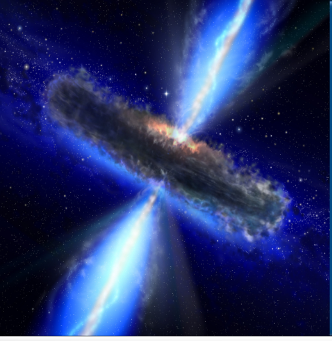

Timing warm absorbers in AGN

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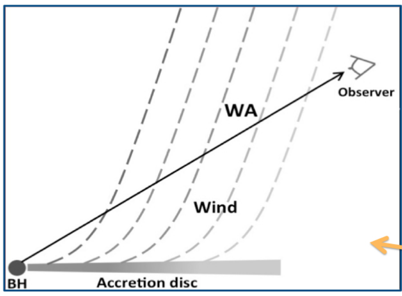
Abstract

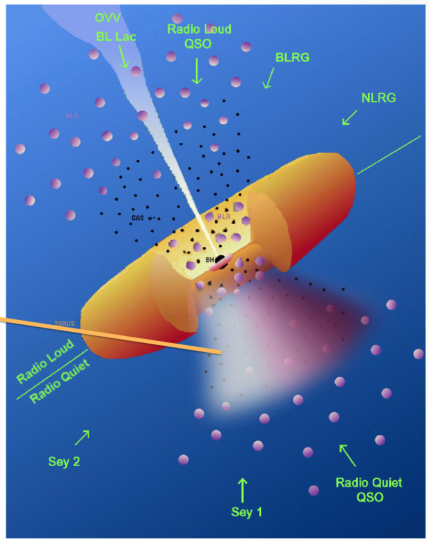
Here we present our preliminary results of the combined timing and spectral analysis on NGC4051, a highly variable and bright Seyfert I galaxy, extensively observed by XMM-Newton. By making use of more than 600ks of archival data[1], we analyze the X-ray time lags corresponding to the response of the ionized gas relative to variations in the flux of the central source. The timing information will enable us to estimate the distance of the warm absorber components and their contribution to AGN feedback.

Accessing AGN feedback

AGN are powered by accretion onto a supermassive black hole[2]. These systems have also been associated with ejection of matter, either in the form of collimated relativistic jets and/or outflows of gas[3], rich in metals. The impact of such outflowing winds in the surrounding environment, so-called **AGN feedback**, is thus of crucial importance in modeling the evolution of black holes across cosmic time and their host galaxies[4,5]. However, the wind energetics is dependent on the distance to the central source, which is challenging to determine[6].



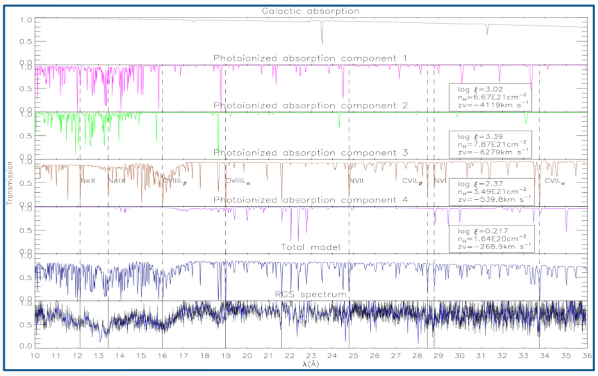
Schematic diagram of a stratified accretion disc wind, showing possible locations of the warm absorber (WA) components. Adapted from Tombesi et al. 2013.



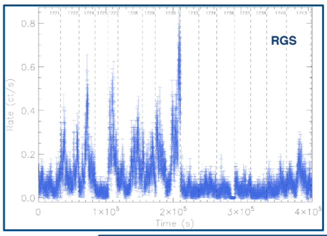
Unified model for AGN. Adapted from C. M. Urry and P. Padovani.

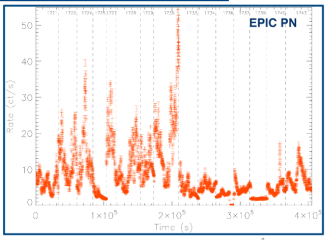
How can we compute the distance of the multicomponent absorber to the central source?

The case of NGC4051



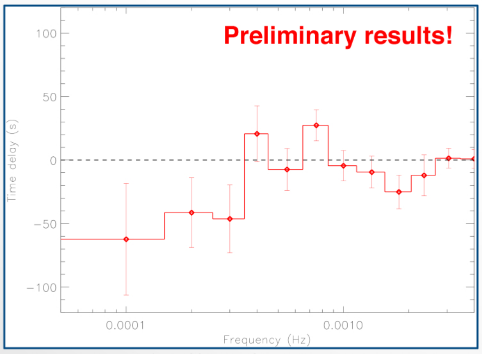
Plot of the results of spectral fitting of the RGS spectrum and correspondent multicomponent model of the warm absorber. The high energy resolution of RGS allows us to investigate single absorption features.





Cross Spectrum[7]

Top: RGS light-curves of the Fe UTA absorption feature (15-17 Å). Bottom: EPIC PN light-curves of the soft reference band of the ionizing continuum (0.3-2.0 keV). The vertical dotted lines separate the individual observations.



Taking the cross-spectrum of the RGS and EPIC PN light-curves showed above, we can calculate the time lags of the Fe UTA absorption feature relative to the soft band of the ionizing continuum. These are very preliminary results still to be carefully analyzed.

Time delays at low frequencies seem to indicate the absorption feature lags the ionizing continuum.

Combining high resolution X-ray spectroscopy and timing analysis

The response of the absorber to the variable ionizing continuum can be interpreted to give the recombination time[6].

time lag ⟶ $t_{rec} \propto n^{-1}$

The spectral fitting gives the ionization parameter, ξ.

$$\xi = \frac{L}{nr^2}$$

We can estimate the distance of the warm absorber

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Acknowledgments

The timing products used so far in this project were computed by making use of the IDL code written by Vaughan, S., available online at http://www.star.le.ac.uk/~sav2/idl/cross_spectrum.pro.

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