g. using the VLT: Optical spectroscopy proved GRBs to originate from massive stars experiencing a supernova, and polarimetry provided unequivocal evidence for the jet-like emission geometry.



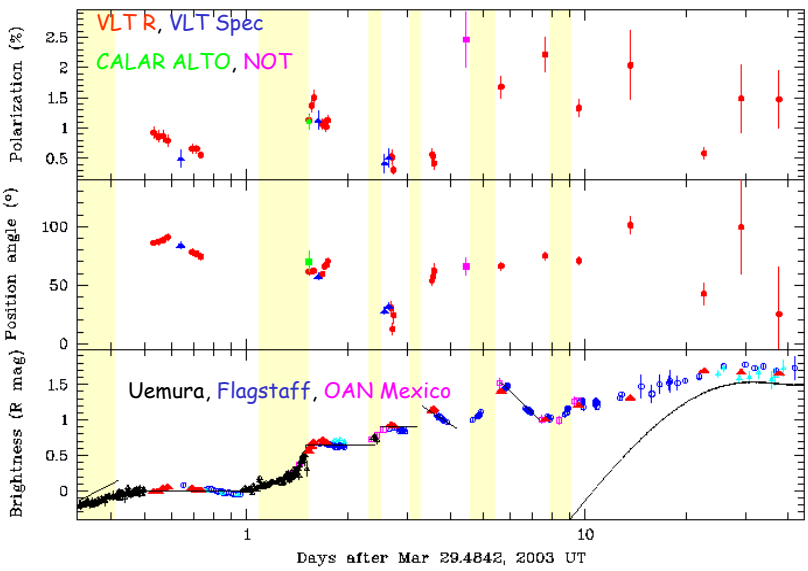
With a redshift of 0.168, GRB 030329 was among the GRBs with the smallest distance ever measured. It was brighter than *R*=20 mag for about 20 days, thus offering unique observing possibilities.

A sequence of FORS/VLT spectra revealed the signatures of a supernova Ic (Hjorth et al. 2003), named SN 2003dh, very similar to SN 1998bw connected to GRB 980425 (left figure). From the SiII λ6335 line the expansion velocity on day 10 was estimated to be 36000 km/s, considerably larger than any previously known SN.

Since type Ic SN light curves are powered by radioactive decay, the data indicate the synthesis of several tenths of a solar mass of ^{56}Ni. This is the most direct evidence so far that long-duration GRBs result from the death of massive stars.

The lack of hydrogen lines is consistent with model expectations that the star lost its hydrogen envelope to become a WR star before exploding.

An extensive series of R-band polarimetry with FORS/VLT allowed to establish for the first time a polarization light curve, i.e. the variation of polarization degree and angle θ with time (right figure; Greiner et al. 2003). GRB 030329 is so far the only case where the polarization evolution supports the break as being due to the jet nature. The jet opening angle is determined to be 3 deg. The late-time (3-10 days) polarization variation is not the result of small number of coherent magnetic field cells with random orientation, but instead θ must be associated with some global geometry. This suggests an entangled magnetic field in the jet.



References:

- Greiner J., Klose S., Reinsch K. et al 2003, Nature 426, 157
- Hjorth J., Sollermann J., Moller P. et al. 2003, Nature 423, 847

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