CHEESES: Constraining the High Energy Emission Sources in the Environment of Supermassive black holes

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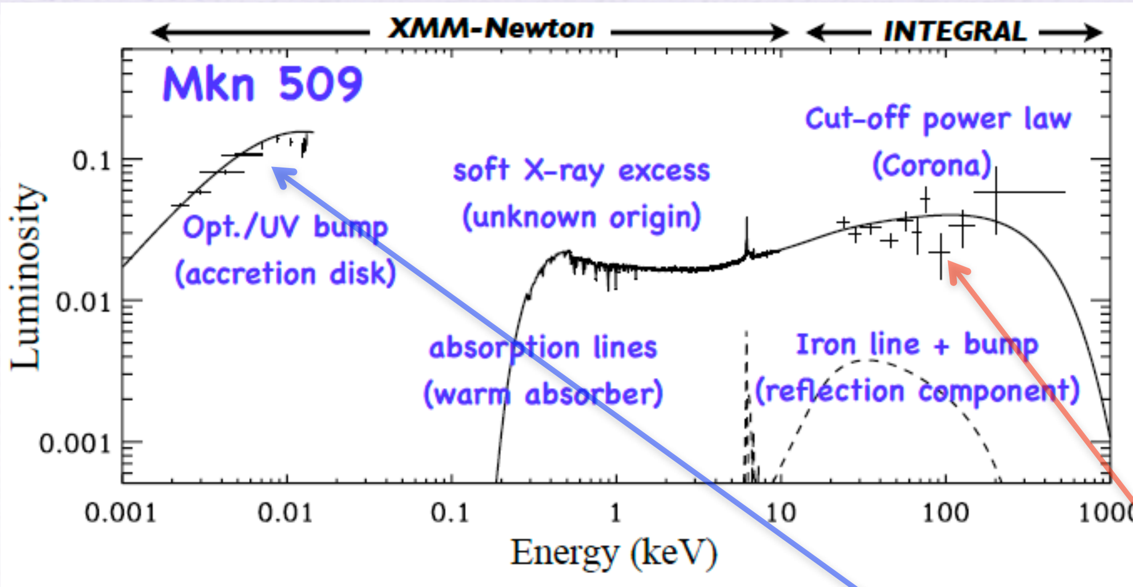
Outline

- The high energy emission of AGNs
- The Cheeses project
- The multiple XMM-OM EPIC observations of unabsorbed AGNs
  - Sample selection and properties
  - Physical modelling of simultaneous SED

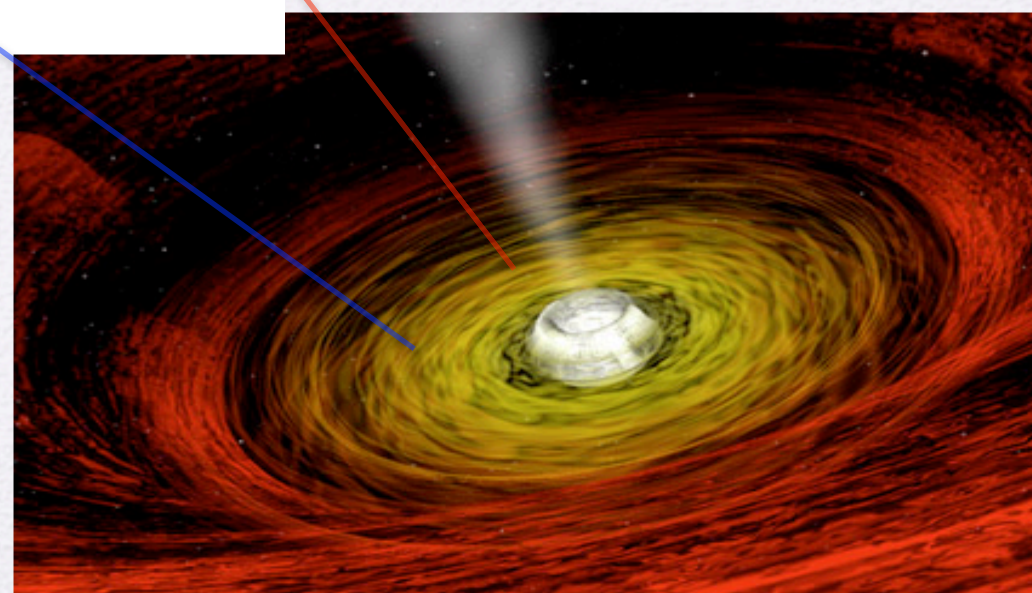
- work in progress & future

AGN emission model

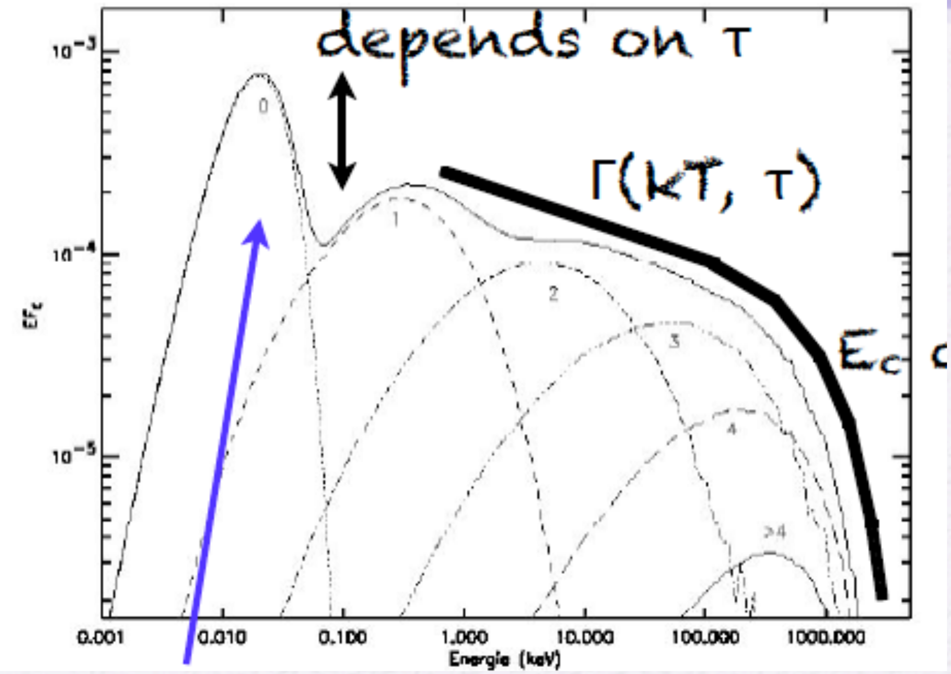


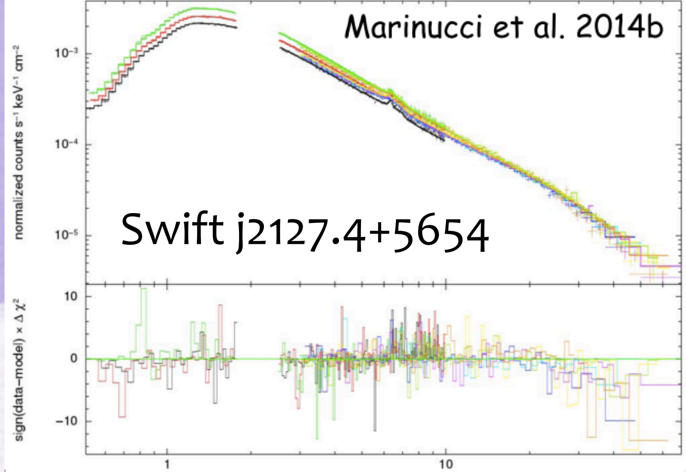
Petrucci+12

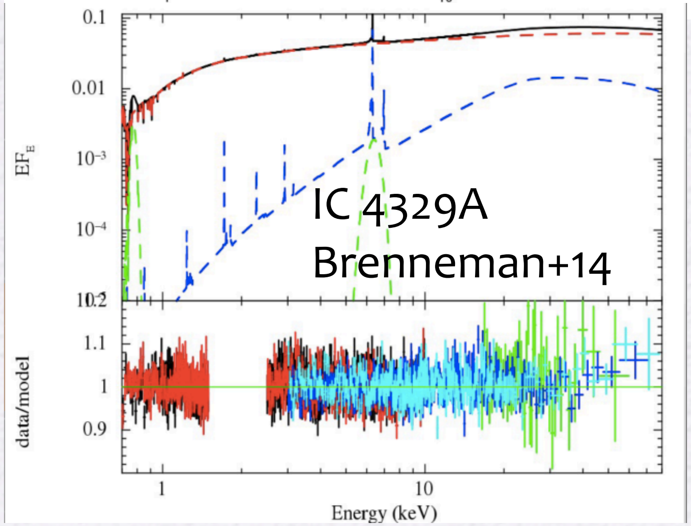
- Radio-quiet AGNs emit the bulk of their luminosity in the UV and X-ray bands
- optically thick cold plasma and hot and optically thin plasma
- Cold and hot phases are expected to be radiatively linked one with each other

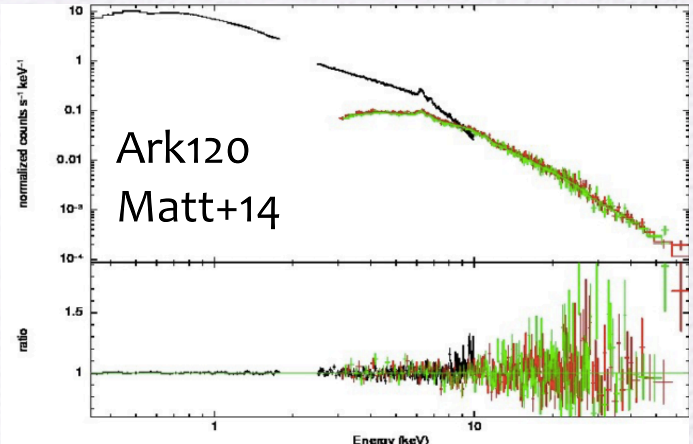


Comptonisation spectrum









Comptonised spectrum well approximated by a cut-off power-law

$EF(E) = E^{-\Gamma(\tau,\, kT)} \exp(-Ec(KT)/E)$

The Cheeses project

The french-italian PICS project (INAF/CNRS): a systematic and detailed spectral analysis of the best quality data of a large sample of AGN by using the most up-to-date high energy radiative models

- use realistic and up-to-to date comptonization models to derive the physical and geometrical parameters (the temperature and optical depth) of the hot corona responsible for the hard X-ray emission in AGN
- constrain the origin of the « secondary » spectral component (especially the soft X-ray excess)

Multiple OM and EPIC simultaneous observations of AGNs

Analysis

- Realistic Comptonization models using Simultaneous XMM-pn & OM multiple observations. **Spectral Variability study.**

The sample

- X-rays: *CAIXA* (Bianchi+2009): all the radio-quiet X-ray unobscured (Nh <2e22 cm^{-2}) AGNs observed by *XMM-Newton* in targeted observations.
- UV: Serendipitous Ultra-violet Source Survey *XMM-SUSS2* (Page+2012) : optical/UV sources detected serendipitously by the OM/XMM-Newton in 6 filters (W2,W1,M2,U,B,V)
- 70 sources (16 NLsy1,30 BLsy1, 24 no Hbeta), 253 obsID with pn and at least one OM filter

Previous studies: Jin+12 (I; II, III): SDSS (DR7) and XMMi (high S/N); Vasudevan: XMM (epic and uvot) of the reverberation sample (Peterson+12); Lusso+10:XMM-COSMOS.

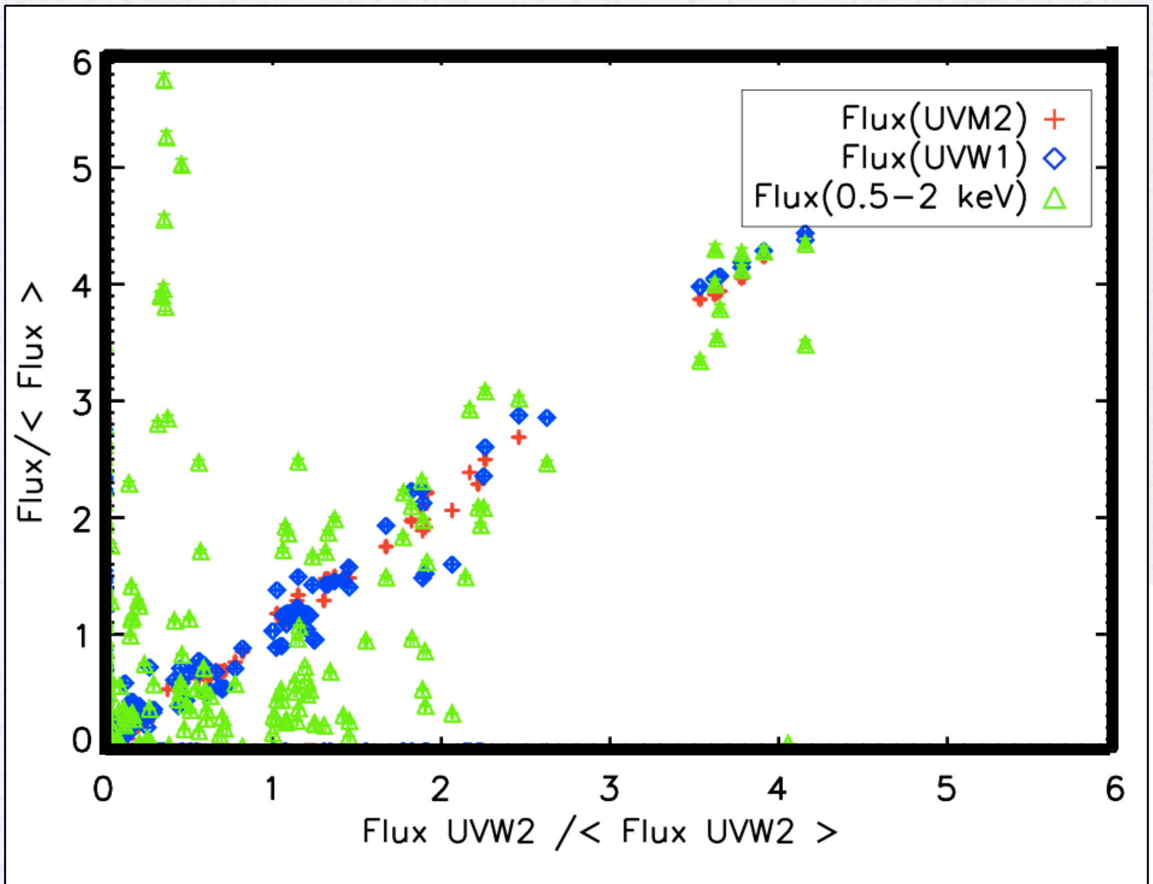
Sample global properties

Flux-flux correlations

Intra-band and inter-band variability

NLSy1 vs BLSy1

UV vs X-ray variability

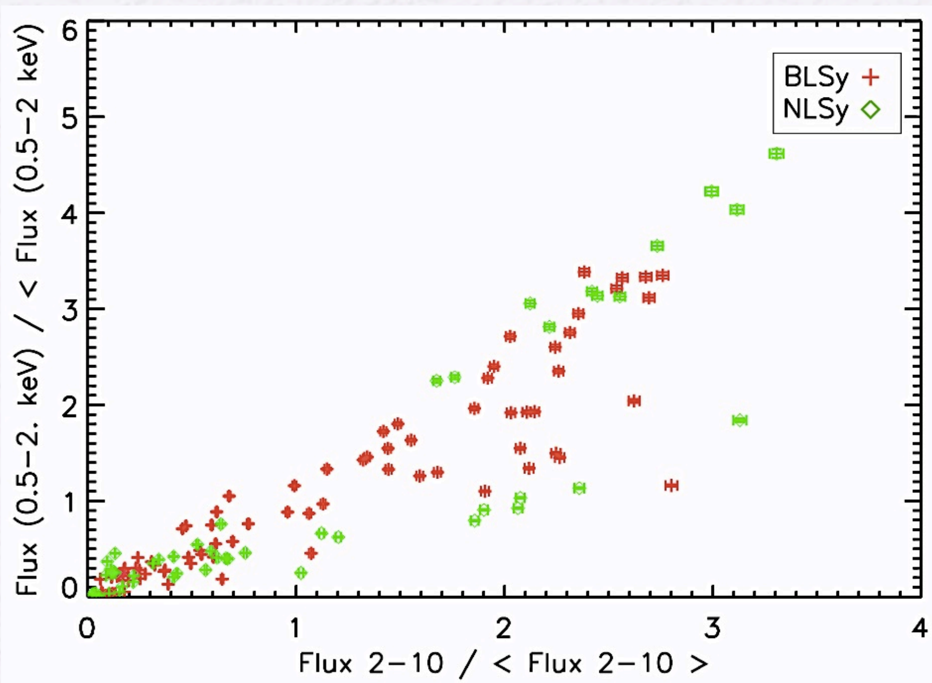


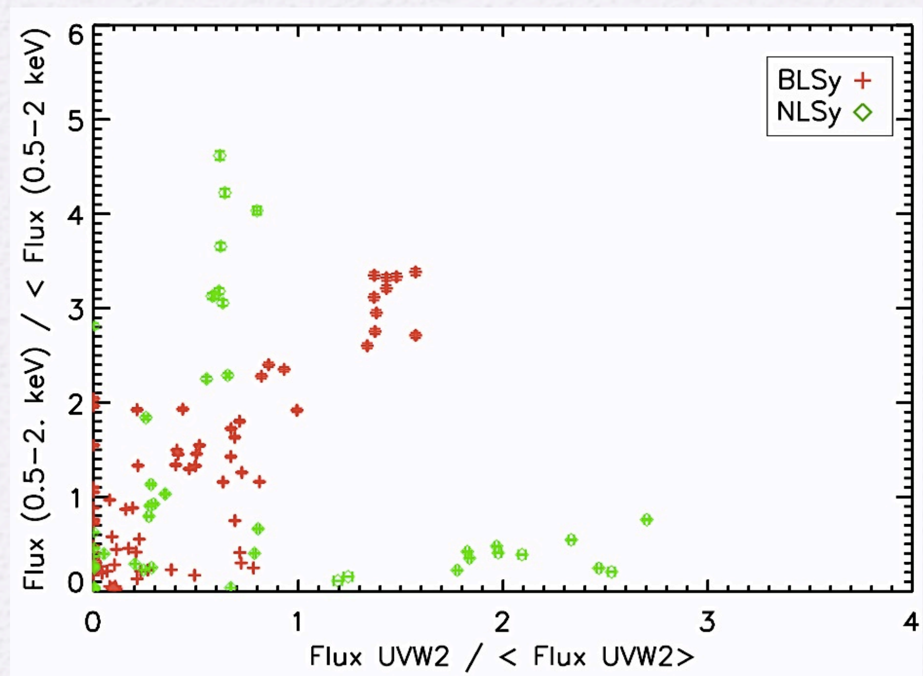
Trend of variability is different between UV and soft-X

FILTER	&lambda$_{max}$ (Â)	Δλ (Â)
UVW2	1,894	1,805-2,454
UVM2	2,205	1,970-2,675
UVW1	2,675	2,410-3,565

Flux-flux variability

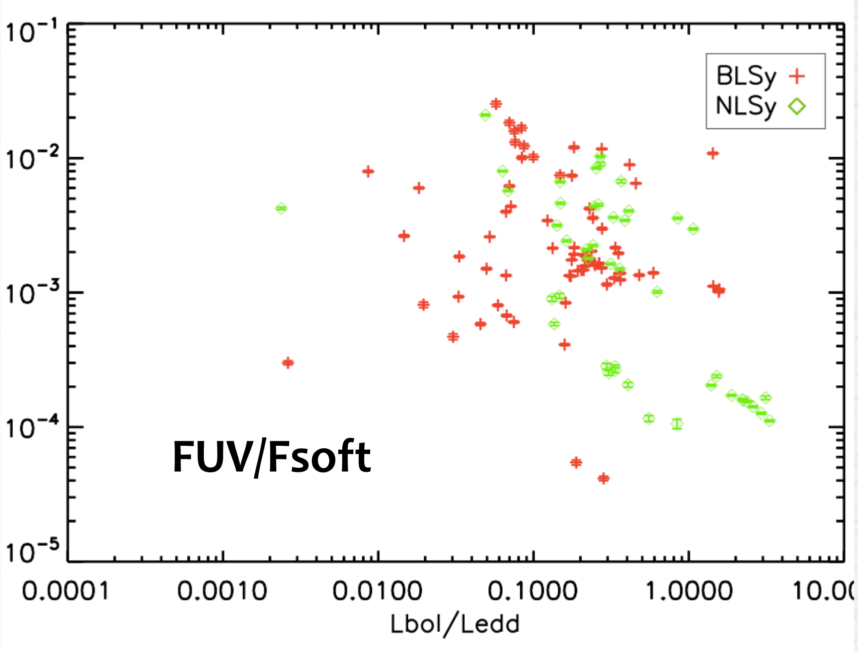
- NLSy1s exhibit larger amplitude of variation with respect to BLSy1

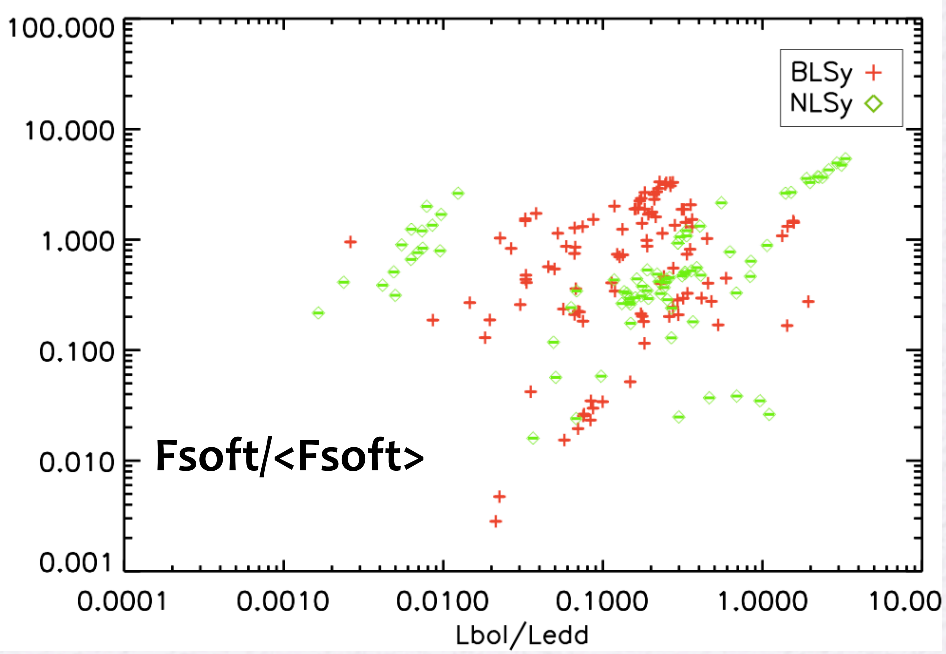




NLSy1: FWHM(Hb)<2000 km/s
BLSy1: FWHM(Hb)>2000 km/s (CAIXA, Bianchi+09)

Inter-band variability

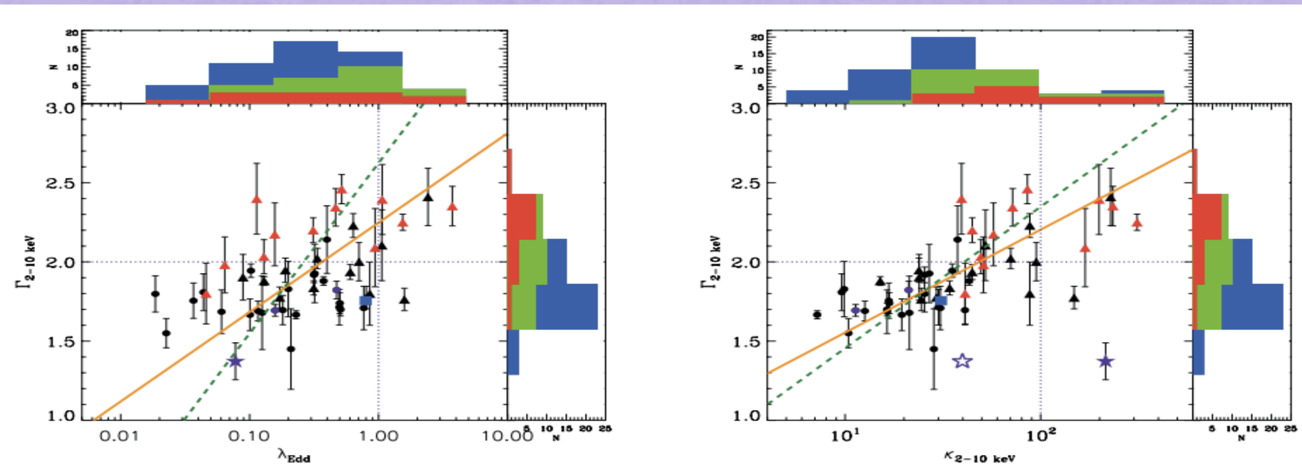




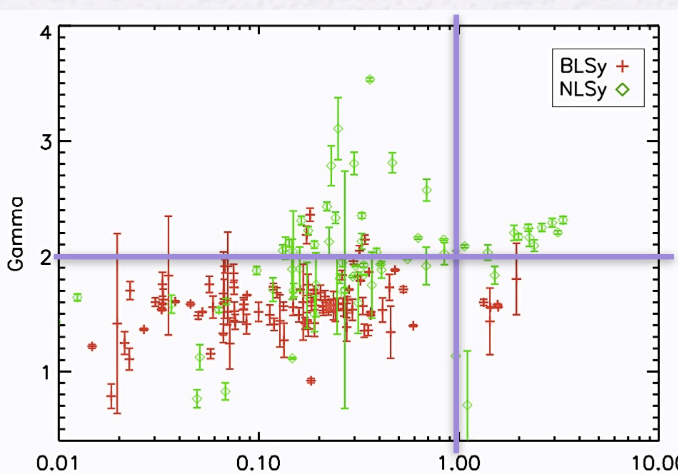
At Higher accretion rates

the soft-X flux increases with respect to the UV

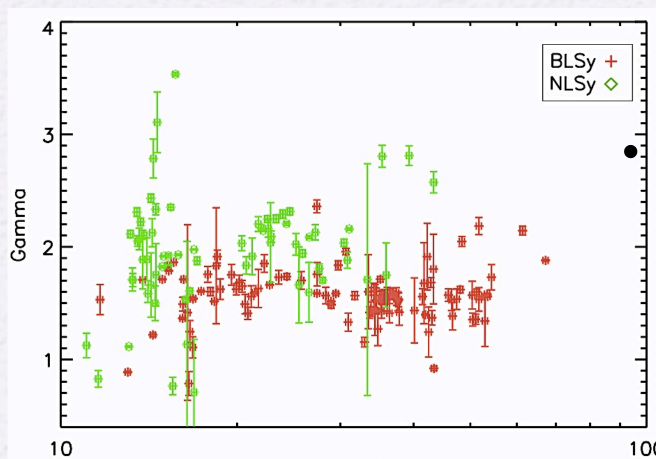
Photon index vd Lbol/Ledd



- increasing the mass accretion rate leads to enhanced emission from the accretion disc
- seed photons from the disc will increase the Compton cooling of the corona
- Softening the Comptonized hard X-ray spectrum, i.e. the slope of Gamma(2–10 keV) increases.



Lbol/Ledd



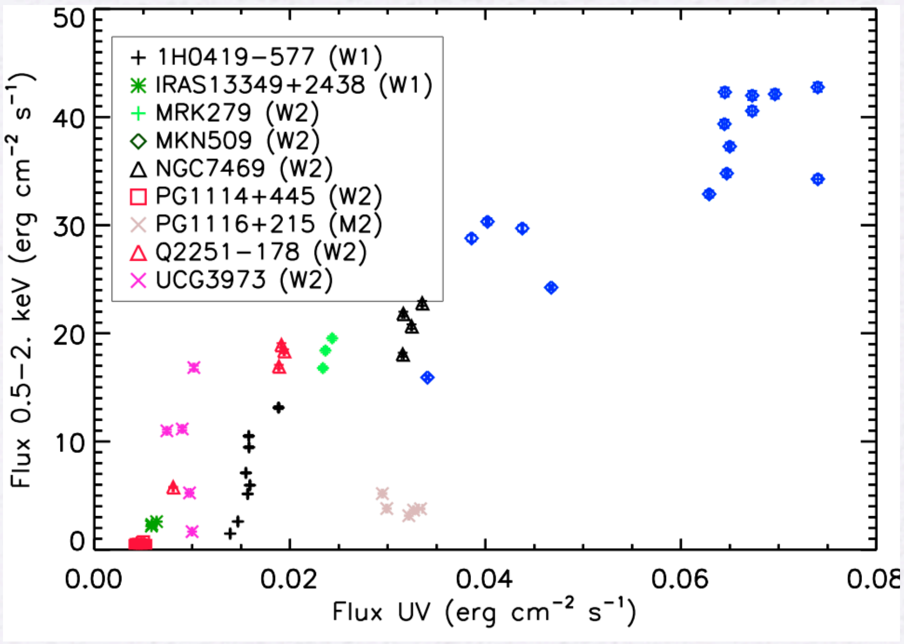
kbol

Single source analysis

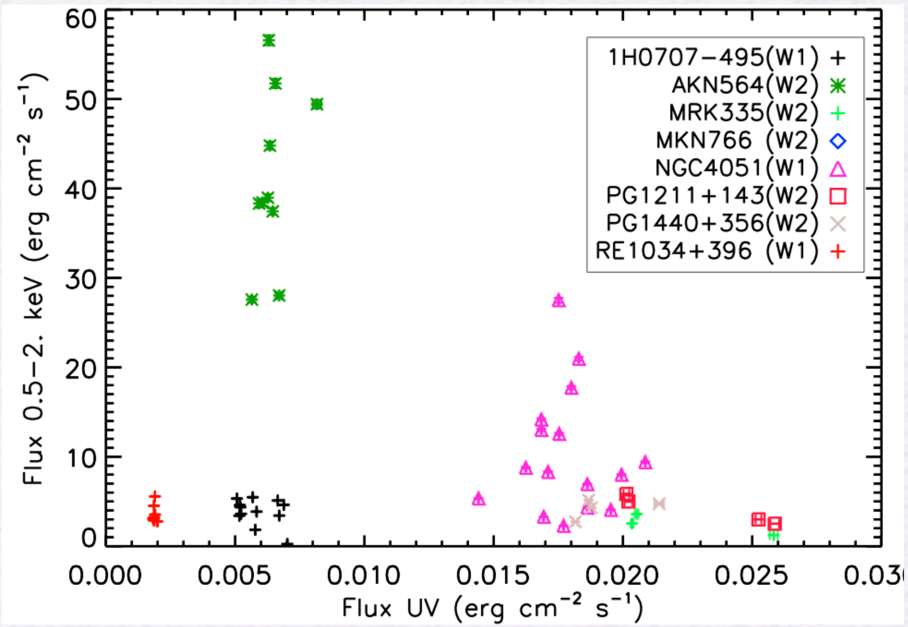
Sources with more than three EPIC and OM simultaneous observations: 11 BLSy1 8 NLSy1

Inter-band flux correlations

BLSy1

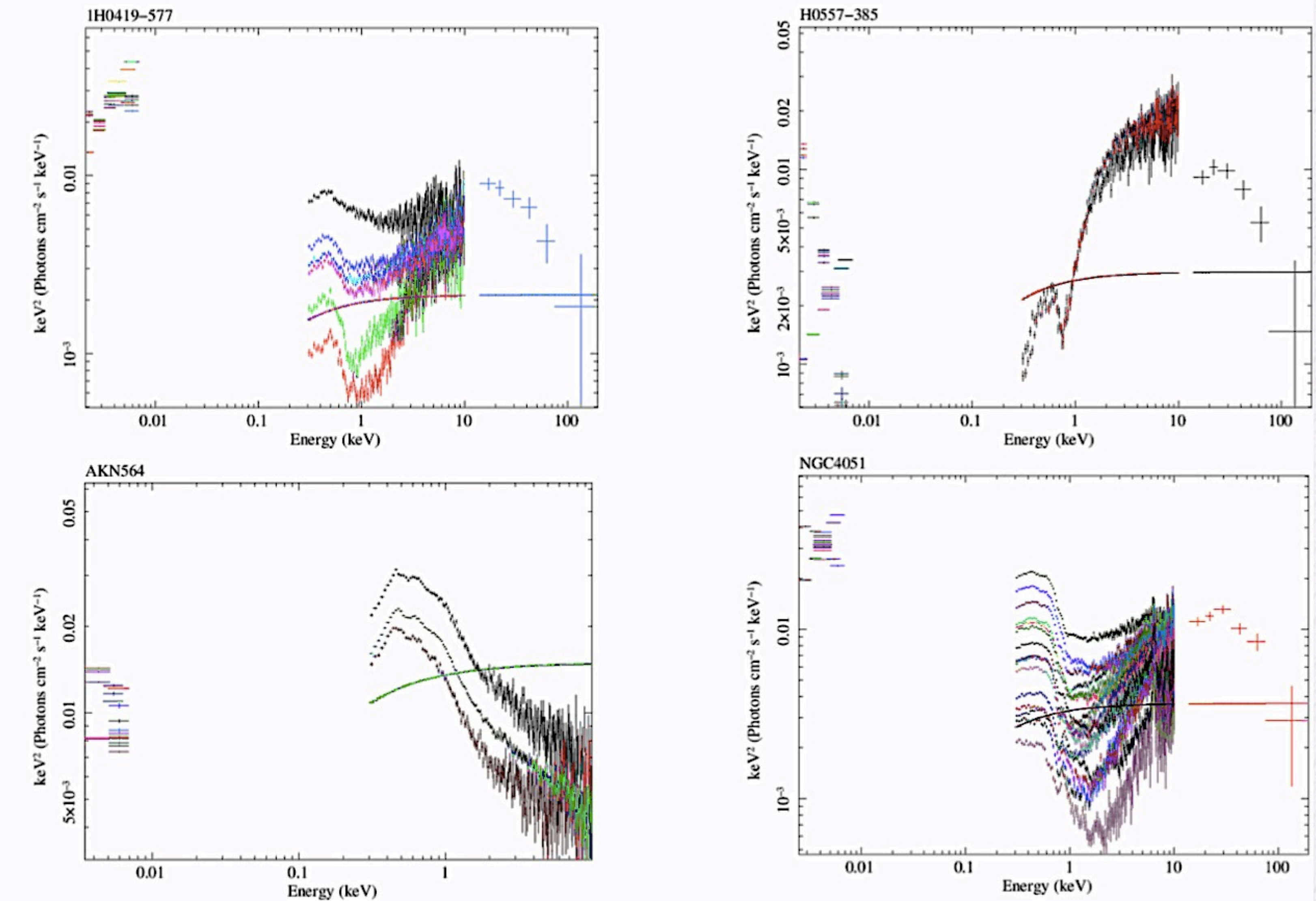


NLSy1

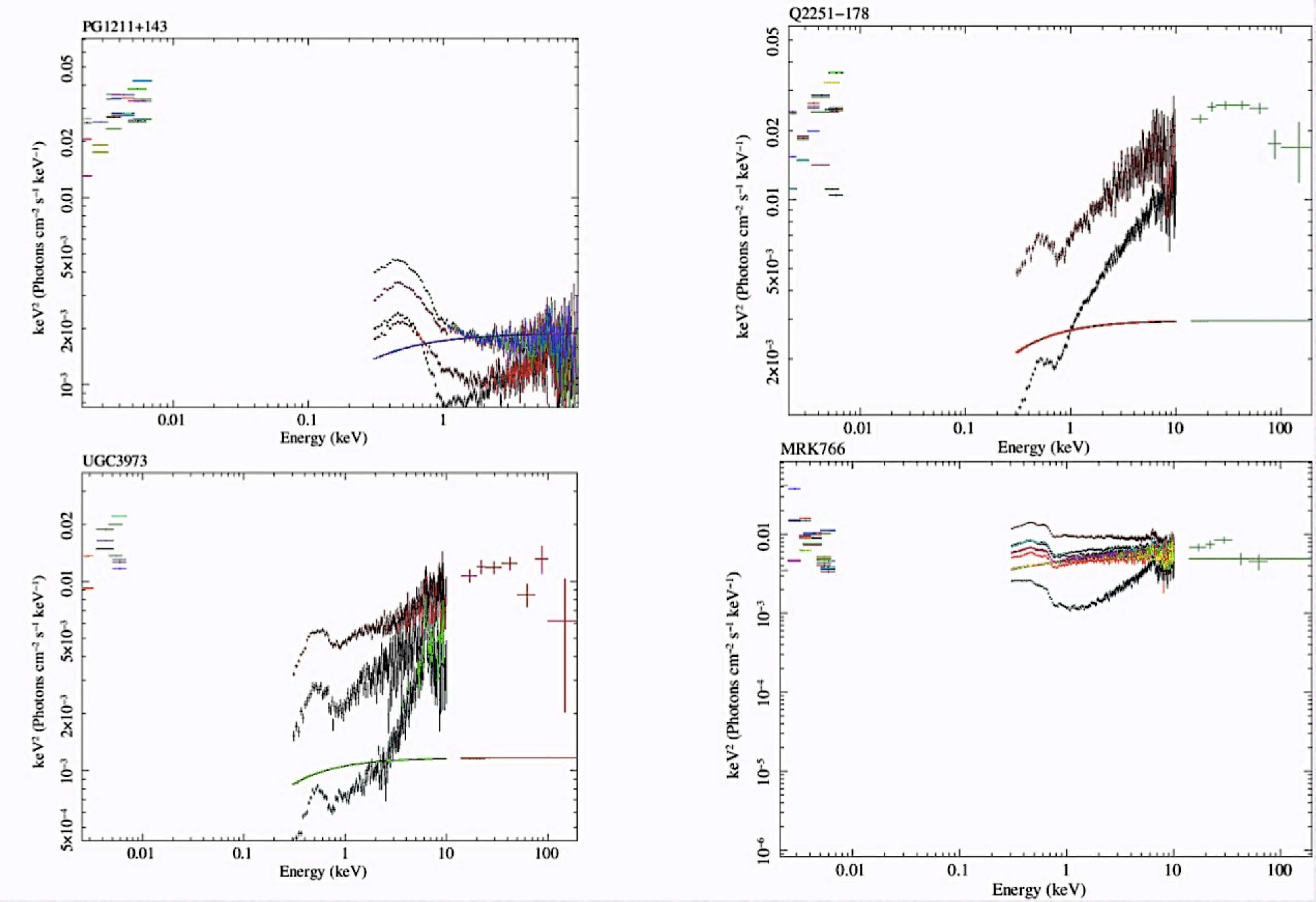


The different variability patter on NLSy1 and BLSy1, may be due to variability, different components in the band, physical??

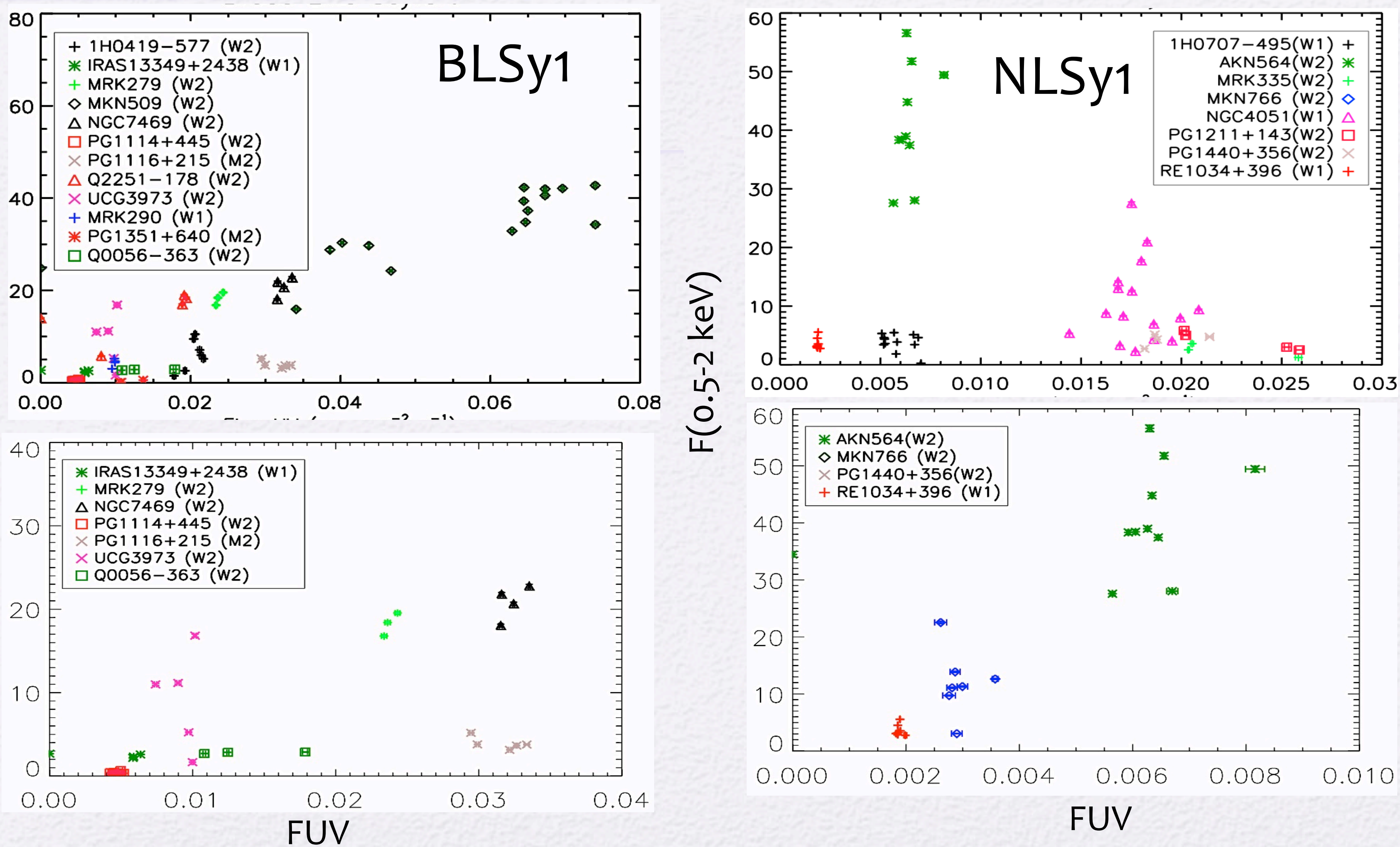
Simultaneous SED variable absorption?



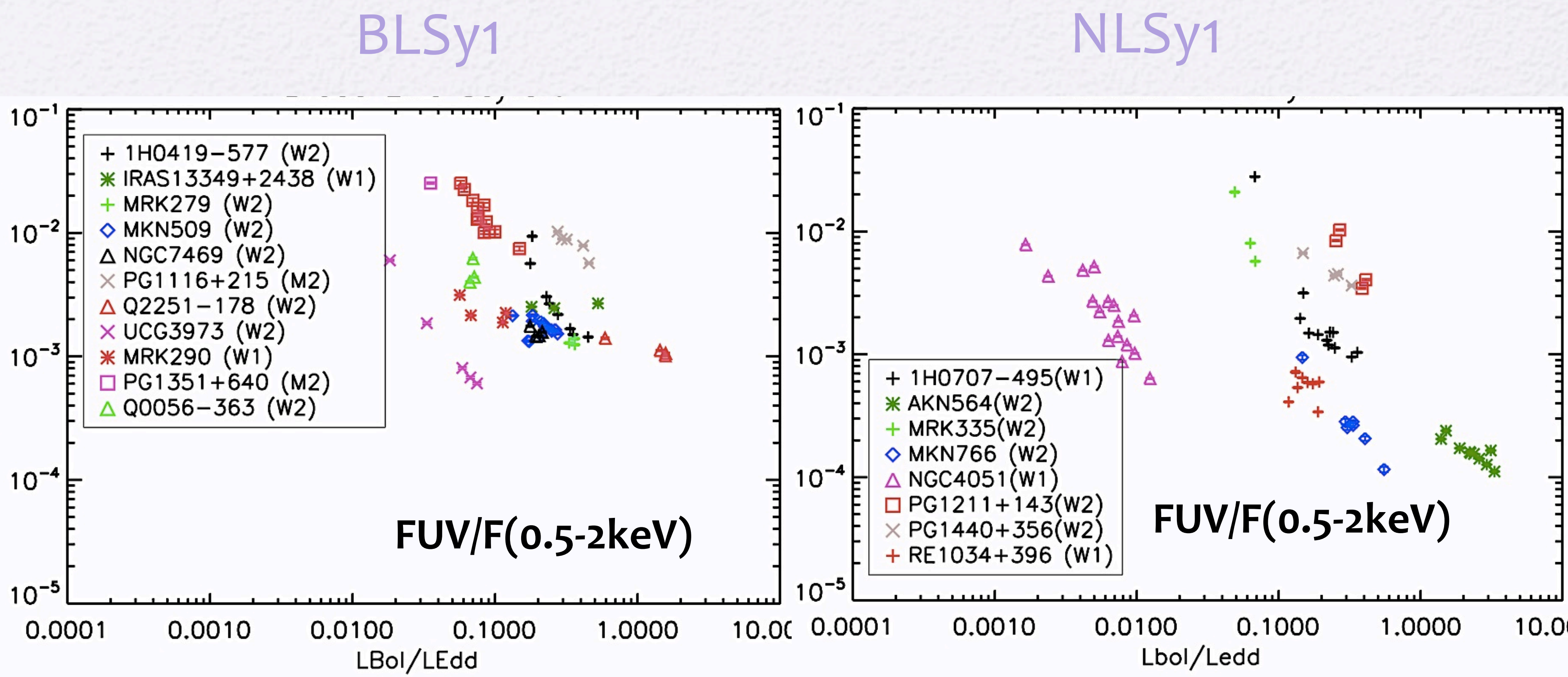
Simultaneous SED variable absorption?



Inter-band flux correlations free for absorption

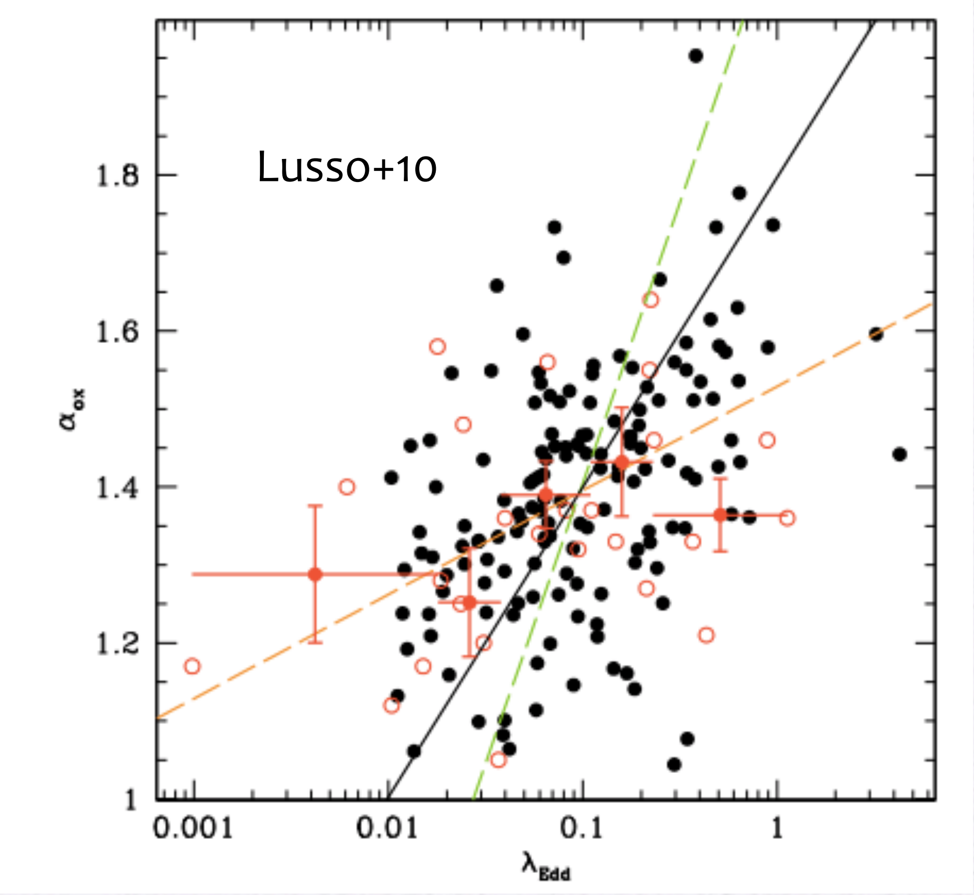


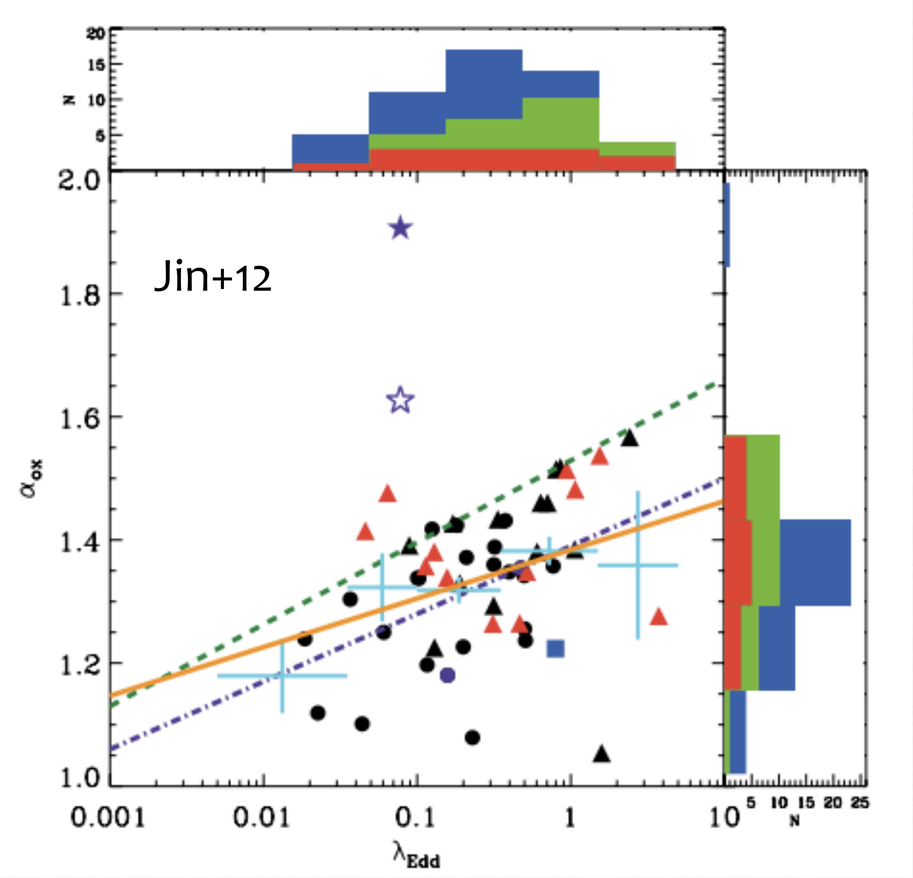
αox vs Lbol/Ledd



At Higher accretion rates
the soft-X flux increases with respect to the UV …?

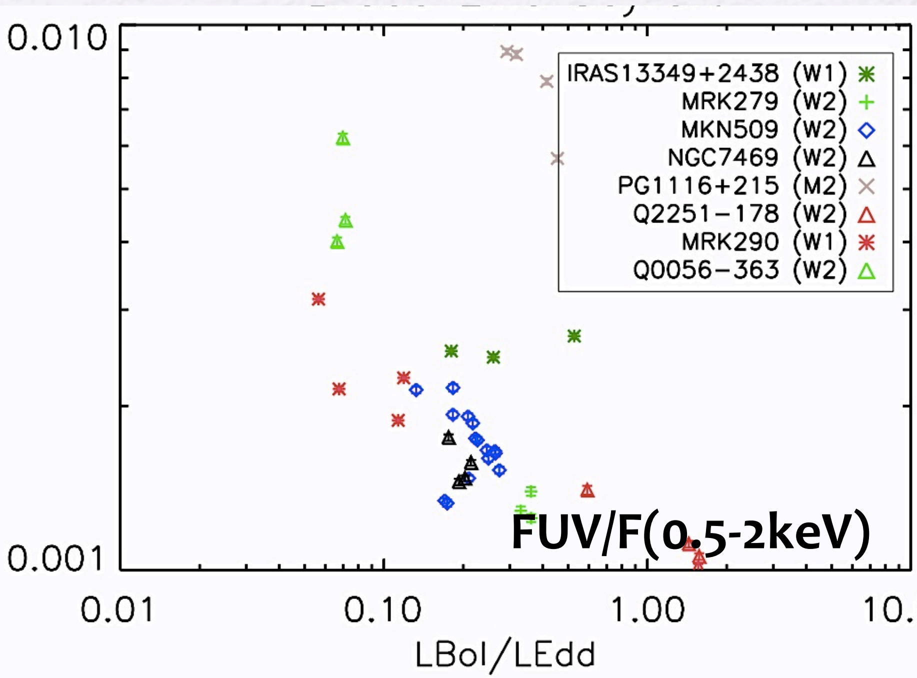
Comparison with larger sample



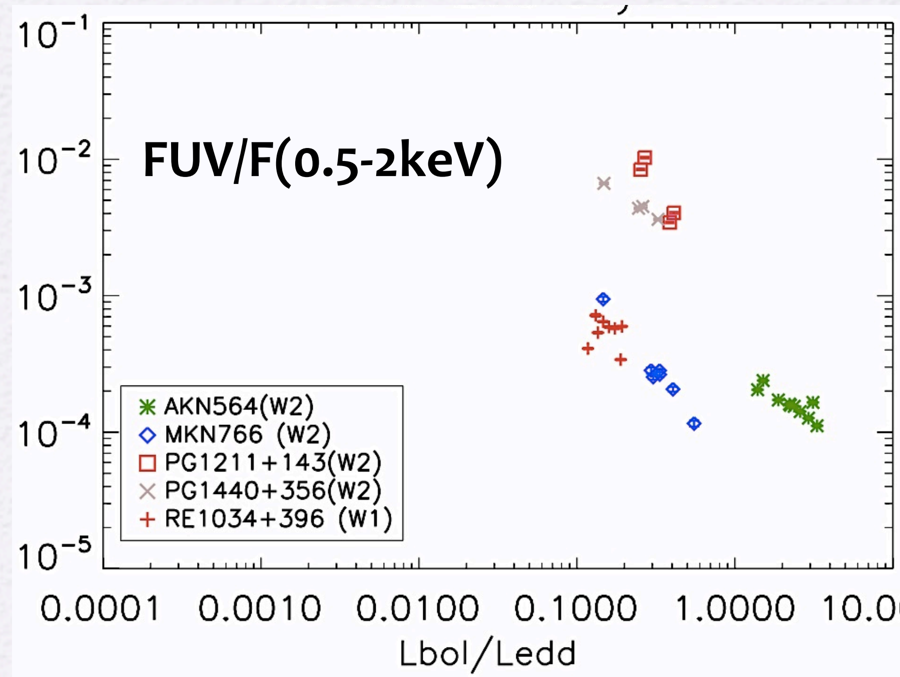


αox vs Lbol/Ledd - src free of absorption

BLSy1



NLSy1



At Higher accretion rates

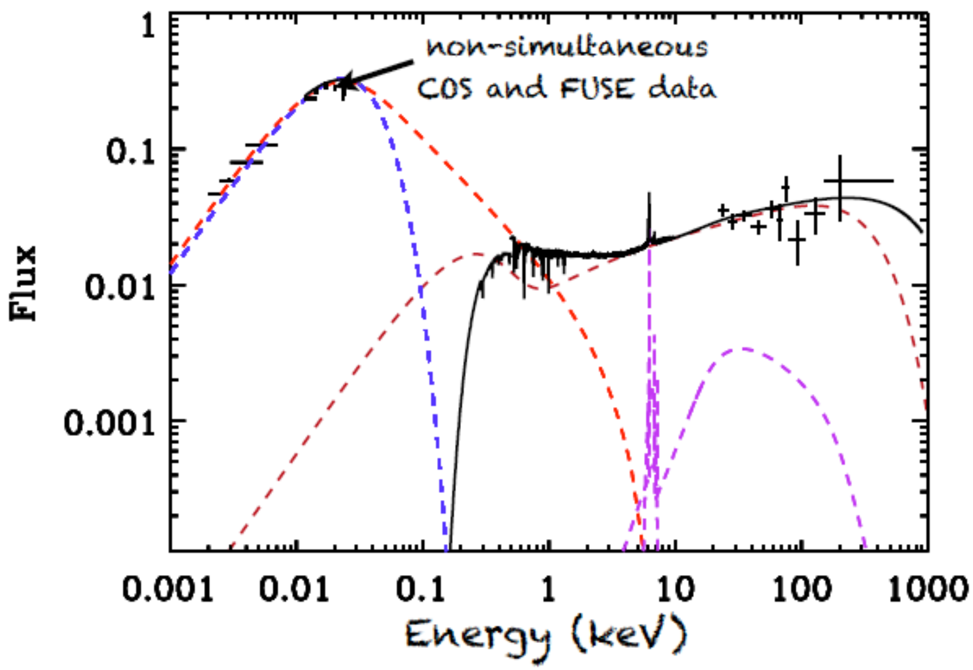
the soft-X flux increases with respect to the UV …?

simultaneous SEDs with EPIC and OM

Building the SED

Modelling with comptonizzation models: a test case

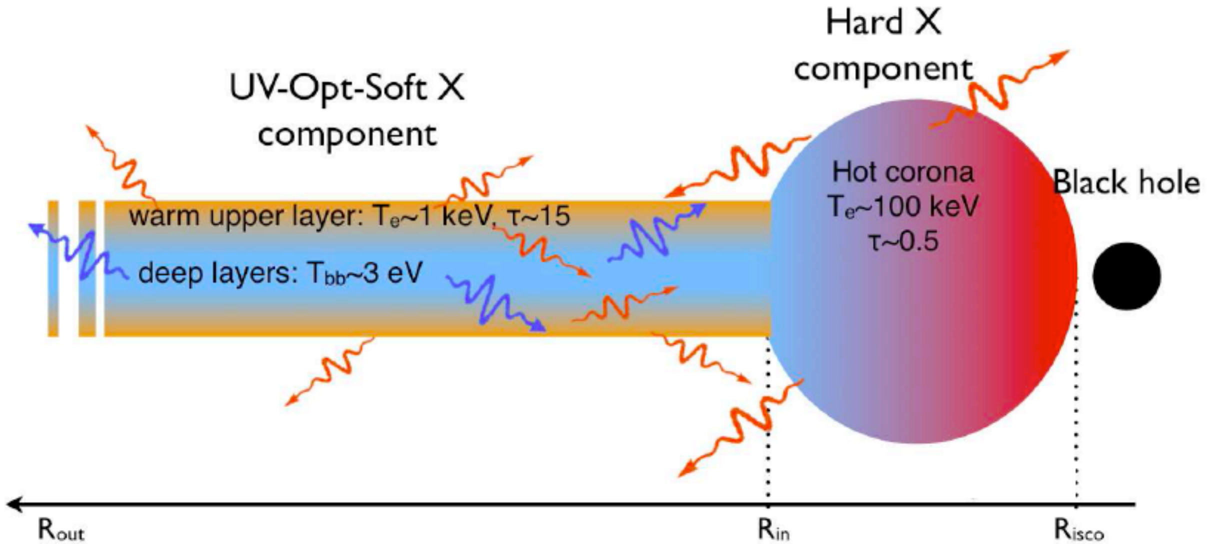
The model



- A multi-black body disc to fit the optical-UV data
- A "warm" corona to fit the soft X-ray emission
- A "hot" corona to fit the hard X-rays
- Reflection components to fit the iron line profile
- A warm absorber from the outflow analysis

Mkn 509, Petrucci+12
MW campaign with
COS/HST
XMM
Swift
INTEGRAL

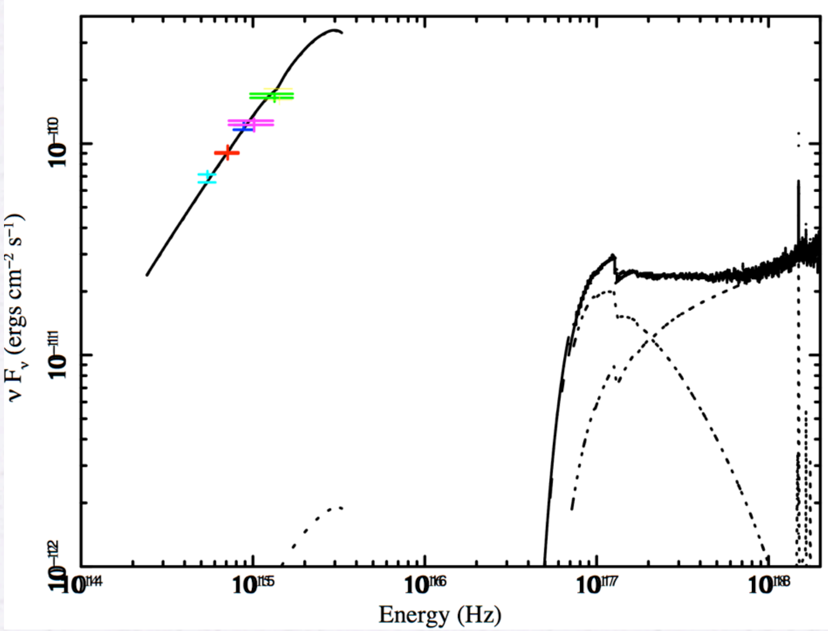
A schematics picture



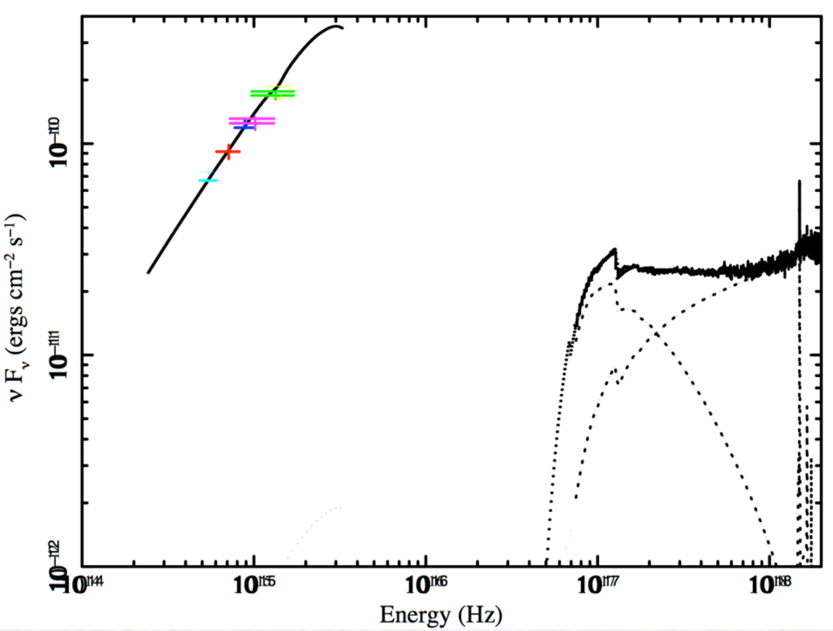
- Warm corona: upper layer of the accretion disc?
  - ➡ soft photon (3 eV) from the deeper layers?
  - ➡ accretion power mainly released in the warm corona
- Hot corona: inner part of the accretion flow?
  - ➡ contributes to the formation of the warm corona through X-ray irradiation
  - ➡ soft photon (100 eV) from the warm corona?

SED modelling

Mkn509 obs1



Mkn 509 obs2



Warm corona: optically deep, kT=.0.5 keV, Tsoftph~eV

Hot corona: kT~200 keV, Tsoft~150 eV

(very) Preliminary results

- Soft X-rays have different trend of variability with respect to UV(W2)
- In the soft X-ray and UV band the NLSy1s exhibit larger amplitude of variation with respect to BLSy1
- NLSy1 tend to have higher L/Ledd and higher alpha_ox wrt BLSy1
- The different variability patter on NLSy1 and BLSy1, in the soft X-rays may be due to, different components in the band, physical??

Work in progress

- SED modelling for all the observations of the sample
- Timescale variability. Further constraint for sample selection
- Hard-X rays. MW campaigns are ongoing and proposed (XMM+NuStar & Swift+NuStar) for the brightest AGNs above 10 keV