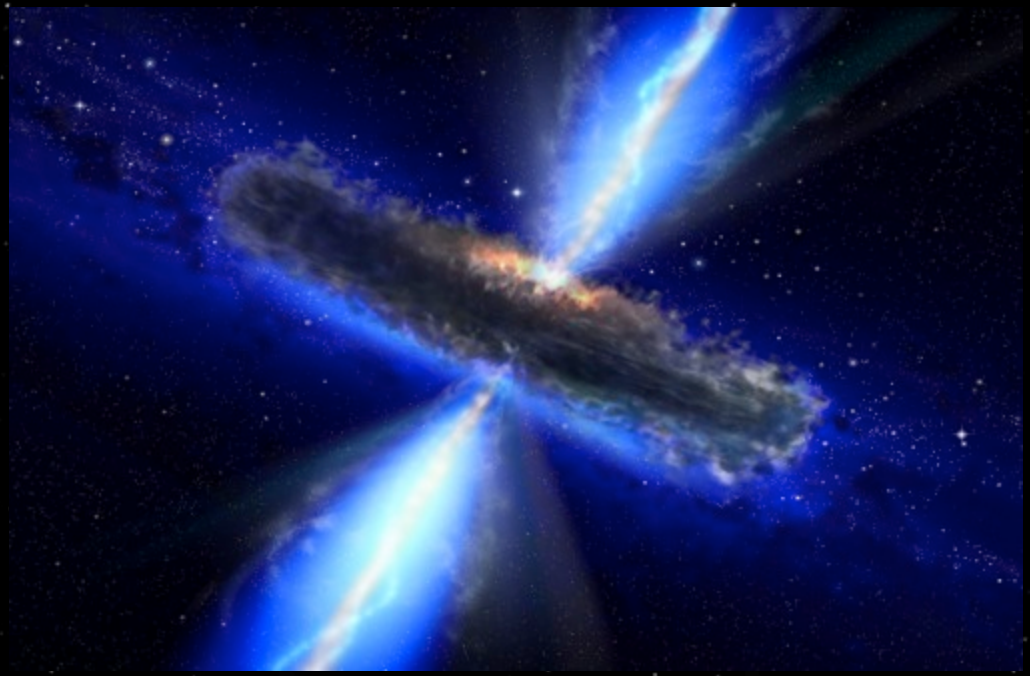
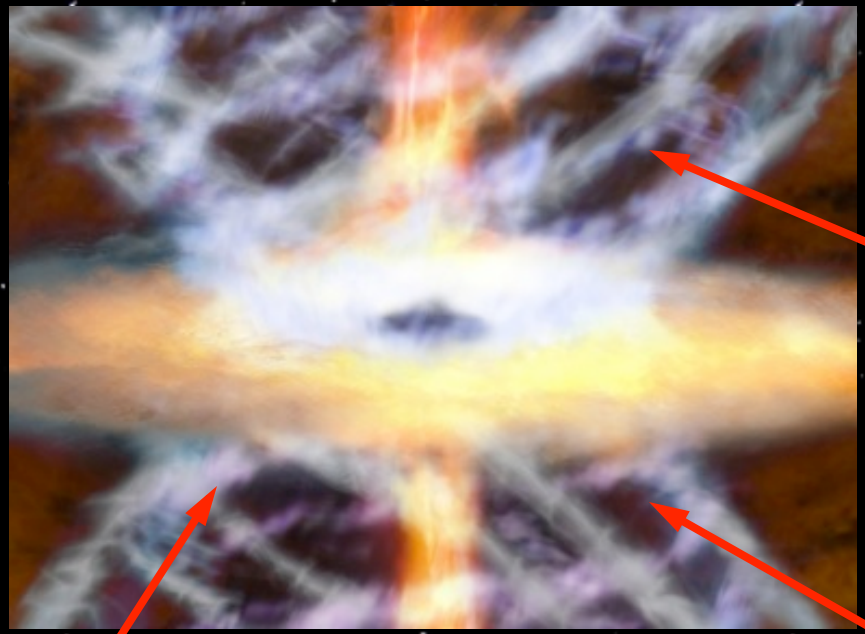
Accretion disk winds in AGNs: recent results on radio galaxies and implications for ASTRO-H

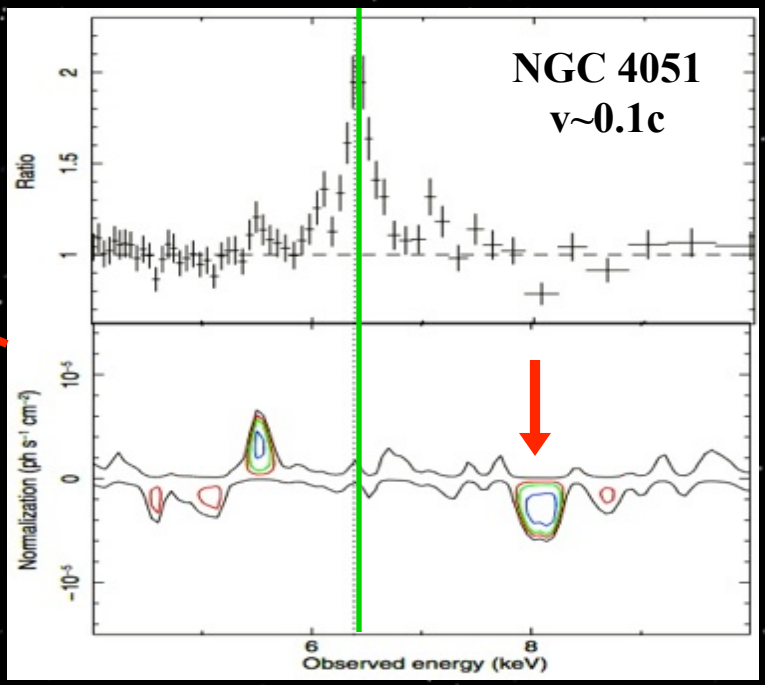


Francesco Tombesi (NASA-GSFC & UMD)

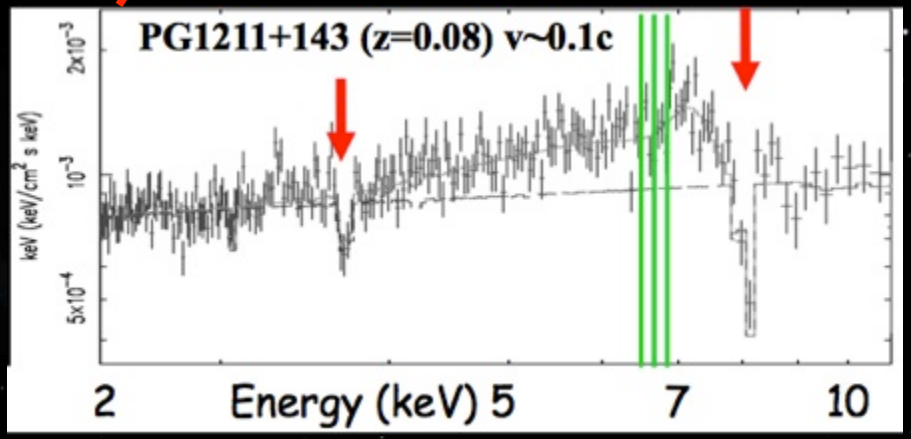
F. Tazaki – Kyoto University, Japan
R. F. Mushotzky – UMD, USA
Y. Ueda – Kyoto University, Japan
M. Cappi – INAF-IASF Bologna, Italy
J. Gofford – UMBC, USA
J. N. Reeves – Keele University, UK
M. Guainazzi – ESA/ESAC, Spain

Ultra-fast outflows in radio-quiet AGNs

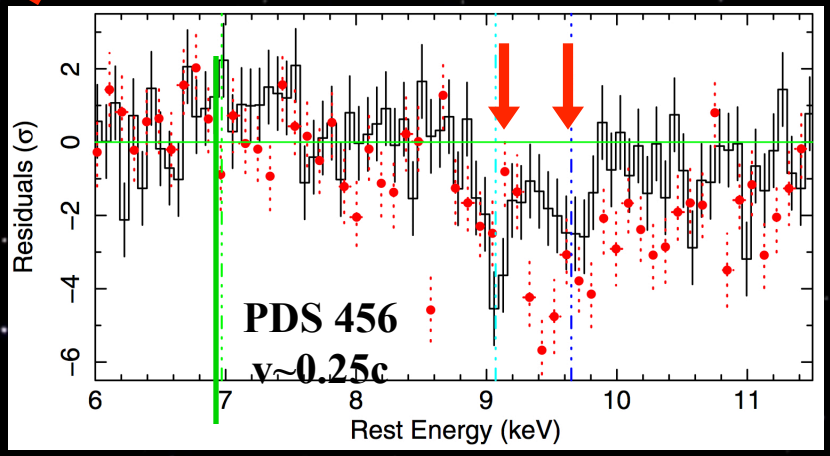




(Tombesi et al. 2010a)

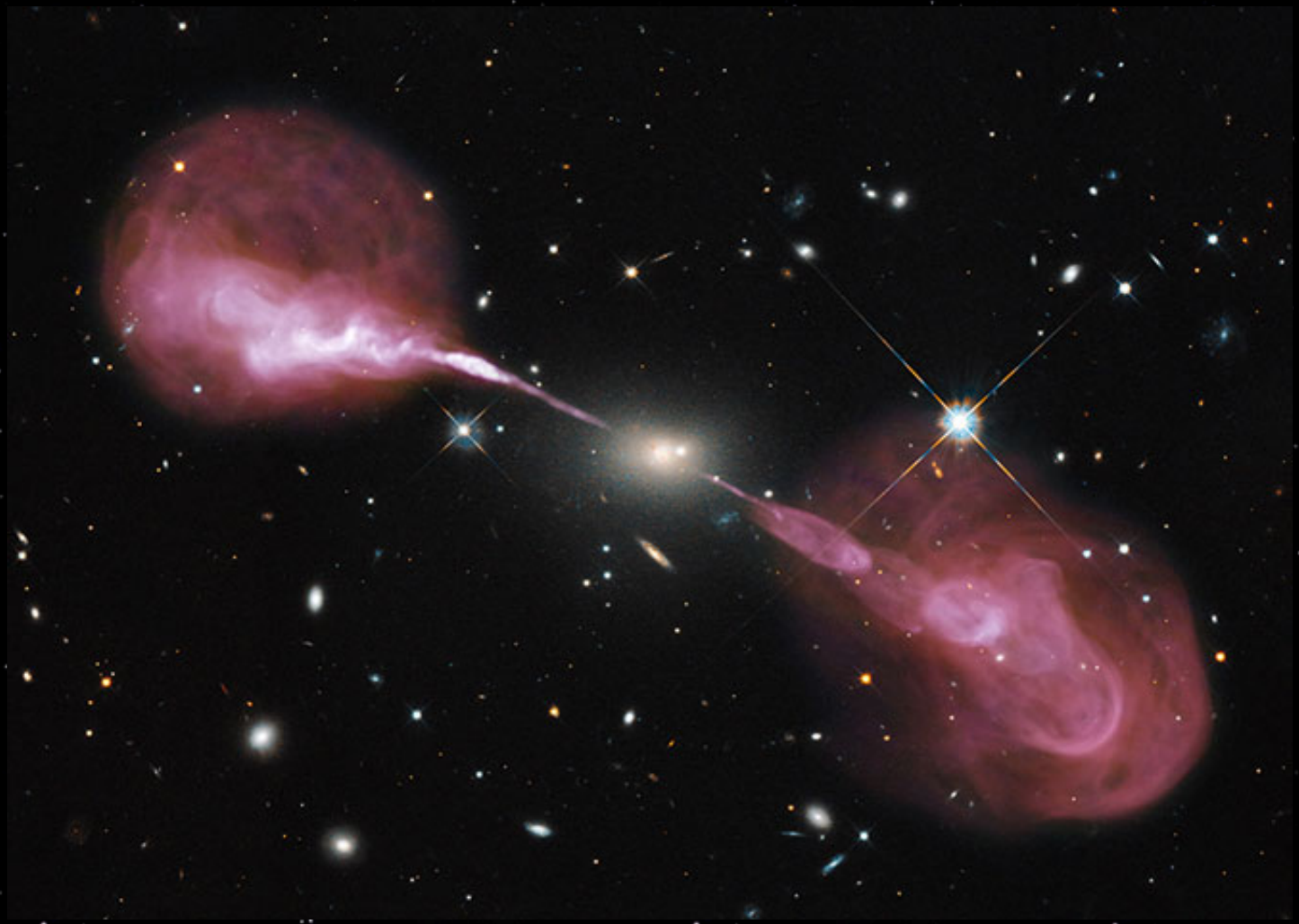


(Pounds et al. 2003)



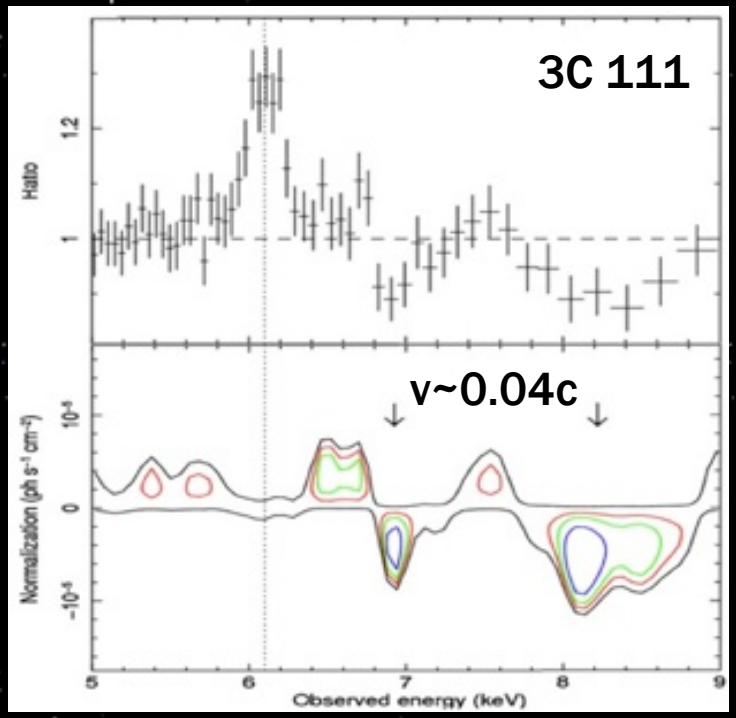
(Reeves et al. 2009)

X-ray disk winds in radio galaxies

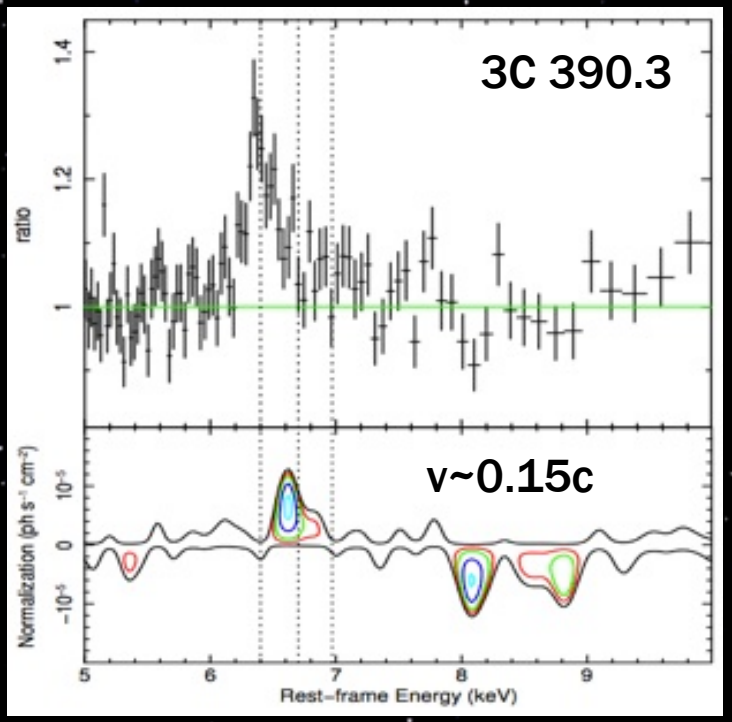


Hercules A

Discovery of UFOs in broad-line radio galaxies



(Tombesi et al. 2010b)



(Gofford et al. 2013)

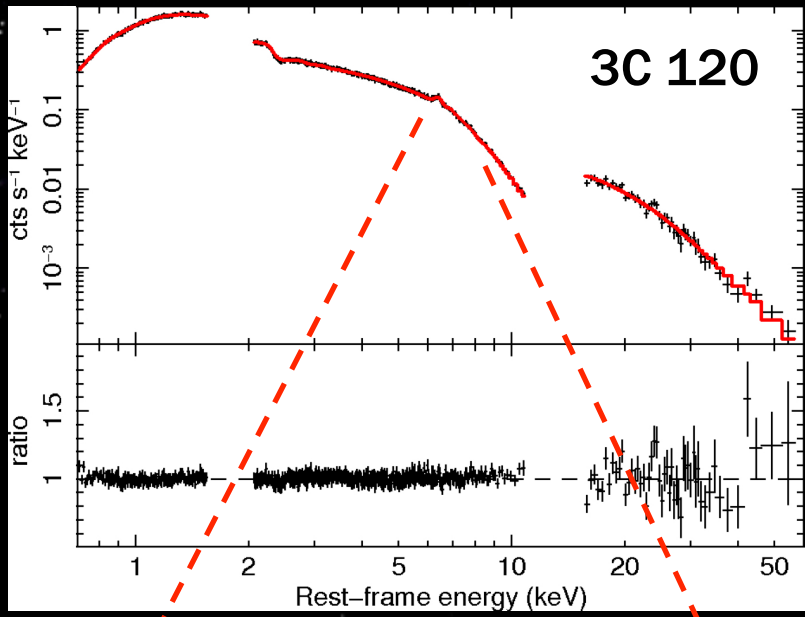
- **BLRGs are the radio-loud counterparts of Seyferts, but have powerful jets**
- **UFOs with v~0.1c detected in ~4/6 sources observed with Suzaku (Tombesi et al. 2010b, 2011b; Gofford et al. 2013)**
- **Warm absorbers also observed (Reeves et al. 2009; Torresi et al. 2010, 2012)**

What is the incidence of UFOs in radio galaxies?

Ultra-fast outflows in radio-loud AGNs

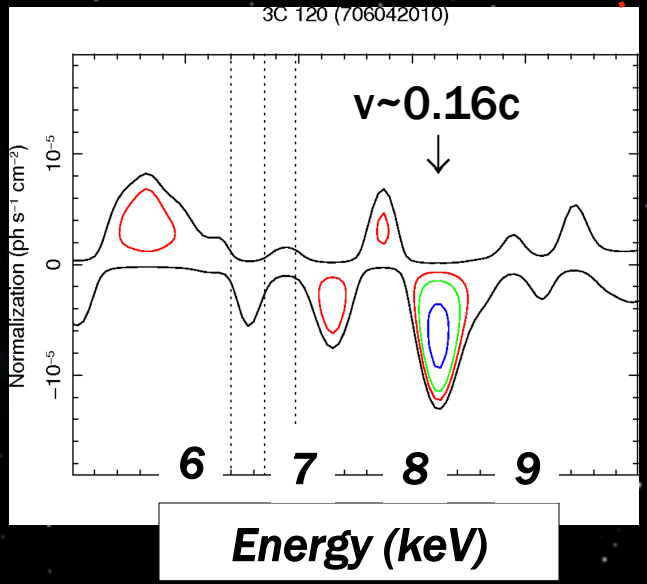
The sample:

- 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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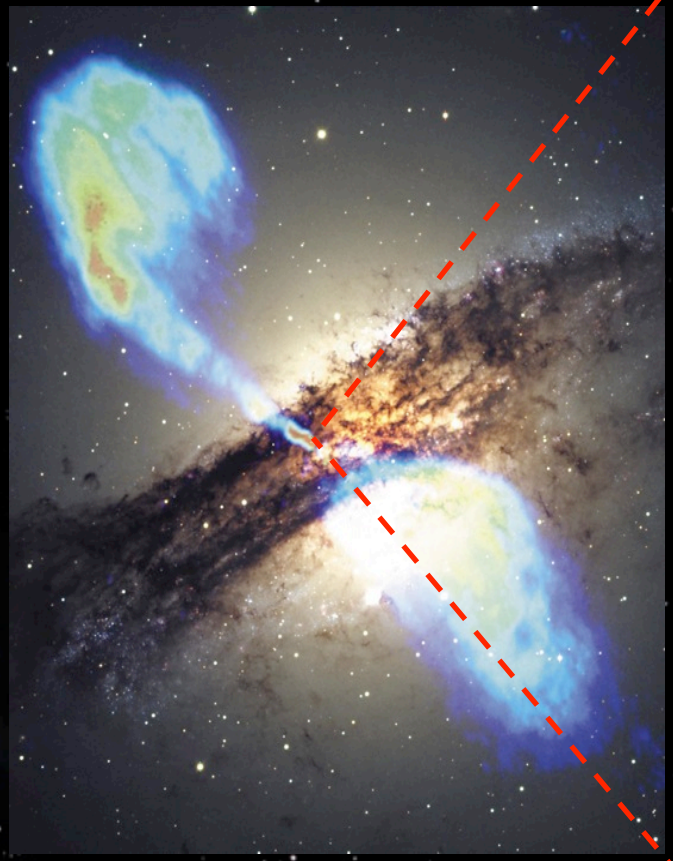
Fe K absorption lines in Centaurus A

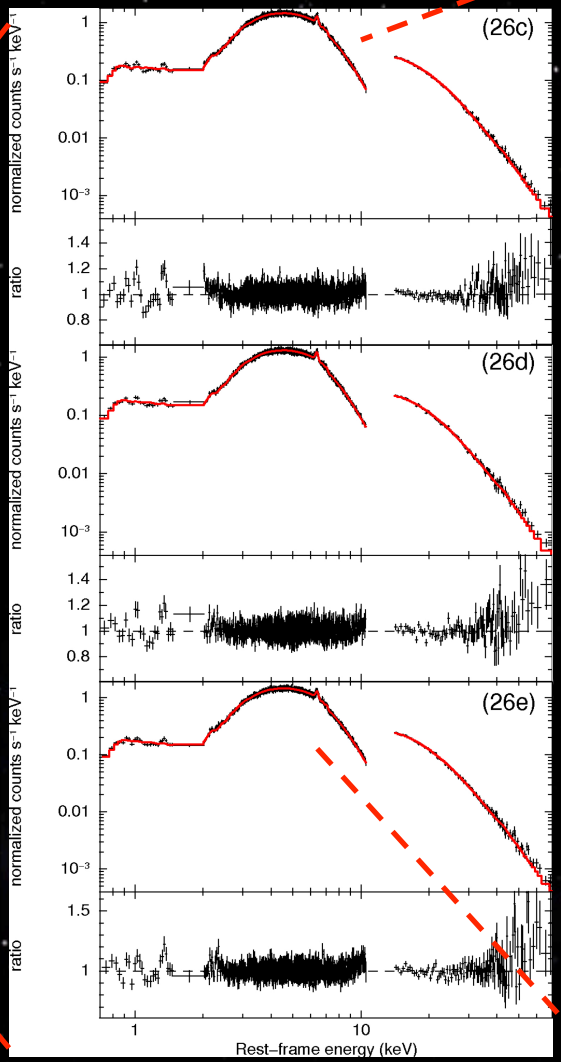
EW~10eV, Fe XXV-XXVI, >5σ

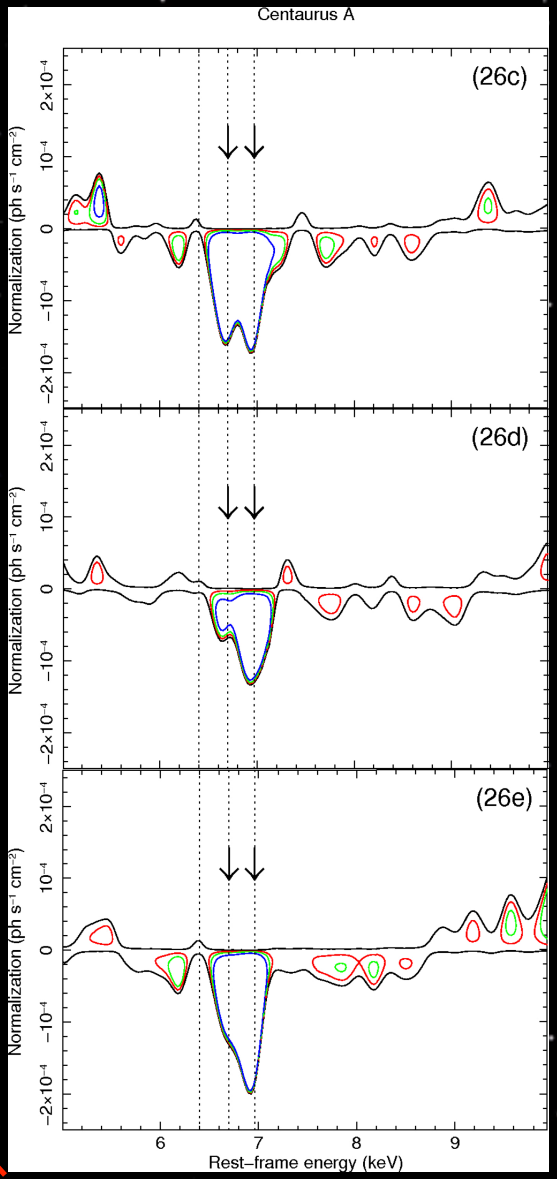
Observed velocity <1500 km/s, projected ~vertical wind?

High jet inclination 50°<i<80°

3 Suzaku obs in 2009







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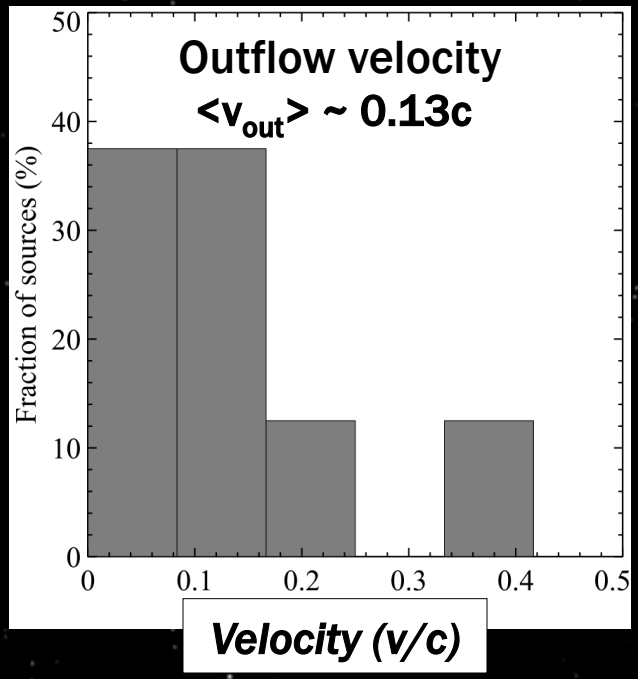
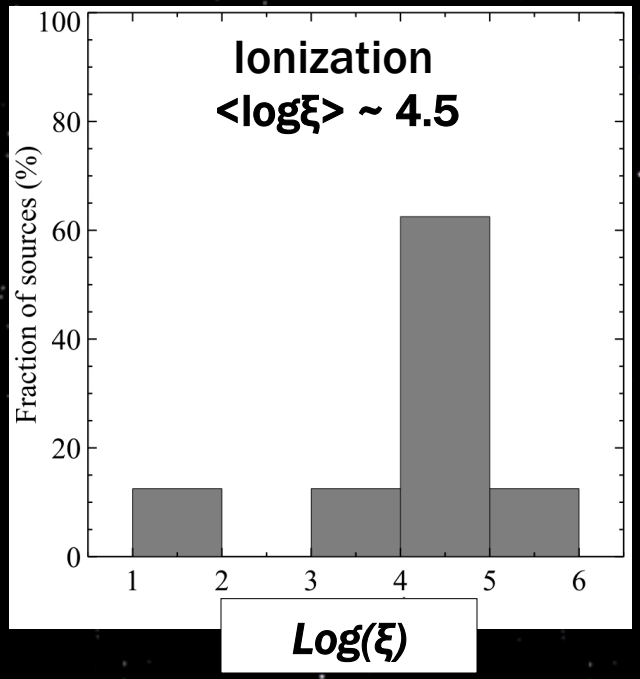
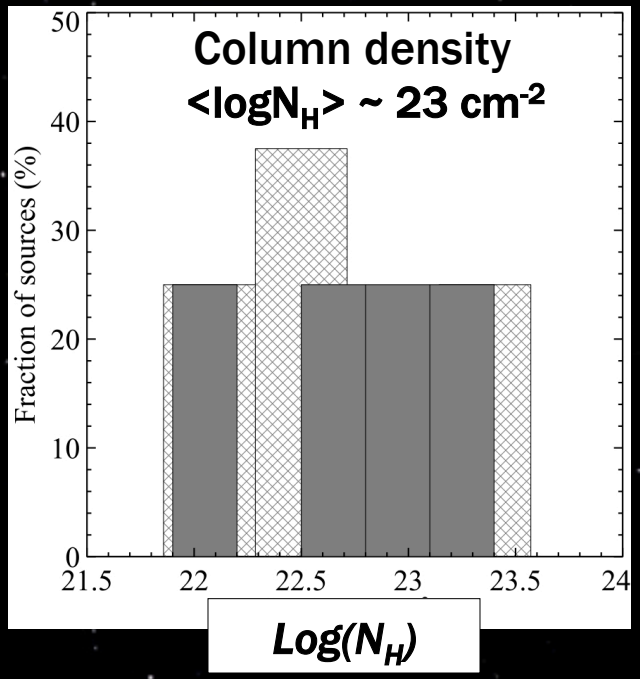
Fe K absorbers in radio-loud AGNs







- **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?**

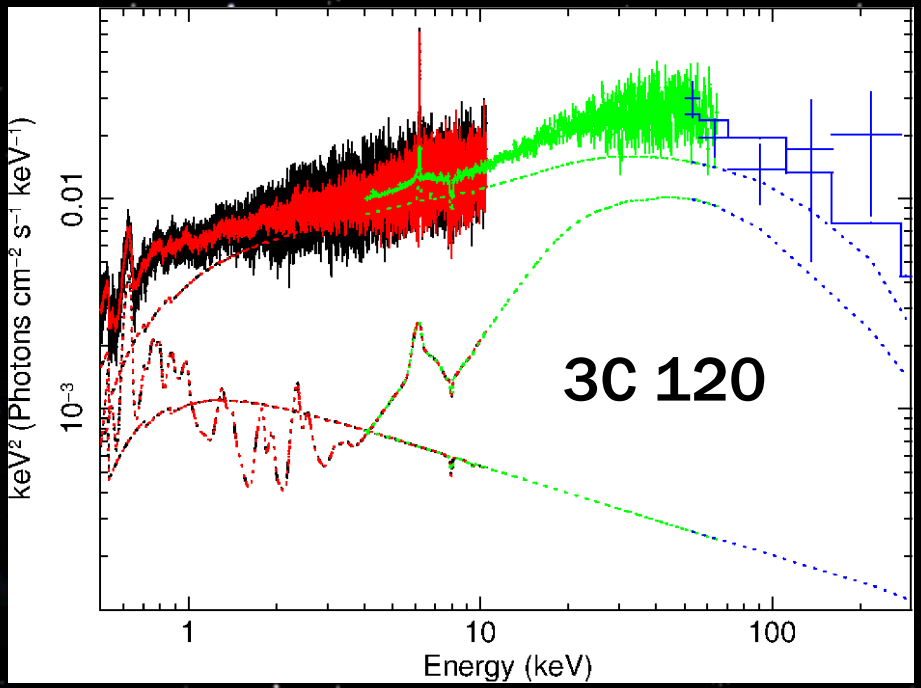
(Tombesi et al. 2014)

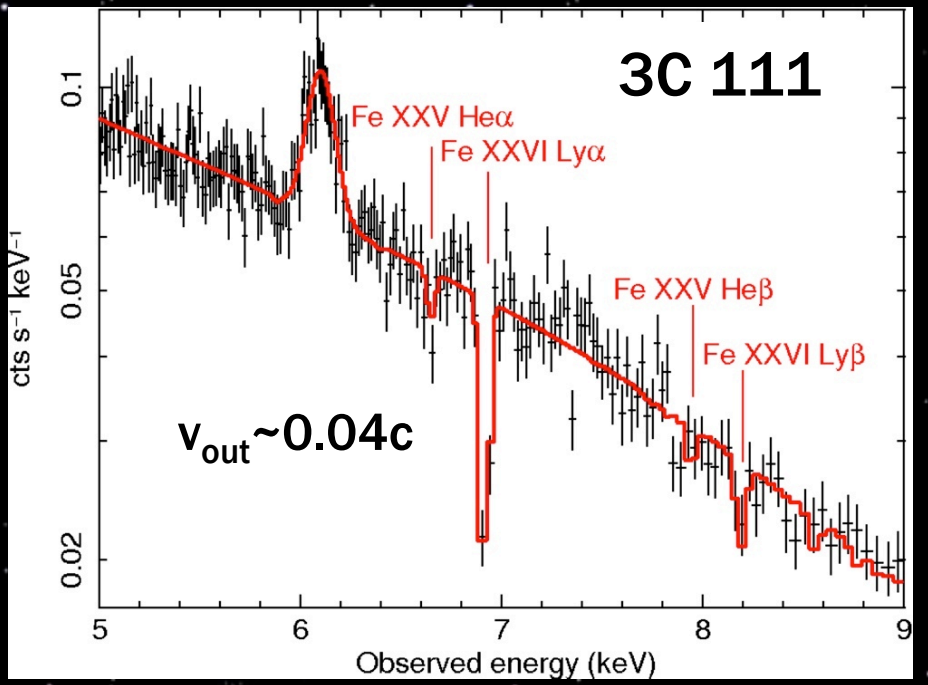
Work in progress: 500ks Chandra winds in 3 BLRGs!


X-RAY OBSERVATORY
ASTRO-H

ASTRO-H observations of radio-loud AGNs

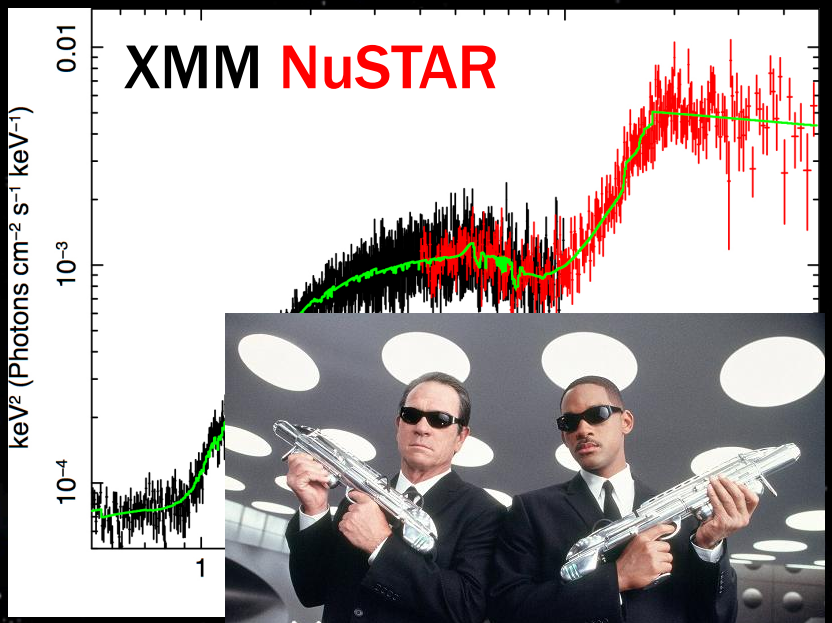
- SXS micro-calorimeter unprecedented energy resolution (6eV) and sensitivity
- Simultaneous broad-band coverage 0.5-200 keV (SXS+SXI+HXI+SGD)

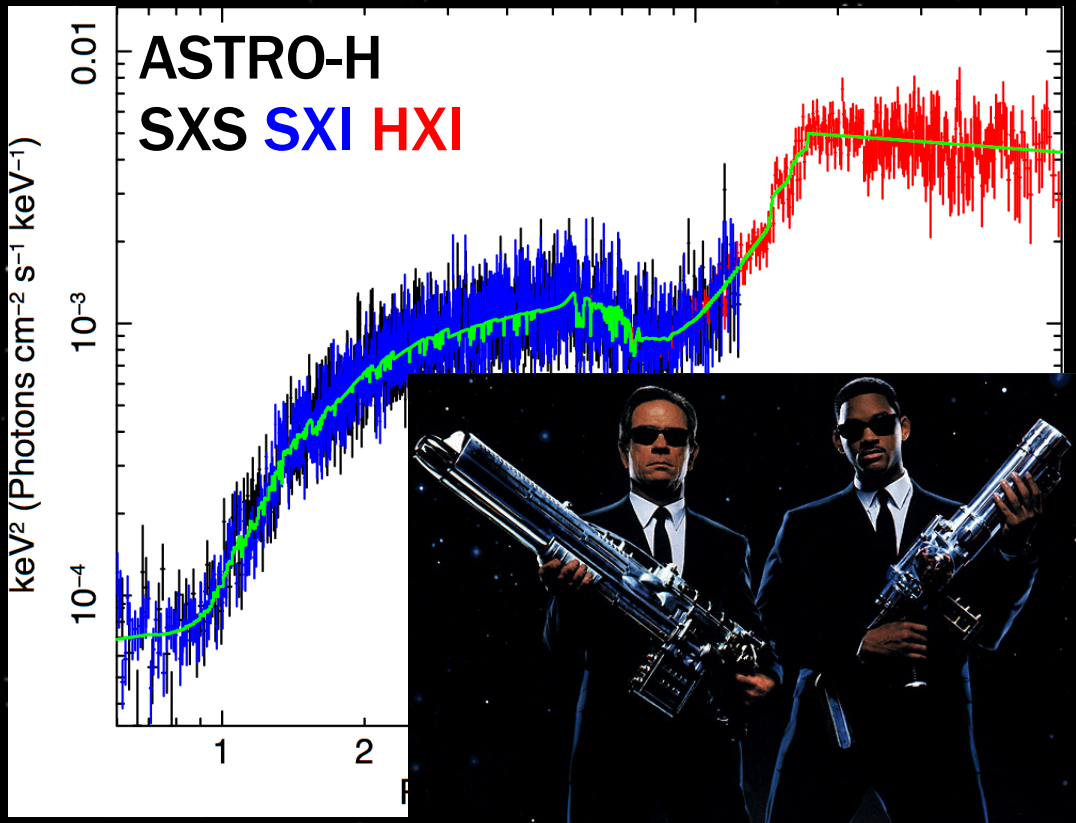




Partial covering Compton-thick AGN winds

- 100ks, broad-band 0.5-50keV ASTRO-H spectrum
- 2-10 keV flux of ~10^{-12} erg s^{-1} cm^{-2}





Properties	SXS	SXI	HXI	SGD (photo-abs)	SGD (Compton)
Effective area (cm^2)	50/225 (@0.5/6 keV)	214/360 (@0.5/6 keV)	300 (@30 keV)	150 (@30 keV)	20 (@100 keV)
Energy range (keV)	0.3-12.0	0.4-12.0	5-80	10-600	40-600
Angular resolution in HPD (arcmin)	1.3	1.3	1.7	N/A	N/A
Field of view ($arcmin^2$)	3.05x3.05	38x38	9x9	33x33 (<150 keV) 600x600 (>150 keV)	33x33 (<150 keV) 600x600 (>150 keV)
Energy resolution in FWHM (eV)	5	150 (@6 keV)	< 2000 (@60 keV)	2000 (@40 keV)	4000 (@40 keV)
Timing resolution (s)	$8x10^{-5}$	4	several x 10^{-5}	several x 10^{-5}	several x 10^{-5}
Instrumental background (/s/keV/FoV)	$2x10^{-3}/0.7x10^{-3}$ (@0.5/6 keV)	0.1/0.1 (@0.5/6 keV)	$6x10^{-3}/2x10^{-4}$ (@10/50 keV)[1] $2x10^{-3}/4x10^{-5}$ (@10/50 keV)[2]		$1x10^{-4}/1x10^{-5}$ (@100/600 keV)

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!