GRB 011121: A collimated outflow into wind-blown surroundings[1]

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ABSTRACT

We report optical and near-infrared follow-up observations of GRB 011121 collected predominantly at ESO telescopes in Chile. We discover a break in the

afterglow light curve after 1.3 days, which implies an initial jet opening angle of about 9°. The jet origin of this break is supported by the fact that the spectral energy distribution is achromatic during the first four days. During later phases, GRB 011121 shows significant excess emission above the flux predicted by a power law, which we interpret as additional light from an underlying supernova. In particular, the spectral energy distribution of the optical transient approximately 2 weeks after the burst is clearly not of power-law type, but can be presented by a black body with a temperature of ∼6000 K. The deduced parameters for the decay slope as well as the spectral index favor a wind scenario, i.e. an outflow into a circum-burst environment shaped by the stellar wind of a massive GRB progenitor. Due to its low redshift of z=0.36, GRB 011121 has been the best example for the GRB-supernova connection until GRB 030329, and provides compelling evidence for a circum-burster wind region expected to exist if the progenitor was a massive star.

Subject headings: gamma rays: bursts — techniques: photometric — supernovae: general

1. Introduction

In the presently favoured scenario for classical gamma-ray bursts (GRBs), occurring at cosmological distances (measured redshift range so far $0.36 < z < 4.5$; van Paradijs et al. 1997; Andersen et al. 2000), the explosion of a very massive star leads to a fireball and a short, beamed flash of gamma-rays (Woosley 1993; Fryer et al. 1999; Mészáros 2002), resulting in three physically distinct observational phenomena, namely the GRB itself, a long-lasting afterglow and the classical supernova (SN) light. Whereas the afterglow emission is probably fed by the kinetic energy of the collimated, relativistic outflow, the supernova light is caused by the decay of radioactive nuclei created and released during the stellar explosion. The maximum of the supernova light is expected at ∼10–20 (1+z) days after the explosion, though at present it is not clear whether or not the GRB and the supernova explosion are delayed (Vietri & Stella 1998). One of the basic consequences of this hypernova scenario is that it predicts (and links) the occurrence of a GRB with a jet, the unavoidable strong wind from the massive progenitor star, and the supernova light (Heger et al. 2003).

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