Studying the variability of the X-ray spectral parameters of high-redshift host galaxies

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Overview

Several results of measuring high-redshift X-rays are available for GRBs that have been detected by Swift. The standard process of fitting is usually by using general starting parameters - the variability of fittings hasn't been examined yet thoroughly, as is the case with the robustness properties of the X-ray spectral fittings. With the available, more precise input data we can examine the robustness of previous fittings, and test how sensitive is the result to the changes of the starting parameters. Moreover, we analyzed the increase of the intrinsic hydrogen column density during an X-ray flare.

X-ray spectral fitting

XSpec is a widely used X-Ray Spectral Fitting Software Package. The UK Swift Science Data Centre (UKSSDC) analyzes the Swift XRT spectral data using a semi-automatic algorithm. Because the X-ray spectrum observed by the satellite is modified by the attenuation of HI column density in the line of sight, we examined the dependence of intrinsic column density on each starting parameter and how sensitive the fitting is to these changes. We assume that the background and the data are also Poissonic, and therefore we used the C-statistic process.

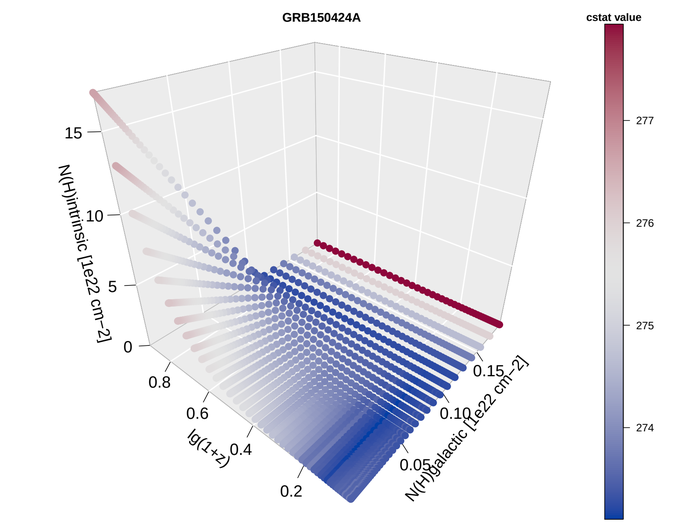

Figure 1: We varied these parameters between realistic physical limits, increasing them by 10% in each case and performing the fitting accordingly. The figure shows that there's a linear connection between galactic and intrinsic N(H) (hydrogen column densities), while they heave a quadratic relationship with the redshifts.

We randomly selected the GRB samples, with unknown redshifts and several (in these cases 3) breakpoints in the Swift X-ray light curves, so we could examine the spectral evolution.

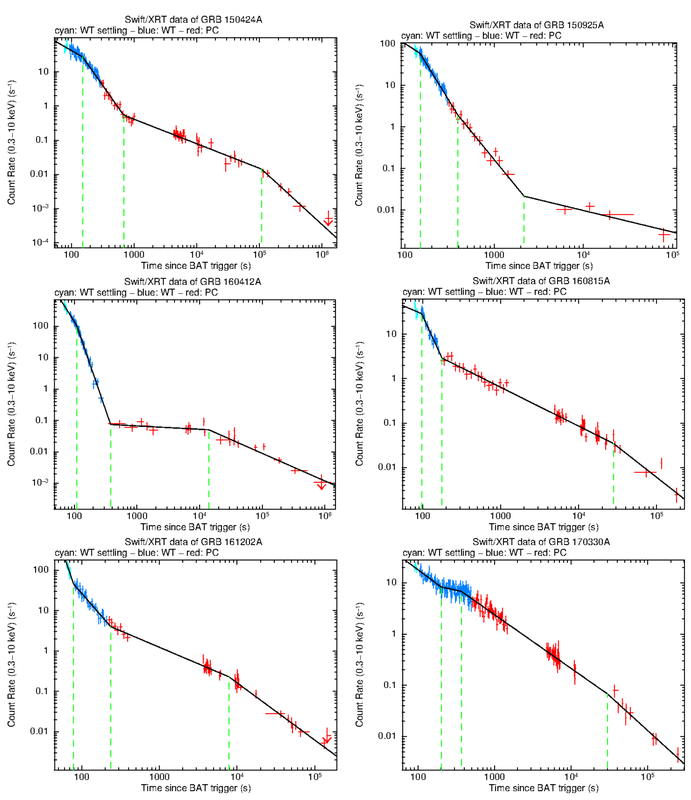

Figure 2: The light curves of the selected GRBs. In our analysis we used both Window Timing (blue) and Photon Counting (red) data. Source of pictures: UKSSDC

Evolution

We have analyzed several GRBs' (with 3 breaks and without flares) intrinsic column density evolutions. We have 5 phases in each case (because we used both WT and PC mode).

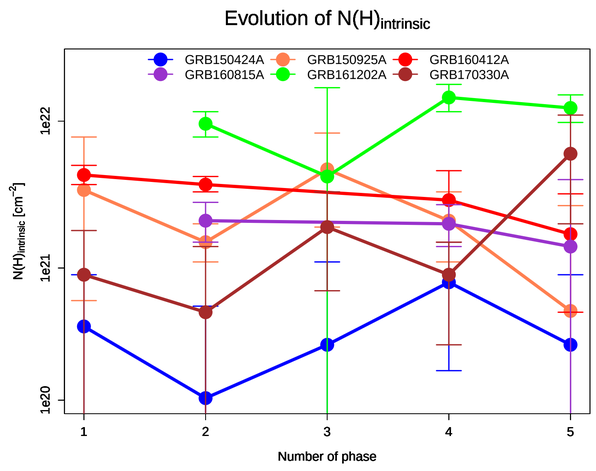

Figure 3: We were expecting the numbers to decrease from phase 1 to phase 5, but in fact our results didn't show the significant column density decrease.

Robustness of evolution

We examined the robustness in the fitting of the intrinsic column density, as it strongly depends on the galactic foreground density.

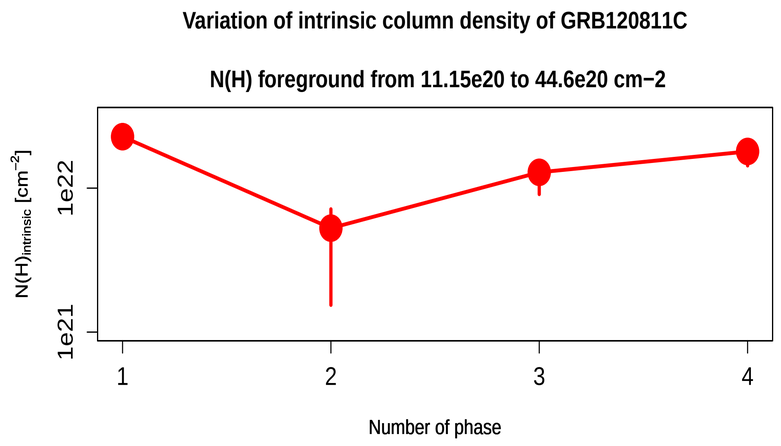

Figure 4: We performed the fitting of the X-ray spectra in all phases separately, while treating the galactic foreground as a free parameter. The galactic N(H) ranged of 50% to 200%. The variability of the intrinsic column density seems to be stable enough.

NH during flare

We studied the changes of the intrinsic column density in the duration of an X-ray flare. We selected the 160325A because the 4 analyzed phases have been observed in WT mode and without any breakpoints.

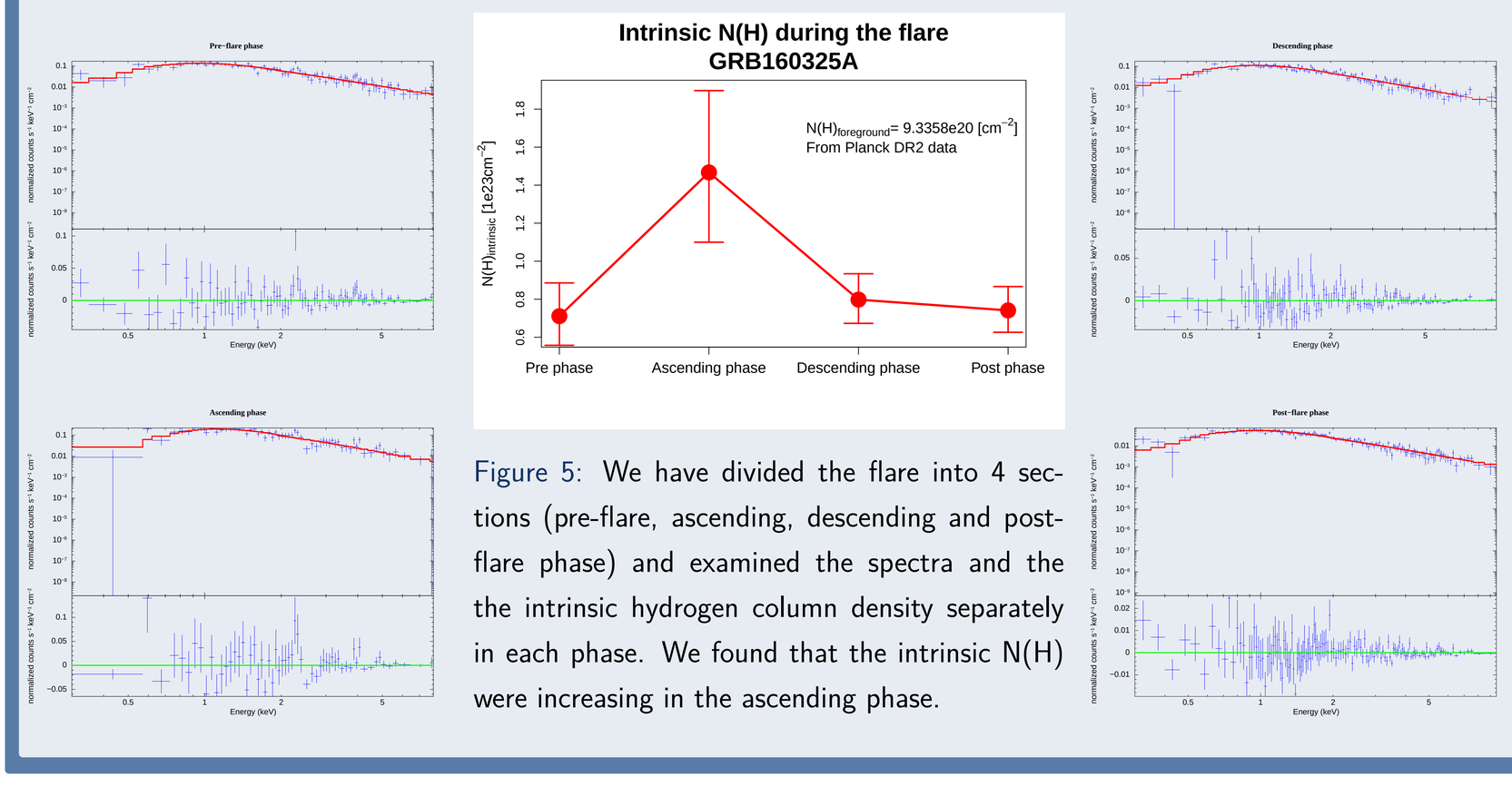

Figure 5: We have divided the flare into 4 sections (pre-flare, ascending, descending and post-flare phase) and examined the spectra and the the intrinsic hydrogen column density separately in each phase. We found that the intrinsic N(H) were increasing in the ascending phase.

Conclusion

The intrinsic N(H) has linear dependence on the galactic foreground and quadratic relation with the redshift. The intrinsic column density changes in time, but there isn't a standard model for it. During the X-ray flare the intrinsic hydrogen column density increased significantly.

References

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