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Gamma-ray burst X-ray afterglows and time-evolving photoionisation: clues for the missing gas problem

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Gamma-ray burst spectra are absorbed by a significant amount of gas within their host galaxy. We can estimate the amount of this gas through broadband spectroscopy. X-ray spectra provide the most complete estimate of the amount of gas as they probe the total amount of material along the line of sight compared to optical spectra, which can only probe the relatively neutral gas and miss dust contribution. When optical and X-ray inferred column densities have been compared for the same GRB, they are typically found to differ by up to an order of magnitude. This is referred to as the "*missing gas problem*" since it is expected to arise from a column of very highly ionised material in the immediate vicinity of the GRB. We fit a flux-selected sample of seven GRB X-ray spectra using a newly developed time-dependent ionised absorber to model the medium using the GRB-specific ionising flux. We find that the time-dependent absorber fits improve upon a standard neutral absorber model fit for six out of seven bursts in our sample, providing evidence of this missing highly ionised gas. For all six of these, the corresponding best-fit parameters predict a region of size ~ 10 pc with typical number densities of 10^{3-4} cm^{-3}, consistent with the progenitor having exploded in a dense star-forming environment.

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