Probing the variability of the warm absorber in Mrk 279

J. Ebrero (SRON), E. Costantini (SRON), J. S. Kaastra (SRON), R. G. Detmers (SRON), N. Arav (Virginia Tech), G. A. Kriss (STScI)

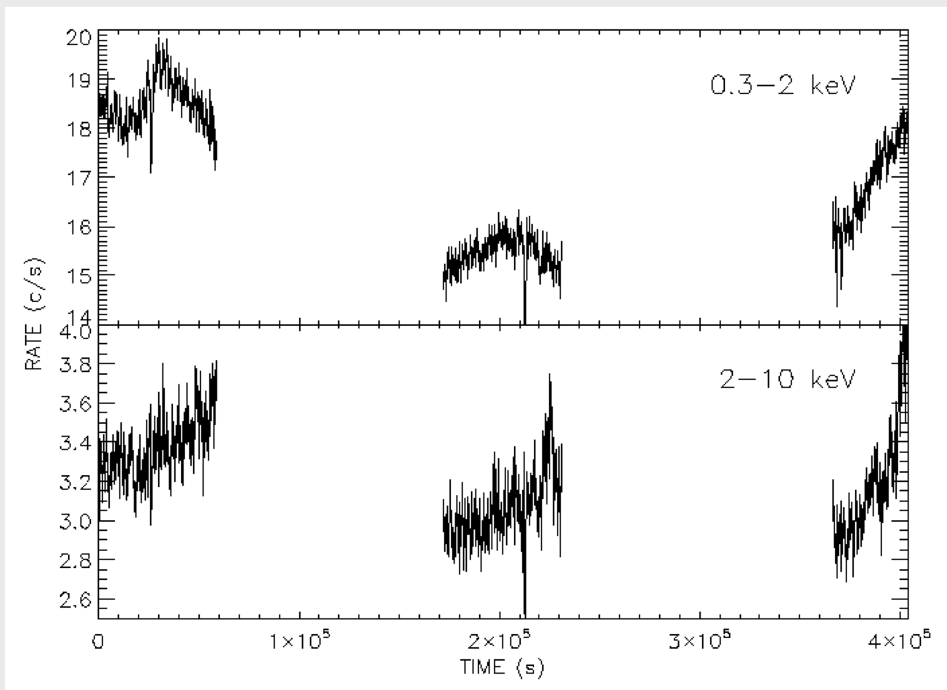
Abstract

We present here the results on the detailed modeling of the complex absorption spectrum of the Seyfert 1 galaxy Mrk 279. The source was observed three times by XMM-Newton RGS for a total exposure time of ~150 ks spread over three satellite orbits. The data are modeled in terms of two warm absorber components with different ionization parameters and blue-shifted with respect to the rest frame of the source. We find no significant response of the absorbing gas to the smooth (~25%) continuum variation of the source during the observations. We also investigate long term (~2 years) variations of the absorber, therefore putting important constraints on the distance of the absorber to the ionizing source as well as studying the possible relationship between the spectral components on long term timescales.

1. *XMM-Newton* observation of Mrk 279

- Mrk 279 was observed by *XMM-Newton* in three consecutive orbits (15-19 November 2005).
- The lightcurve shows a significant (~25%) variation in flux between the first observation (high) and the second (low), and a recovery in the third (see Fig. 1).
- We studied the absorption features in the RGS spectra in both the high and low states

Fig. 1. Lightcurve of Mrk 279



2. Modeling the absorbed spectrum

- The analysis was carried out using the SPEX package.
- The continuum was modeled by a PL+BB+gaussian.
- Local Galactic absorption was modeled using two collisionally ionised plasma components with $N_H=1.41\times10^{20}$ and 1.92×10^{19} cm^{-2}, and T=0.5 and 7 eV, respectively (see Costantini et al. 2007).
- The warm absorber intrinsic to Mrk 279 was modeled using two photoionised absorption model components (*xabs* in SPEX) with ionisation parameters log $\xi \sim 0.8\pm0.2$ and log $\xi \sim 2.0\pm0.1$, $N_H=8.7\pm3.7\times10^{19}$ and $2.2\pm1.2\times10^{19}$ cm^{-2}, and outflow velocities of -400±120 and -320±100 km s^{-1}, respectively.
- No significant variations in the *xabs* parameters were found between the high and low flux states of Mrk 279.

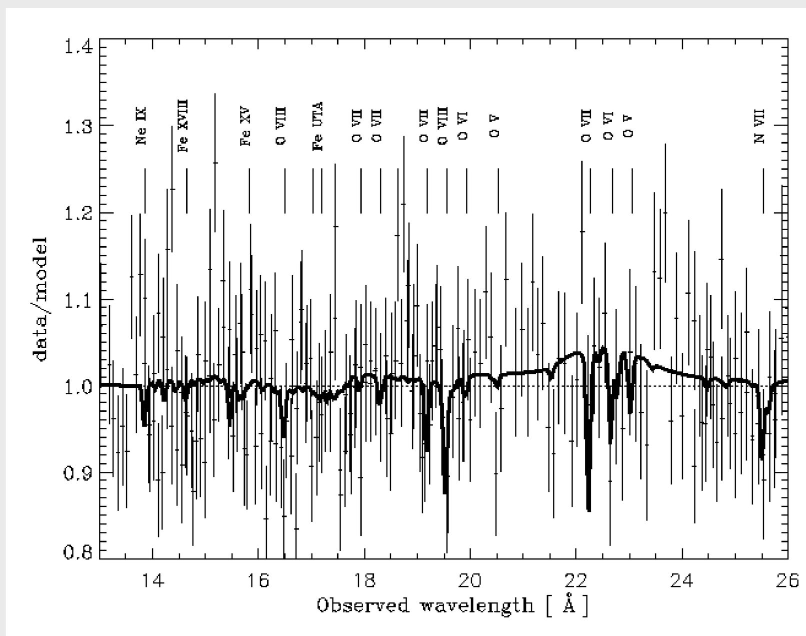


Fig. 2. Transmission spectrum of Mrk 279. The most prominent absorption features are labeled. Notice the broad emission component of O VII between 20 and 24 Å (see Costantini et al. 2007 for further discussion).

3. Long-term variability of the warm absorber

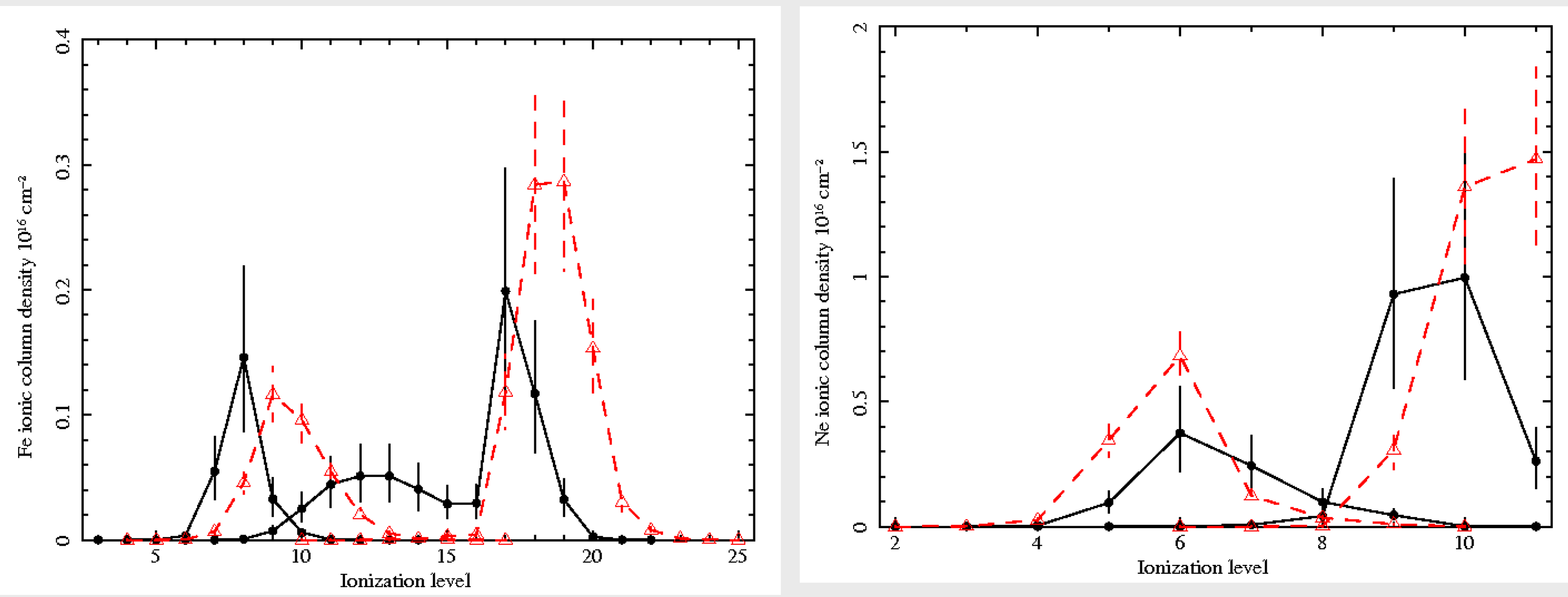


Fig. 3. Ionic column densities for Fe (*left*) and Ne (*right*) measured by *XMM-Newton* (dots) and *Chandra* (triangles, Costantini et al. 2007) for both components of the warm absorber. The F-test shows that there exist ~3σ variation in the ionic N_H measured for both elements, pointing out a long-term variability in the warm absorber.

4. Constraining the warm absorber

- From the ionisation parameter ξ and the recombination rates for each ion we can estimate a lower limit for the density of a given ion (e.g. Bottorff et al. 2000).
- We focus here on the Fe (tracer of the low-ξ phase of the warm absorber) and Ne (tracer of the high-ξ phase) ions, see Fig. 4.
- Using $\xi = L/nR^2$ we can set an upper limit for the distance of the ionizing source to the warm absorber of R < 8 pc for the high-ξ component, and R < 29 pc for the low-ξ component. The lack of variability in two consecutive *XMM-Newton* observations (2 days) provides a lower limit to R of 0.4 and 1.4 pc for the high- and low-ξ components, respectively.
- Assuming that the outflowing matter has reached the escape velocity (see e.g. Blustin et al. 2005) we can also estimate a lower limit for R > ~ 2 pc.

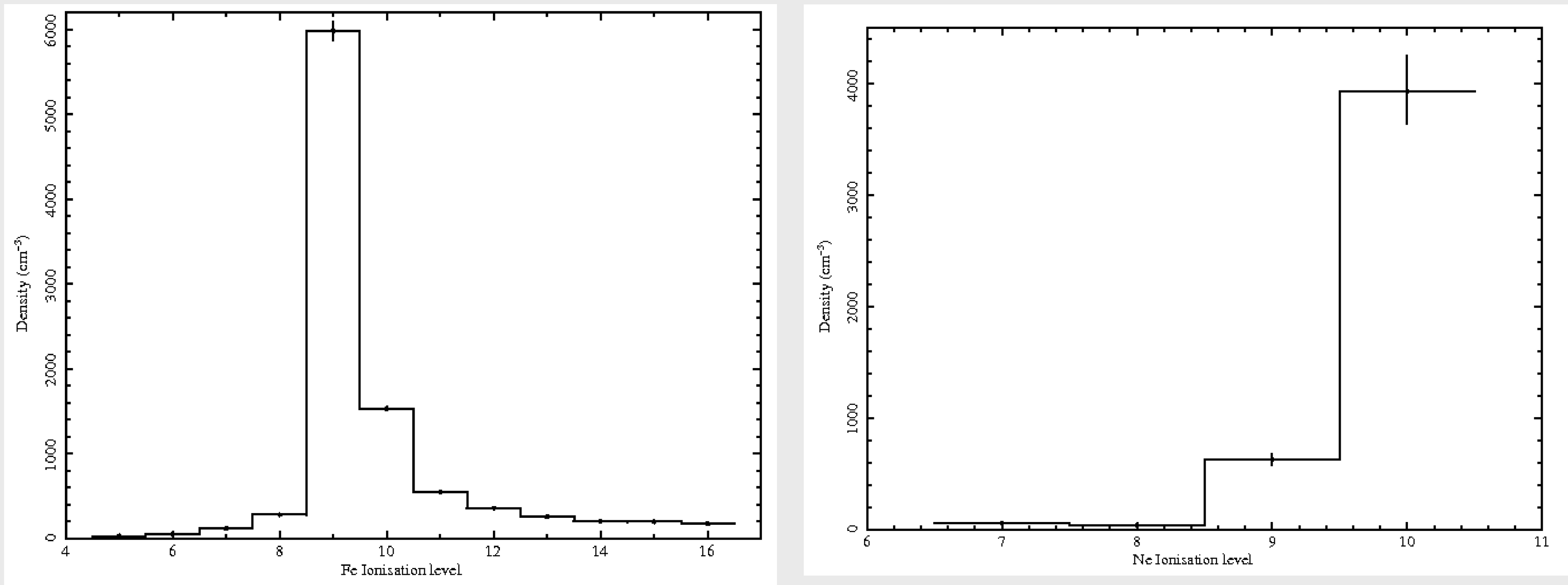


Fig. 4. Lower limits to the density of Fe (*left*) and Ne (*right*) ions. The values have been obtained from the recombination rates of the ions at a temperature *T* provided by the ionisation balance of the warm absorber.

Conclusions and prospective work

- We have analysed the RGS spectrum of Mrk 279 in two different flux states finding no signs of short-scale variations in the warm absorber.
- Comparison with *Chandra* observations in 2003 indicates long-term variability which we have used to constrain the distance of the warm absorber to the ionizing source.

Work in progress also includes determination of the abundancies of the most relevant elements detected in RGS. This analysis and further discussion will be presented in a forthcoming paper (Ebrero et al., in preparation).

References

Blustin et al. 2005, A&A, 431, 111; Bottorff et al. 2000, ApJ, 537, 134; Costantini et al. 2007, A&A, 461, 121.