Accretion disk winds in AGNs: recent results on radio galaxies and implications for ASTRO-H

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Ultra-fast outflows in radio-quiet AGNs

NGC 4051 $v \sim 0.1c$ 

PDS 456 $v \sim 0.25c$

(Pounds et al. 2003)

(Tombesi et al. 2010a)

(Reeves et al. 2009)
X-ray disk winds in radio galaxies
Discovery of UFOs in broad-line radio galaxies

- BLRGs are the radio-loud counterparts of Seyferts, but have powerful jets

- UFOs with $v \sim 0.1c$ detected in $\sim 4/6$ sources observed with Suzaku (Tombesi et al. 2010b, 2011b; Gofford et al. 2013)

- Warm absorbers also observed (Reeves et al. 2009; Torresi et al. 2010, 2012)

What is the incidence of UFOs in radio galaxies?
Ultra-fast outflows in radio-loud AGNs

The sample:
- 26 local RL-AGNs from Swift BAT catalog
- Majority FR II, no blazars
- 61 XMM-Newton and Suzaku obs

Analysis method:
- Search for Fe K absorption lines
- Confirmation with broad-band analysis
- XSTAR photo-ionization modeling

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Fe K absorption lines in Centaurus A

EW~10eV, Fe XXV-XXVI, >5σ

Observed velocity <1500 km/s, projected ~vertical wind?

High jet inclination 50°<i<80°

3 Suzaku obs in 2009

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Fe K absorbers in radio-loud AGNs

- Combining results with literature, UFOs in 7/26 (~30%) sources
- But only ~56% spectra have enough S/N, frequency of UFOs is f=(50±20)%
- Similar to RQ AGNs: jet related RQ/RL dichotomy does not apply to disk winds? (Tombesi et al. 2014)

Work in progress: 500ks Chandra winds in 3 BLRGs!

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ASTRO-H observations of radio-loud AGNs

- SXS micro-calorimeter unprecedented energy resolution (6eV) and sensitivity
- Simultaneous broad-band coverage 0.5-200 keV (SXS+SXI+HXI+SGD)
Partial covering Compton-thick AGN winds

- 100ks, broad-band 0.5-50keV ASTRO-H spectrum
- 2-10 keV flux of $\sim 10^{-12}$ erg s$^{-1}$ cm$^{-2}$
<table>
<thead>
<tr>
<th>Properties</th>
<th>SXS</th>
<th>SXI</th>
<th>HXI</th>
<th>SGD (photo-abs)</th>
<th>SGD (Compton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective area (cm^2)</td>
<td>50/225 (@0.5/6 keV)</td>
<td>214/360 (@0.5/6 keV)</td>
<td>300 (@30 keV)</td>
<td>150 (@30 keV)</td>
<td>20 (@100 keV)</td>
</tr>
<tr>
<td>Energy range (keV)</td>
<td>0.3-12.0</td>
<td>0.4-12.0</td>
<td>5-80</td>
<td>10-600</td>
<td>40-600</td>
</tr>
<tr>
<td>Angular resolution in HPD (arcmin)</td>
<td>1.3</td>
<td>1.3</td>
<td>1.7</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Field of view (arcmin^2)</td>
<td>3.05x3.05</td>
<td>38x38</td>
<td>9x9</td>
<td>33x33 (&lt;150 keV)</td>
<td>33x33 (&lt;150 keV)</td>
</tr>
<tr>
<td>Energy resolution in FWHM (eV)</td>
<td>5</td>
<td>150 (@6 keV)</td>
<td>&lt; 2000</td>
<td>2000 (@40 keV)</td>
<td>4000 (@40 keV)</td>
</tr>
<tr>
<td>Timing resolution (s)</td>
<td>8x10^{-5}</td>
<td>4</td>
<td>several x 10^{-5}</td>
<td>several x 10^{-5}</td>
<td>several x 10^{-5}</td>
</tr>
<tr>
<td>Instrumental background (/s/keV/FoV)</td>
<td>2x10^{-3}/0.7x10^{-3} (@0.5/6 keV)</td>
<td>0.1/0.1 (@0.5/6 keV)</td>
<td>6x10^{-3}/2x10^{-4} (@10/50 keV)</td>
<td>2x10^{-3}/4x10^{-5} (@10/50 keV)</td>
<td>1x10^{-4}/1x10^{-5} (@100/600 keV)</td>
</tr>
</tbody>
</table>
My contribution to ASTRO-H...

- Member of the Science Working Group since 2010
- Member of the task forces “AGN winds/reflection” and “Broad-band studies”
- Wrote several chapters for the ASTRO-H White Papers
- Led two PV (Performance Verification) target proposals
- Co-I of four other PV proposals
- Collaborations with main ASTRO-H groups in Japan, USA and Europe

...what about Italy?
Coming next winter... stay tuned!