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DETERMINING THE DISTANCES OF THE STRUCTURES SURROUNDING SUPER-MASSIVE BLACK HOLES

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We use a 100 day optical to gamma-ray monitoring campaign to constrain the distances to the structures surrounding the super-massive black hole in Mrk 509, a nearby luminous Seyfert 1 galaxy.

The surroundings of super-massive black holes located in AGN is complex with: the accretion disk, the corona, the region emitting the soft excess, the reflection component, the broad line region, the torus and an ionised outflow called the warm absorber. The distance from the black hole, the size and geometry of most of these components is poorly constrained. We use time-resolved UV and X-ray high- and medium-resolution spectroscopy, and the comparison between optical, UV and X-ray light-curves to put distance limits. The campaign included data from Swift, XMM-Newton, INTEGRAL, Hubble Space Telescope (HST) and Chandra (Kaastra et al. 2011a).

The soft excess comes from an optically thick and relatively low temperature layer Compto-ionising the accretion disk photons. The maximum distance from the cold accretion disk, which is detected in the optical and UV part of the SED, is 4 light days (Mehdipour et al. 2011; Petrucci et al. 2013). The reflection component, detected through the broad Fe Kα line, is located between 40-1000 gravitational radii from the black hole, where the lower limit comes from the lack of a relativistic profile of this line (Ponti et al. 2013).

From the lack of spectral variability in the medium resolution spectra over 40 days of the XMM-Newton campaign we determine lower limits of the warm absorber components of 4.6, 4.7 and 73 pc, depending on the ionisation of the component. For one component we have an upper limit from comparison with earlier spectra of 33 pc (Kaastra et al. 2012).

In the HST-COS UV spectra we detect 13 different kinematic components (Kriss et al. 2011). In the XMM-Newton RGS spectra we cannot resolve the different kinematics components, but we detect 5 differently ionised components (Detmers et al. 2011). Fig. 1 shows 8 Å of the RGS spectrum detailing the oxygen lines. The outflow velocities measured are consistent with the UV determined kinematic components. We determined that the abundances relative to oxygen for C, N, Ne, Si, Ca are consistent with solar abundances and possibly somewhat lower for S and Fe (Steenbrugge et al. 2011).

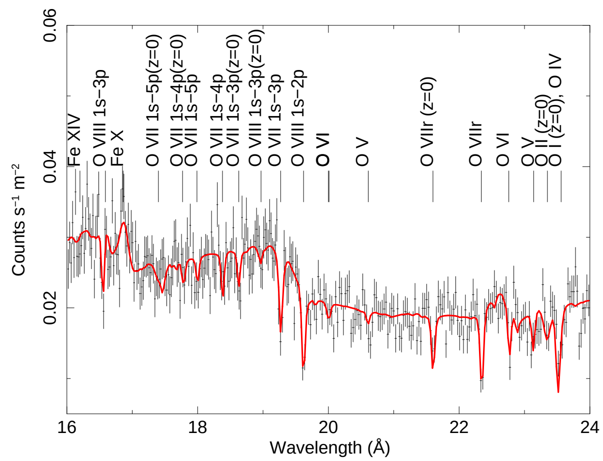

Fig. 1. Part of the RGS high-resolution X-ray spectrum between 16 and 24 Å, detailing the range in oxygen ions detected in the spectrum.

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