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Time-evolving photoionisation in GRB afterglows

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GRB absorption spectra are powerful probes of the circumburst medium of their progenitor and the host galaxy's ISM. The column densities as derived from the X-ray and the optical spectra differ by up to an order of magnitude, suggesting the presence of a highly ionised region close to the GRB. This happens because the X-ray absorption probes the total column along the line of sight, including the immediate vicinity of the GRB, while optical absorption probes the neutral ISM within the host, thus providing a complementary method to study the nature of the medium. In this study, we present a combined analysis by using a newly developed time-evolving photoionisation model to fit the X-ray afterglow spectra of a flux-selected sample of seven GRBs (including the record-breaking GRB221009A) within a physically-motivated picture, which also takes into account the optically-derived absorption. Our model independently constrains a high-ionisation region in the immediate vicinity of the burst, consistent with the GRBs exploding in a dense environment (10^{3-4} cm^{-3}) that is typical of high-mass star-forming regions. Furthermore, time-evolving modelling significantly improves over cold or equilibrium ionised absorber models.

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