Outflows in an AGN

Chandra LETGS observation of Mrk 509

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Abstract

We present here the *Chandra* LETGS spectrum of the Seyfert 1 galaxy Mrk 509. This observation is part of a dedicated multiwavelength campaign with the goal of locating the warm absorber and understanding how it contributes to the feedback on the host galaxy. The 180 ks LETGS spectrum shows several absorption features in a wide range of ionization states. We find three different components, one at the systemic velocity of the source and the others outflowing at several hundreds of km/s.

Introduction

The majority of local Seyfert 1 galaxies present absorption signatures of an ionised gas at the redshift of the source (the so-called warm absorber, WA) in their spectrum. This WA is usually outflowing at several hundreds of km/s and hence it could be the key to understand the feedback processes in the host galaxies of AGNs. The location and structure of these outflows are still a matter of debate, so dedicated multiwavelength campaigns are the only way to give light to this issue. Mrk 509 is a nearby QSO/Seyfert 1 galaxy (z = 0.0344) and was observed for 180 ks with *Chandra* LETGS.

The results of this campaign on Mrk 509 (including observations in X-rays, UV, optical, and gamma rays) will be presented in a series of forthcoming papers.

Continuum and local absorption

The continuum of Mrk 509 at soft (0.2-2 keV) X-rays can be modeled by a power law (Γ = 2.06 ± 0.03) plus a black body component (T = 0.126 ± 0.005 keV). The complexity of the continuum can also be described using a logarithmic spline (Ebrero et al., in prep.).

Some of the absorption features seen in the spectrum are caused by the ISM of our Galaxy consisting of three phases: cold neutral gas (T~5 x 10^{-4} keV), warm mildly ionized gas (T ~ 4.5 x 10^{-3} keV), and a hot highly ionized gas (T ~ 0.15 keV). In addition, depletion of elements into molecules has to be taken into account, being hematite (Fe_2O_3) and pyroxene ($MgFeO_3$) the molecules responsible for the Fe and O edges fine structure (Detmers et al., in prep.).

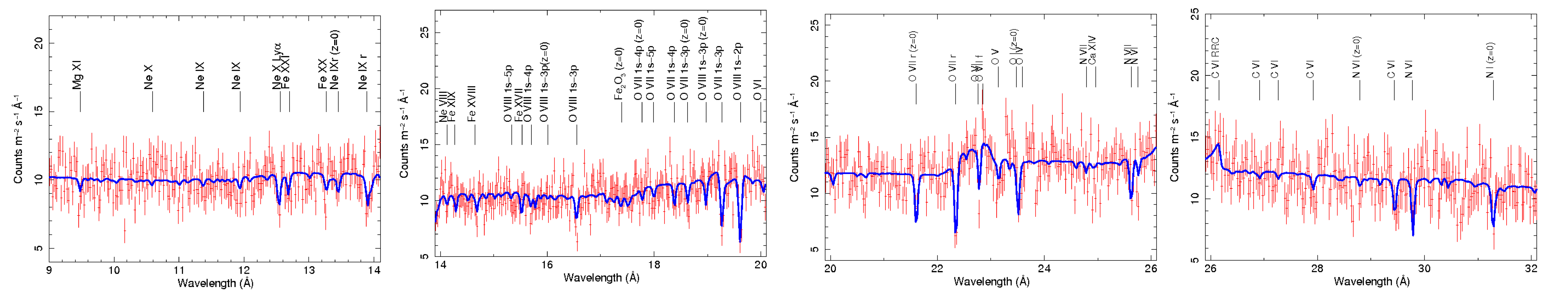

Fig. 1. LETGS spectrum of Mrk 509. The most prominent spectral features have been labeled.

The warm absorber (WA)

The WA was modeled using three *xabs* components in the fitting package *SPEX* to account for the wide range of ionization degrees present in the spectrum. The best-fit paramers are reported in the table on the right. This model requires an ionization balance calculated from the SED of the source (Detmers et al., in prep.). According to Fig. 2, components 2 and 3 share the same pressure ionization parameter within the error bars and therefore are in pressure equilibrium (probably being part of the same structure), while component 1 is not, unless other processes such as magnetic confinement are playing a role. Component 1 is at the systemic velocity of the source whereas components 2 and 3 are outflowing at hundreds of km/s. This points out towards a different origin for these absorbers that will be discussed in a forthcoming work.

Parameter	WA1	WA2	WA3
log ξ (erg cm)	1.0±0.1	2.1±0.1	3.1±0.2
N_H (x10^{20} cm^{-2})	2.3±0.6	6.2±1.9	6.8±3.6
rms (km/s)	80±25	45±19	< 400
V_{out} (km/s)	75±50	-200±70	-500±200

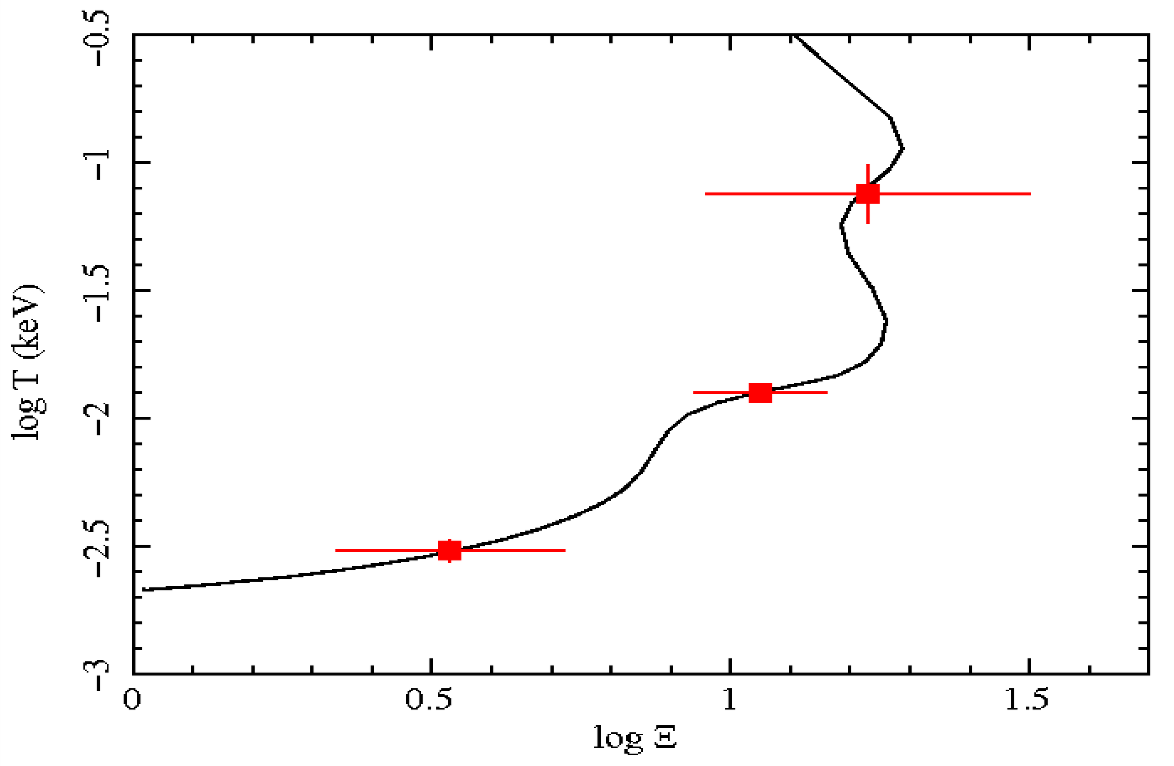

Fig. 2. Pressure ionisation parameter as a function of electron temperature. The WA components are marked as squares.

Emission lines

In addition to the absorption components, there are also a number of emission features present in the spectrum of Mrk 509, mainly Lyα emission of NVII, OVIII, and CVI, plus the He-like OVII triplet. All of them were modeled with gaussian components. We also significantly detect the radiative recombination continua (RRC) of CVI and, marginally, of NVII. These features are clear signatures of recombination in overionized plasmas. The temperatures found are T ~ 4 eV, which is expected for a photoionized gas. The presence of RRC indicates a variable flux history of the source and that the WA responded to it accordingly. This can be used to set limits to the density of the gas and constrain the location of the WA, which will be reported in a forthcoming work.