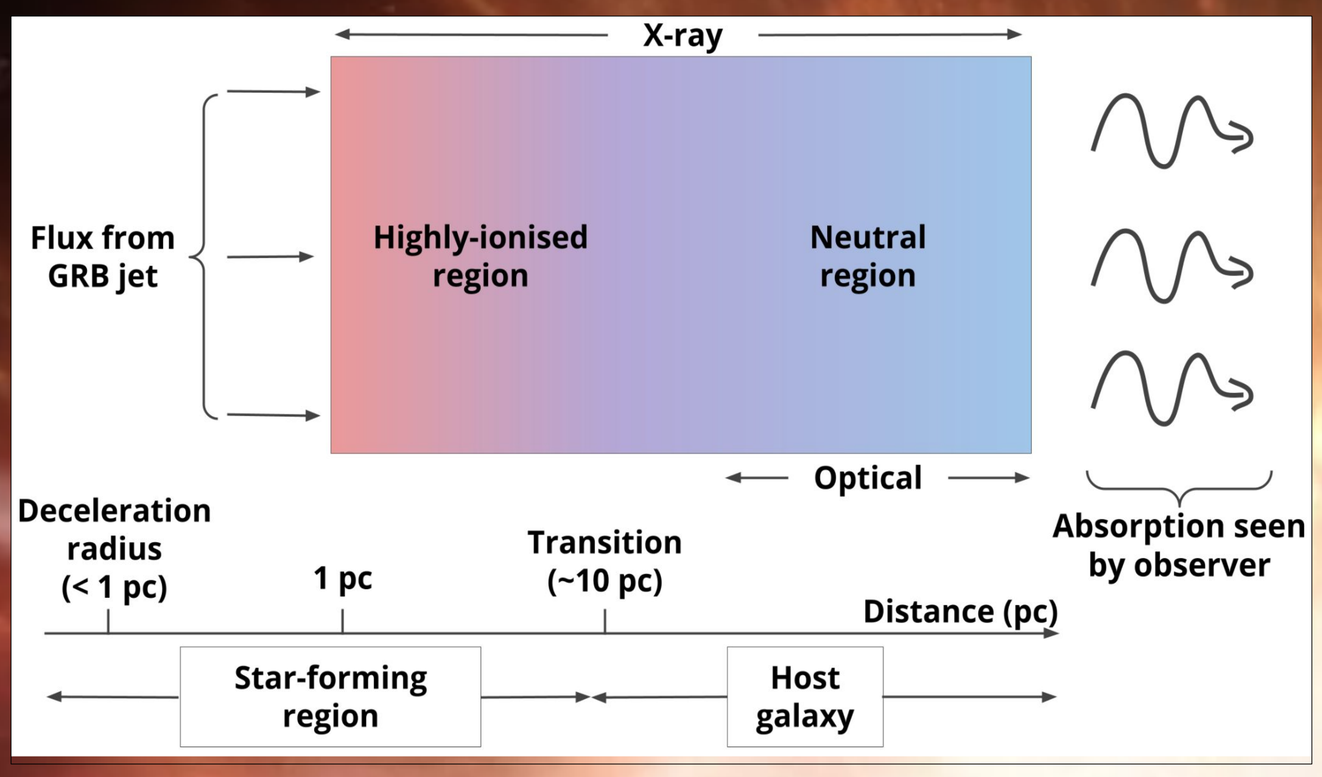
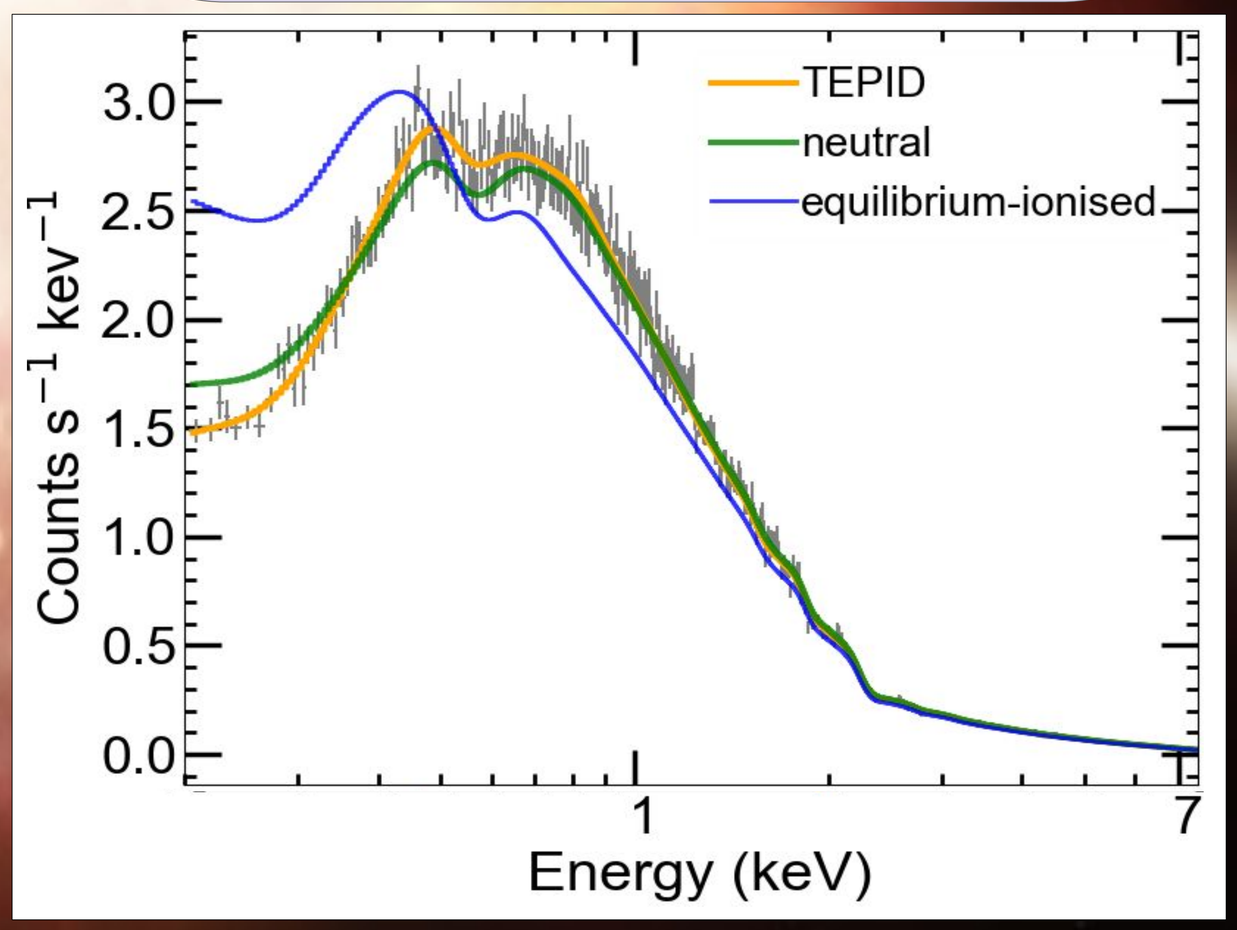
Modelling X-ray afterglows with time-evolving photoionisation: evidence for a highly ionised environment

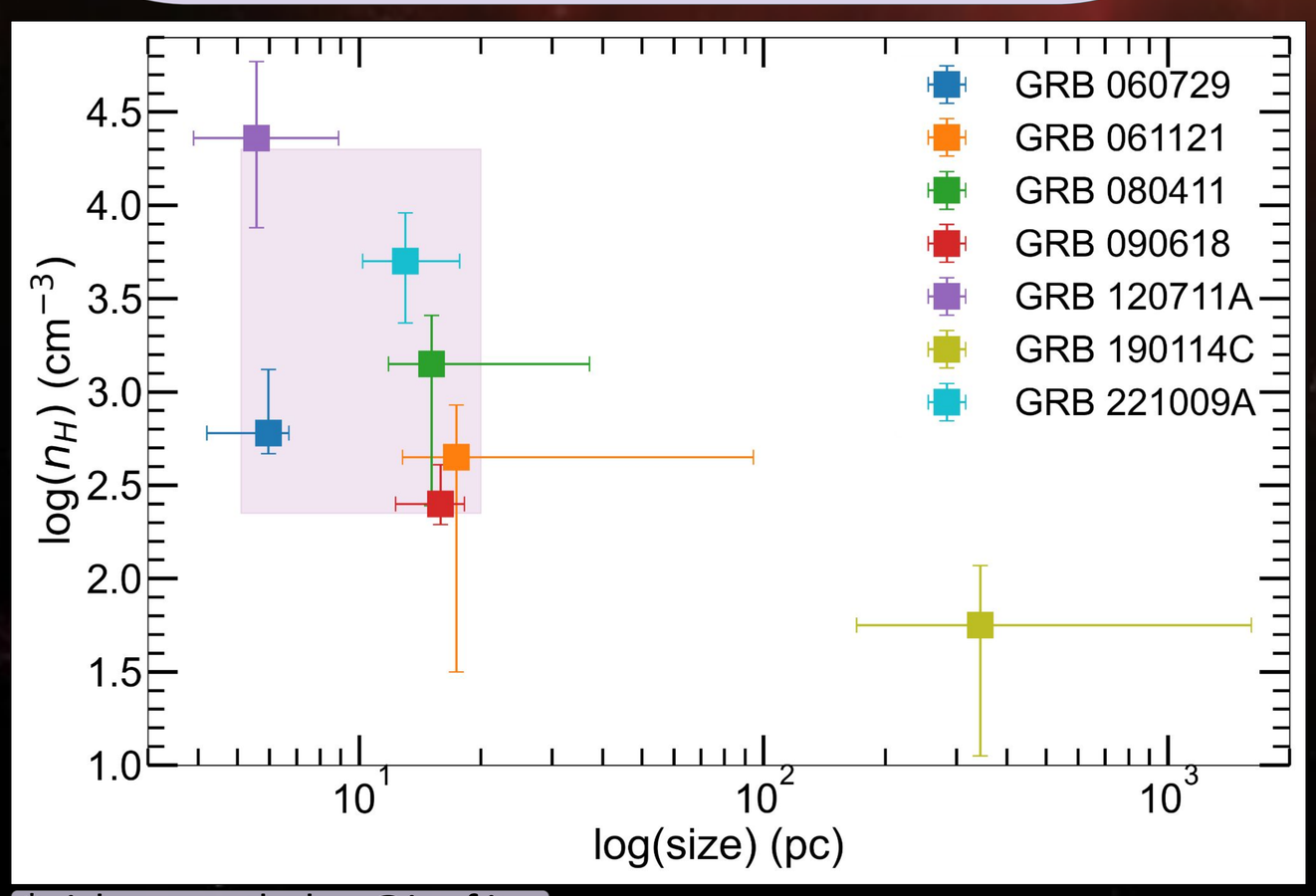
AL Thakur[1*], L Piro[1], A Luminari[1,2], F Nicastro[2], S Savaglio[3], Y Krongold[4], B Gendre[5]
[1]INAF-IAPS, Italy [2]INAF-OAR, Italy [3]UNICAL, Italy [4]UNAM, Mexico [5]UWA, Australia



Context:
Long GRBs are launched by the collapsing core of a massive star, the so called collapsar progenitor model. The medium along the line-of-sight in the GRB's host galaxy is ionised by the evolving radiative output of the GRB. This results in stratification of the medium, evidence for which is found when comparing the optical and X-ray spectra of the GRB. However, this highly ionised close-in medium has never been directly found from fitting the X-ray spectra.

Method:
We have modelled the time evolving photoionisation of the GRB circumburst medium with a novel state-of-the-art time-dependent photoionisation model. We then fit the the X-ray spectra of a sample of bright, *XMM-PN* observed GRBs with this model and compared the resulting fit with a standard neutral model and an equilibrium-ionisation model. We find that a time-dependent photoionised absorber improves the fit ***significantly*** for 6 out of 7 GRBs in our sample, compared to the other tested models.





Conclusions:
Our results show for the first time direct evidence of the time-dependent photoionisation in the GRB medium throughout a rigorous fitting of the X-ray spectra. Furthermore, the size and density of our best-fitting model parameters is fully consistent with the physical parameters of a star-forming region-like environment, lending further support to the collapsar model as a major channel for long GRBs.

*aishwarya.thakur@inaf.it