Transient X-ray absorption in GRBs and its implications for GRB statistics

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Abstract

The recent detection of a transient absorption feature in the prompt emission of GRB 990705 has sparked multiple attempts to fit this feature in terms of photoelectric absorption or resonance scattering out of the line of sight to the observer. However, the physical conditions required to reproduce the observed absorption feature turn out to be rather extreme compared to the predictions of current GRB progenitor models. In particular, strong clumping of ejecta from the GRB progenitor seems to be required. Using detailed 3D hydrodynamic simulations of supernova explosions, we have done a comprehensive study of the dynamics and structure of pre-GRB ejecta predicted in several GRB progenitor models. Based on our results, combined with previous population synthesis studies, we estimate the probability of GRB progenitors producing the environments necessary to lead to observable prompt GRB X-ray absorption features as observed in GRB 990705 to $\lesssim 1$ %. A significantly larger number of bursts may produce fluorescent X-ray emission lines, either in the early afterglow phase (as detected with *Chandra* in GRB 991216) or even in the form of secondary X-ray flashes several weeks to months after the burst.

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