Peering towards Cosmic Dawn
Proceedings IAU Symposium No. 333, 2018
V. Jelić & T. van der Hulst, eds.

doi:10.1017/S1743921317011292

The Zone of Avoidance as an X-ray absorber - the role of the galactic foreground modelling Swift XRT spectra

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Abstract. Gamma-ray bursts (GRBs) are the most powerful explosive events in the Universe. The prompt gamma emission is followed by an X-ray afterglow that is also detected for over nine hundred GRBs by the Swift BAT and XRT detectors. The X-ray afterglow spectrum bears essential information about the burst, and the surrounding interstellar medium (ISM). Since the radiation travels through the line of sight intergalactic medium and the ISM in the Milky Way, the observed emission is influenced by extragalactic and galactic components. The column density of the Galactic foreground ranges several orders of magnitudes, due to both the large scale distribution of ISM and its small scale structures. We examined the effect of local HI column density on the penetrating X-ray emission, as the first step towards a precise modeling of the measured X-ray spectra. We fitted the X-ray spectra using the Xspec software, and checked how the shape of the initially power low spectrum changes with varying input Galactic HI column density. The total absorbing HI column is a sum of the intrinsic and Galactic component. We also investigated the model results for the intrinsic component varying the Galactic foreground. We found that such variations may alter the intrinsic hydrogen column density up to twenty-five percent. We will briefly discuss its consequences.

Keywords. gamma rays: bursts, gamma rays: observations, X-rays: general, X-rays: ISM

1. Introduction

Gamma-ray bursts (GRBs) are the most powerful explosive events in the Universe (Kumar & Zhang(2015)). The prompt gamma emission is followed by an X-ray afterglow that is also detected for over nine hundred GRBs by the Swift BAT and XRT detectors. The X-ray afterglow spectrum bears essential information about the burst and the surrounding interstellar medium (ISM). Since the radiation travels through the line of sight intergalactic medium and the ISM in the Milky Way, the observed emission is influenced by extragalactic and galactic components. The column density of the Galactic foreground ranges several orders of magnitudes, due to both the large scale distribution of ISM and its small scale structures.

We examined the effect of local HI column density on the penetrating X-ray emission, as a first step towards a precise modeling of the measured X-ray spectra. We fitted the X-ray spectra using the Xspec software and checked how the shape of the initially power law spectrum changes with varying input Galactic HI column density. The total absorbing HI column is a sum of the intrinsic and Galactic component. We also investigated the

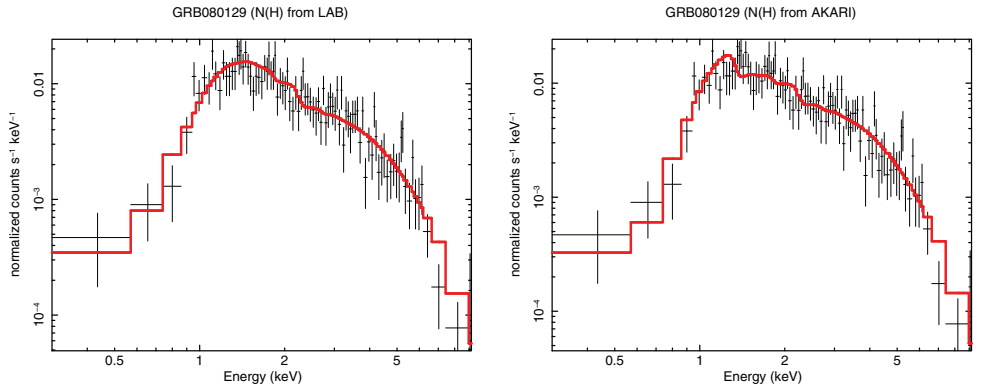

Figure 1. Time-averaged spectra of GRB080129 with the best fits. On the left side we can see the 'catalog' spectrum fit from the UKSSDC, on the right side there is our X-ray spectral fit. We changed the input foreground column density and used the redshift. We found a significant difference (more than 2 magnitudes) in the intrinsic column density. The new absorption model from Xspec v12.9.1 could modify significantly the intrinsic column density.

model results for the intrinsic component varying the Galactic foreground. We found that such variations may alter the intrinsic hydrogen column density up to twenty-five percent. The newest absorbing model can cause similar or even bigger modification.

2. Results

We tried to imporve the results of the standard method, which was published by Evans *et al.* (2007), P. A. Evans and A. P. Beardmore (2009). We examined the following physical inputs to improve the estimation of the GRB parameters (I. I. Racz *et al.* (2017)):

- the new galactic foreground can change not negligibly;
- the intrinsic column density might vary up to one order of magnitude;
- the X-ray flux and intrinsic column density depend heavily on the redshift value;
- the fitted flux and power indices were not sensitive to the initial parameters (except for the redshift);
- newest (most recent) absorption model might improve the fit.

3. Summary

We found that the precise redshift and galactic foreground values are essential parameters in the X-ray spectral fitting of GRBs. This intrinsic column density and the X-ray flux depend heavily on the redshift. We also found that the fitting results were not significantly sensitive on the initial parameters and the cosmological parameters but the newest absorption model might varying the fitting.

Acknowledgements This work was supported by the Hungarian OTKA NN-111016 grant. Supported through the Hungarian New National Excellence Program of the Ministry of Human Capacities (IR). We are grateful to Agnes J. Hortobagyi for her help.

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Rácz, I. I., Bagoly, Z., Tóth, L. V., *et al.* 2017, *Contributions of the Astronomical Observatory Skalnate Pleso*, 47, 100

https://doi.org/10.1017/S1743921317011292 Published online by Cambridge University Press