

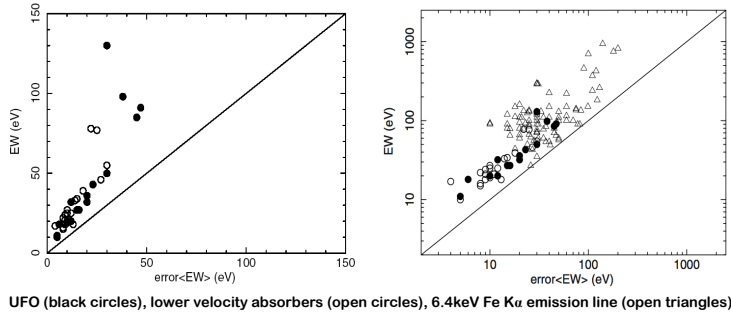
The X-ray view of accretion disk winds in AGNs

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X-ray evidence for massive, highly ionized, ultra-fast outflows (UFOs) has been recently reported in a number of local AGNs through the detection of blue-shifted Fe XXV/XXVI absorption lines. We present the results of a comprehensive spectral analysis of a large sample of 42 local Seyferts and 5 Broad-Line Radio Galaxies observed with XMM-Newton and Suzaku. We assessed the global detection significance of the absorption lines, solving any claimed publication bias, and performed a detailed photo-ionization modeling. We find that UFOs are common phenomena, being present in >40% of the sources. Their outflow velocity distribution spans from 10,000 km/s ($\sim 0.03c$) up to 100,000 km/s ($\sim 0.3c$), with peak and mean value at $\sim 40,000$ km/s ($\sim 0.13c$). The ionization parameter is very high, in the range $\log \xi \sim 3-6$ erg s $^{-1}$ cm, with mean $\log \xi \sim 4.2$ erg s $^{-1}$ cm. The associated column densities are also large, in the range $\sim 10^{22}-10^{24}$ cm $^{-2}$, with mean $\sim 10^{23}$ cm $^{-2}$. Overall, these results point to the presence of extremely ionized and possibly almost Compton thick outflowing material in the innermost regions of AGNs. Their variability and location on sub-pc scales favor a direct association with accretion disk winds/ejecta. This also suggests that UFOs may potentially play a significant role in the AGN cosmological feedback besides jets and their study can provide important clues on the connection between accretion disks, winds and jets.

The radio-quiet AGN sample

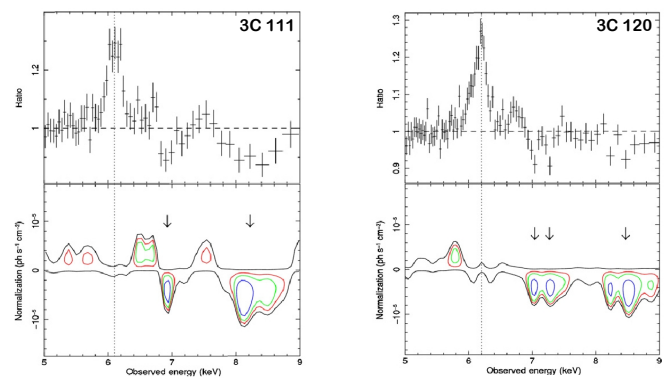


UFO (black circles), lower velocity absorbers (open circles), 6.4 keV Fe K α emission line (open triangles)

- Sample composed of 42 local ($z \leq 0.1$) Seyferts for 101 pointed XMM-Newton observations.
- Systematic and uniform search for blue-shifted Fe K absorption lines at $E > 7$ keV in EPIC pn. Statistical significance established using F-test and extensive Monte Carlo simulations. Variability even on \sim days.
- Global random probability $< 10^{-8}$ and detection independently confirmed by EPIC MOS cameras. Solved claimed publication bias.
- Absorption lines identified as Fe XXV/XXVI transitions. More than 40% of the sources show lines with blue-shifted velocity $> 10,000$ km/s, indicative of UFOs.
- Large covering fraction of $C \sim 0.4-0.6$ and possibly large opening angles.

(Tombesi et al. 2010, A&A, 521, A57)

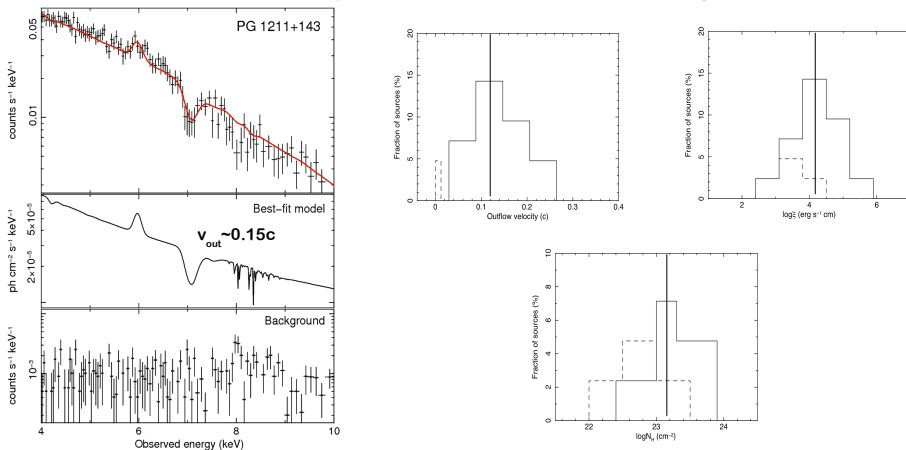
The radio-loud AGN sample



- Sample of five bright BLRGs observed with Suzaku: 3C111, 3C390.3, 3C120, 3C382, 3C445. Highly significant detection of series of blue-shifted Fe XXV/XXVI absorption lines indicative of UFOs in the first three sources (frequency 3/5).
- Photo-ionization modeling using Xstar. Outflow velocities in range $\sim 0.04-0.15c$. Large columns $\sim 10^{22}-10^{23}$ cm $^{-2}$ and high ionization $\log \xi \sim 4-6$ erg s $^{-1}$ cm.
- Location $< 0.01-0.1$ pc from central super-massive black hole.
- $\dot{M}_{\text{out}} \sim 1 \dot{M}_{\text{sun}}/\text{yr}$, $\dot{M}_{\text{out}}/\dot{M}_{\text{acc}} \sim 0.1-1$, $E_k \sim 10^{44}-10^{45}$ erg/s $\sim 0.1 L_{\text{bol}}$ ($\sim 0.1-1 P_{\text{jet}}$).

(Tombesi et al. 2010, ApJ, 719, 700)

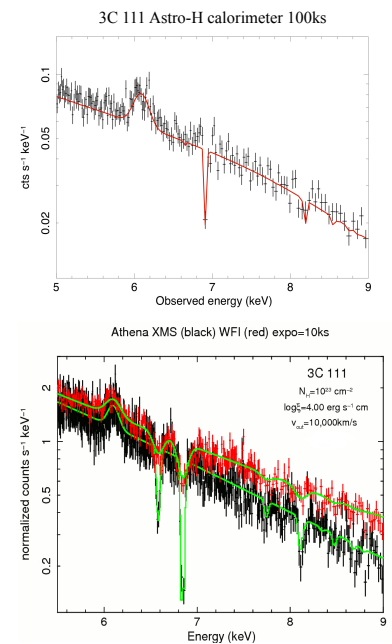
Detailed photo-ionization modeling



Curve of growth analysis of FeXXV/XXVI K absorption lines. Then, modeling of Fe K absorbers in XMM-Newton observations of Seyferts with Xstar. Absorption line width $\sim 1,000-5,000$ km/s. UFO outflow velocity from 10,000 km/s ($\sim 0.03c$) up to 100,000 km/s ($\sim 0.3c$), with peak and mean value at $\sim 40-50,000$ km/s ($\sim 0.13-0.18c$), considering selection effects. High ionization in range $\log \xi \sim 3-6$ erg s $^{-1}$ cm, with mean of $\log \xi \sim 4.2$ erg s $^{-1}$ cm. Large column densities in the range $\sim 10^{22}-10^{24}$ cm $^{-2}$, with mean $\sim 10^{23}$ cm $^{-2}$. Overall, these results point to the presence of extremely ionized and possibly almost Compton thick outflowing material in the innermost regions of AGNs.

(Tombesi et al. 2011, ApJ submitted)

Astro-H and Athena simulations



Through a detailed X-ray spectroscopic analysis we demonstrated the existence of previously unknown Ultra-fast Outflows (UFOs) in the central regions of both local radio-quiet and radio-loud AGNs, with velocities $\sim 0.1c$. They are detected in >40% of the sources. From a detailed photo-ionization modeling we derived the distribution of velocities, ionization and column densities. The characteristics of these highly ionized and massive outflows are in agreement with those expected from accretion disk winds/ejecta. This also suggests that UFOs may potentially play a significant role in the AGN cosmological feedback besides jets and their study can provide important clues on the connection between accretion disks, winds and jets. Significant improvements are expected from the future Astro-H and the proposed Athena missions.