Supersoft AGNs and their relations to Galactic Binaries

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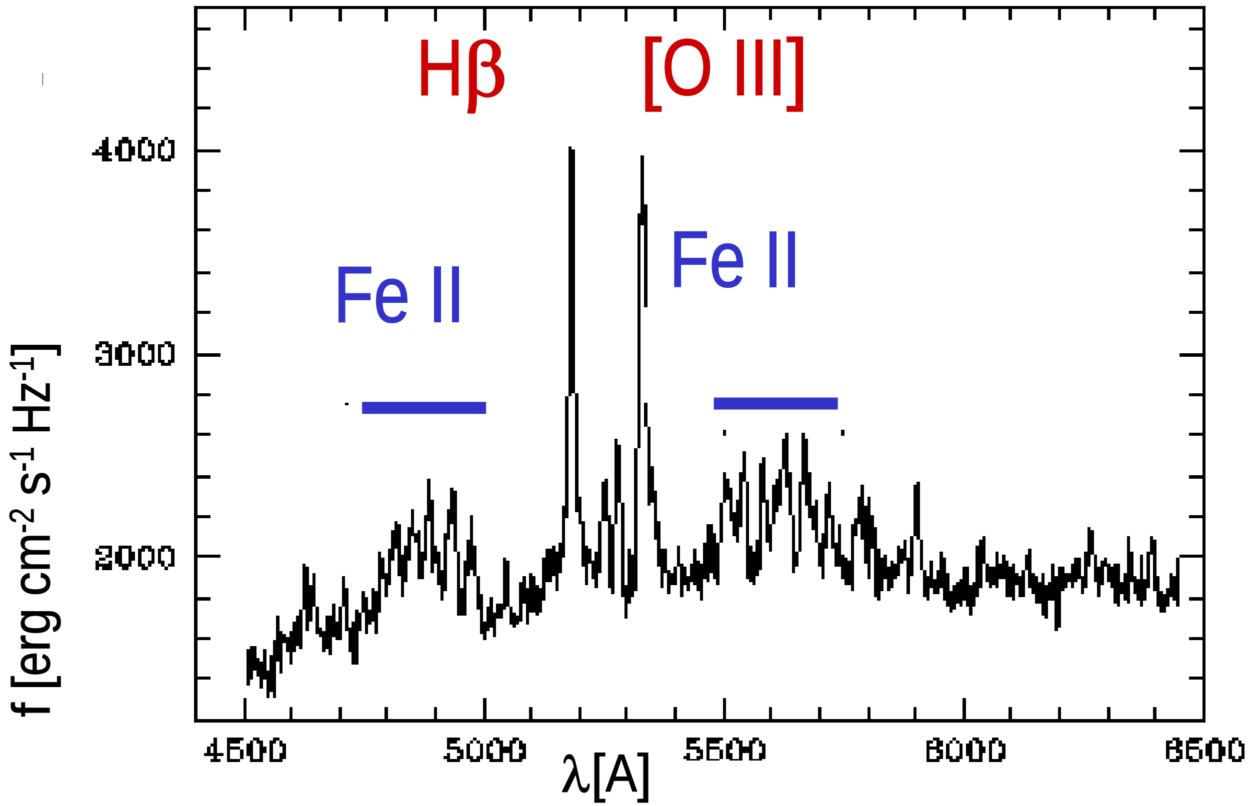
Narrow-line Seyfert 1 galaxies as type 1 AGN and as Super Soft extragalactic sources



FWHM Hβ < 2000 km s^{-1}

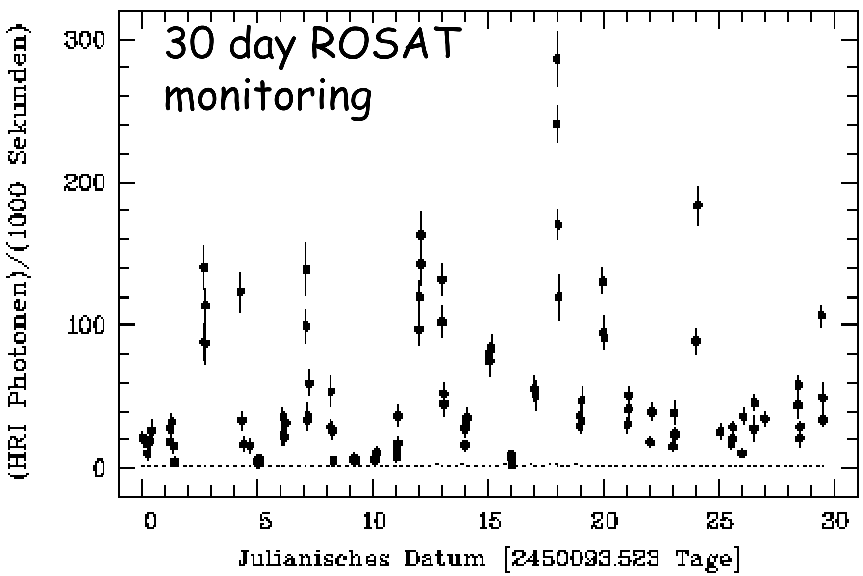
Fe II emission (n_e>10^9 cm^{-3})

Seyfert 1 nature

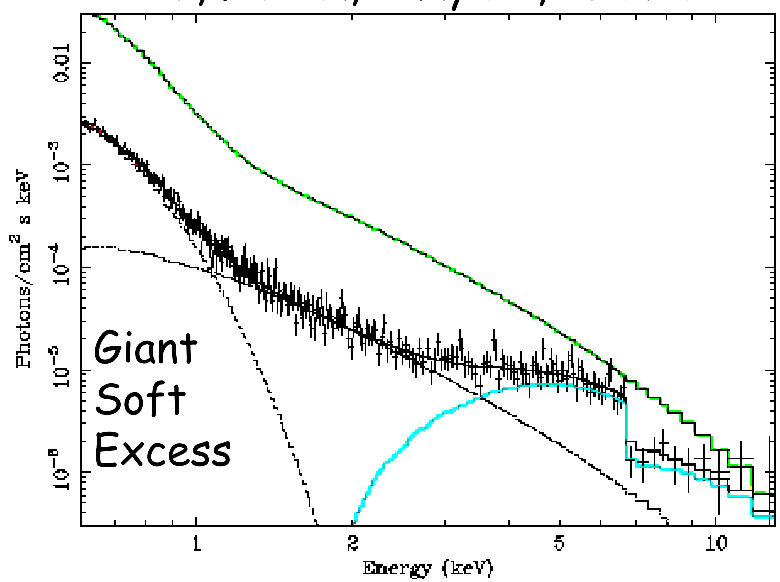
Type 1 nature further supported by X-ray observations

1. Intrinsic absorption consistent with Galactic values
2. Strong and rapid X-ray variability
3. Strongest MCD emission so far seen in AGN

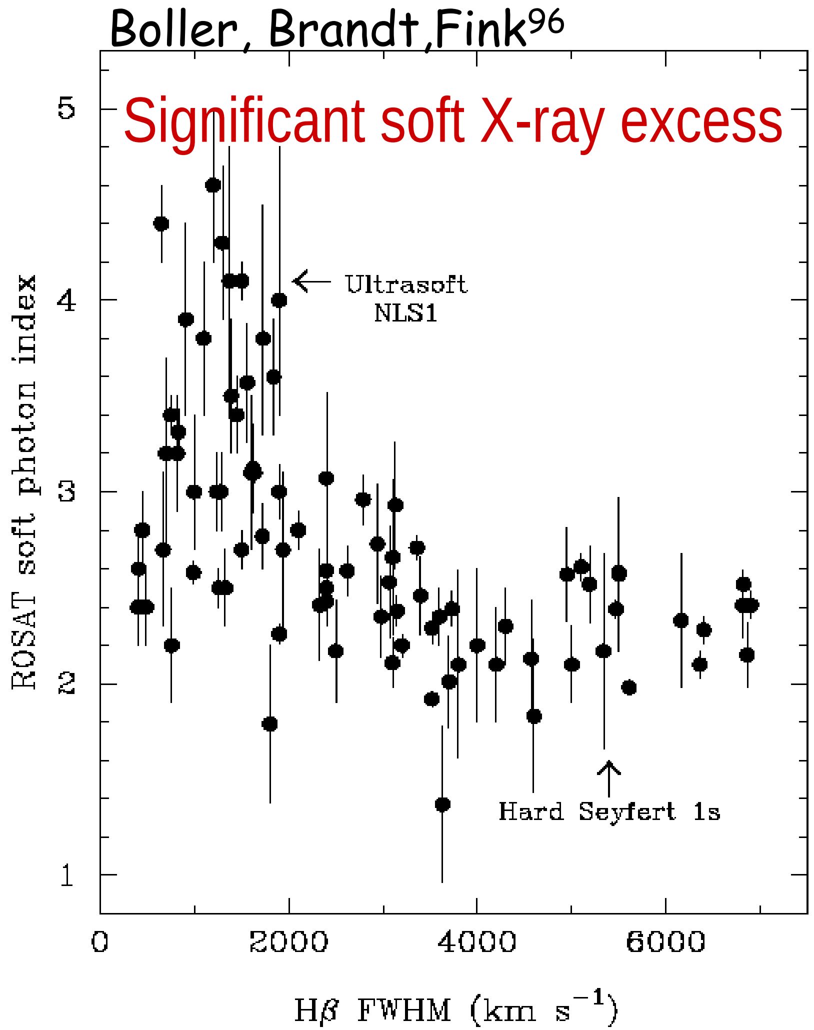
Boller, Brandt, Fink[96]

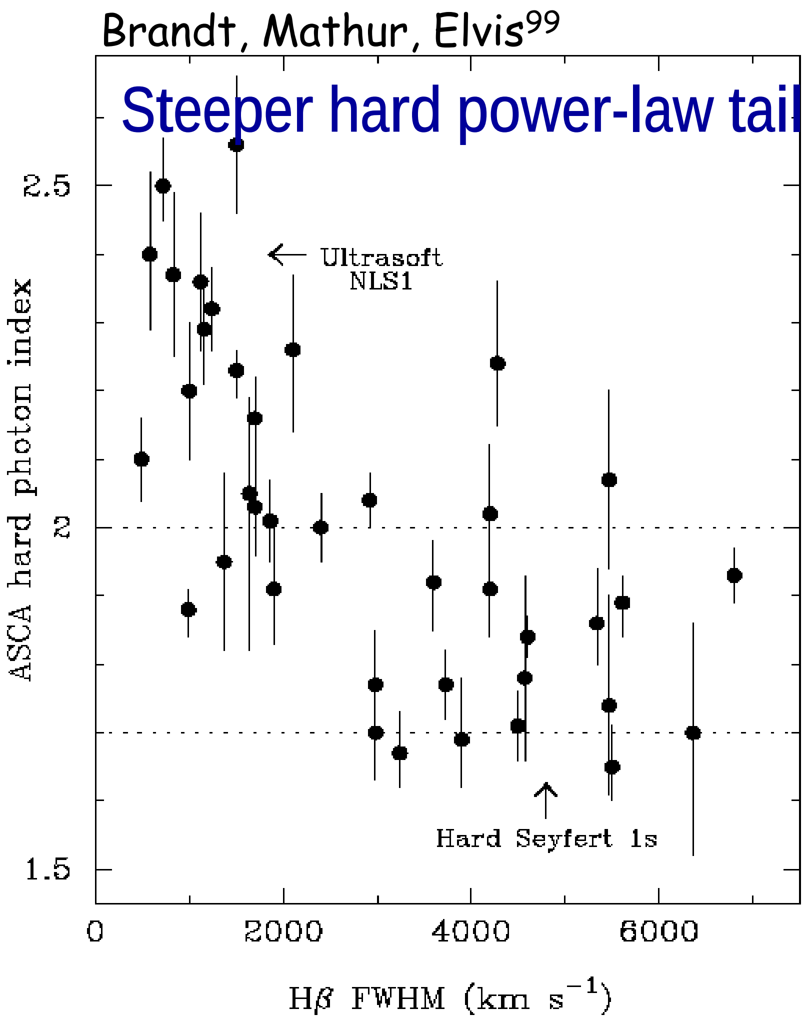


Boller, Fabian, Sunyaev, Brandt[02,03]



NLS1s as Super Soft AGN



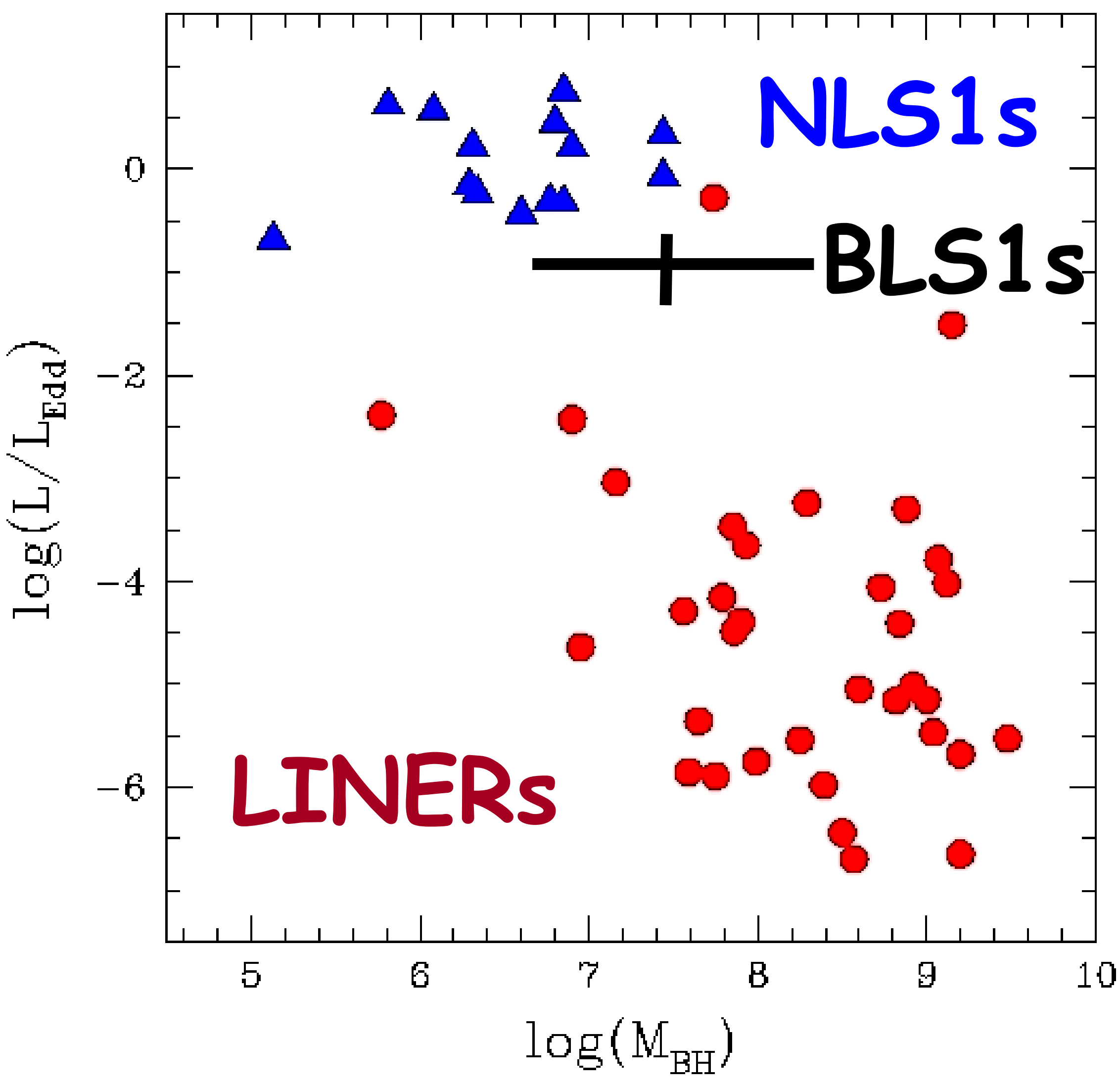


Reminiscent of GBH binaries in their soft states, suggesting very high accretion rates

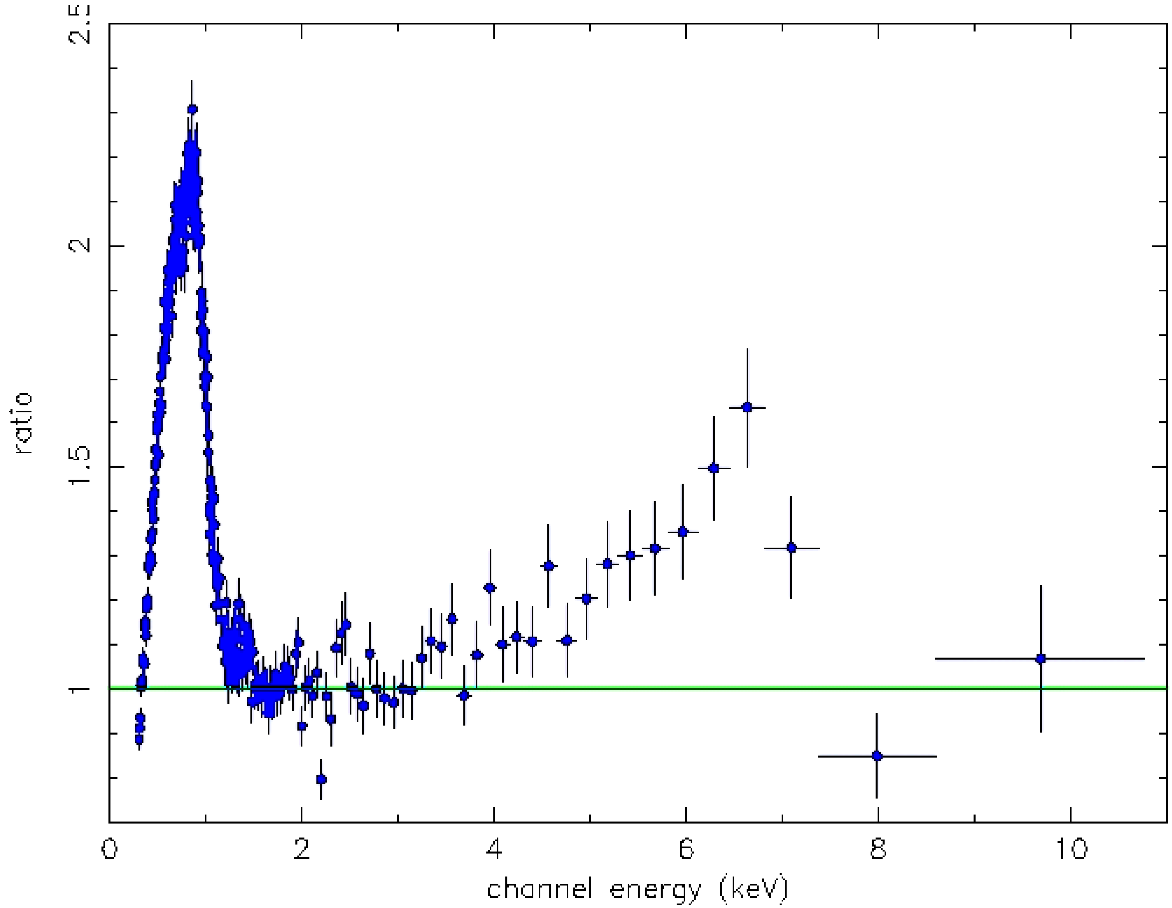
Seyfert 1 unification through physical processes

Broad-Line Seyfert 1		Narrow-Line Seyfert 1
weak	dM/dt, M →	strong disc emission
flat	inverse Compton effect →	steep power-laws
broad	M, dM/dt →	narrow optical lines
strong	huge filling factor in BLR →	narrow [OIII] emission
weak	$\xi(t)$ →	strong Fe II emission
moderate	smaller M, relativistic effects →	extreme X-ray variability

NLS1s as Super Soft AGNs with Super-Eddington accretion rates



Spectral Complexity is related to the Super Soft States in AGNs



Power-law fit
to IRAS 13224-3809

strong residua

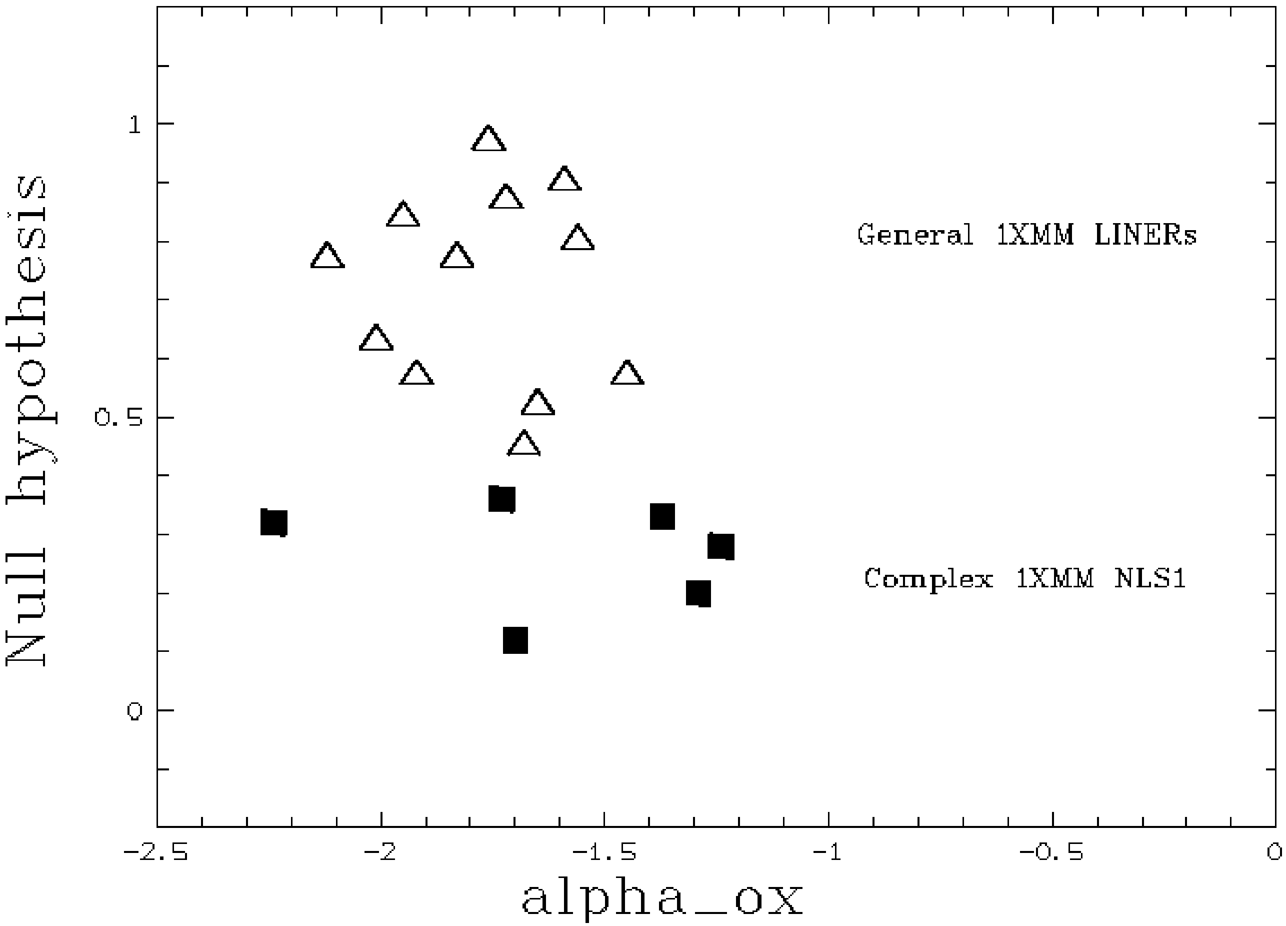
Null hypothesis value <0.1
in 2-10 keV band

0.0 in 0.3 10 keV band

e.g. low Null hypothesis
values indicative for
spectral complexity
as soft excess, lines…

Spectral Complexity correlates with the accretion rate and the Super Soft State

Balestra[08]



fit in the 2-10 keV range

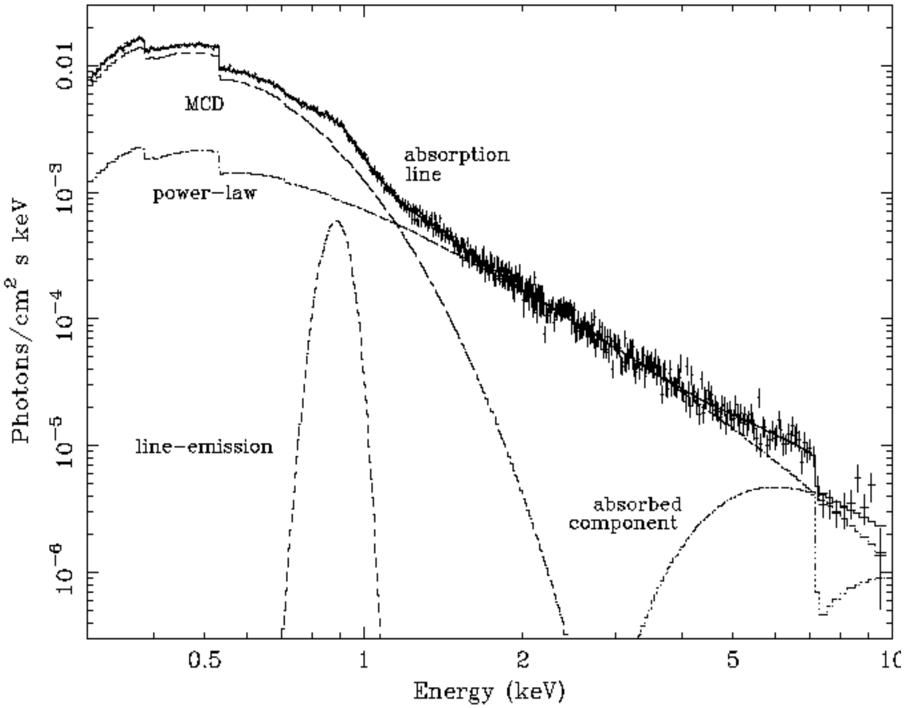
LINERS often as a simple power-law

NLS1s more complex
- soft excess
- spectral curvature
- sharp spectral drops

Metallicity dependence on the accretion rate and on the Super Soft State

13224 with super-Eddington accretion

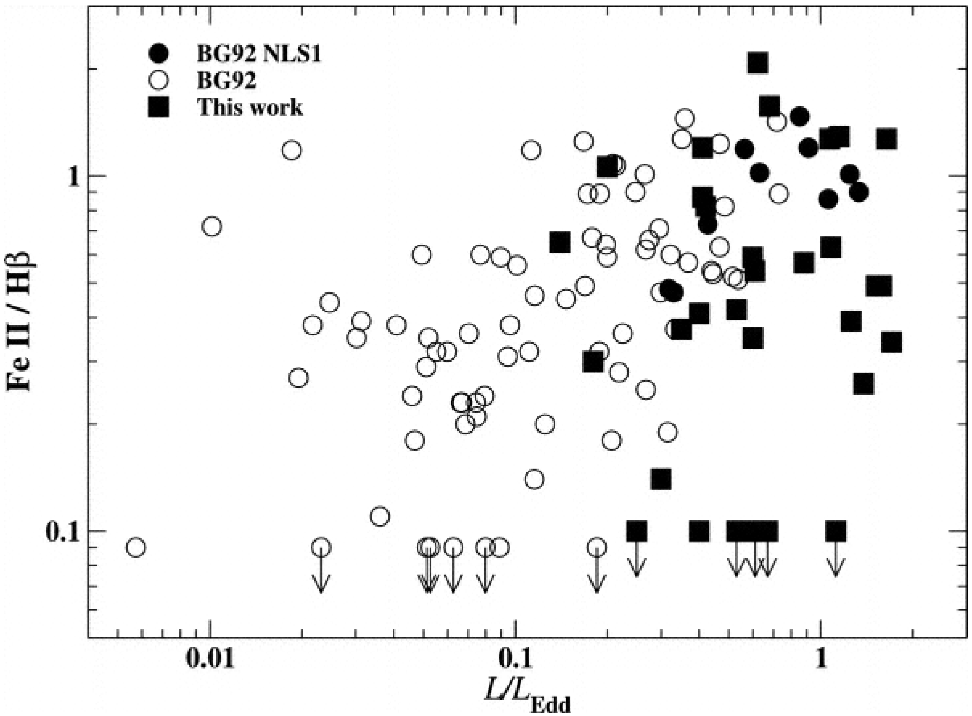
Boller et al. 2003



Fe overabundance **3-10** required in all NLS1s with sharp spectral drop, even for reflection dominated model

Clear trend of FeII/Hβ with accretion rate for NLS1 and high-z QSO

Netzer et al. 2004

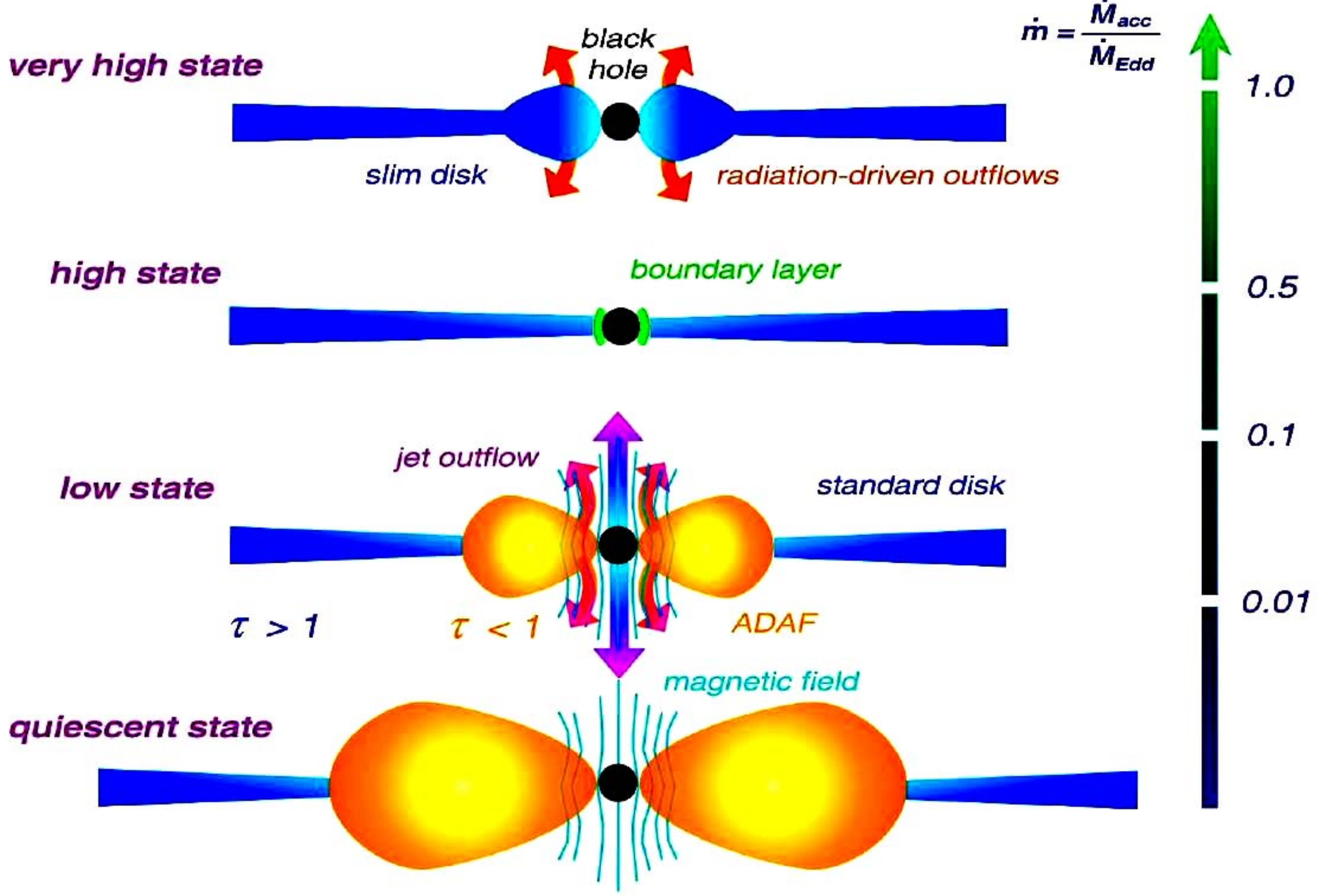


optical Fe II emission increases with accretion rate

reason: young galaxies large SNIa explosions rich in Fe Mathur, Komossa

Comparing the X-ray timing and spectral properties of NLS1s and GB

the comparision is complicated by the fact GB can exist in a number of states



Spectral and Timing Properties

in GB the X-ray emission is dominated by accretion disc photons, as they have huge temperatures of their discs, in contrast to the much cooler AGN disc temperatures

This BB component dominates over the power-law and the X-ray variability is less pronounced compared to Super Soft AGN

in NLS1 the X-ray emission is not due to disc photon
the soft X-ray emission is dominated by the sum of the unresolved reflection dominated emission line component
above 2 keV the power law dominates

according to the light bending model the power law component varies by a factor of about 70, where the reflection component varies by a factor of 4 and NLS1s show the largest X-ray variability compared to broad-line AGNs

in Novae as SSS rapid persistent X-ray variability is seen,
similar to Super Soft AGN

Timing properties

Power Spectral Densities (PSDs) comparision

AGNs at high accretion rates (NLS1s) have soft state PSDs
the same holds for GB of similar accretion rate[McHardy04,05]

if the soft states in AGN are linked to the accretion disc, then perhaps their much cooler discs compared to GB may allow the optically thick disc to survive without evaporation to smaller radii

this is exactly the slim disc regime described by Abramowicz

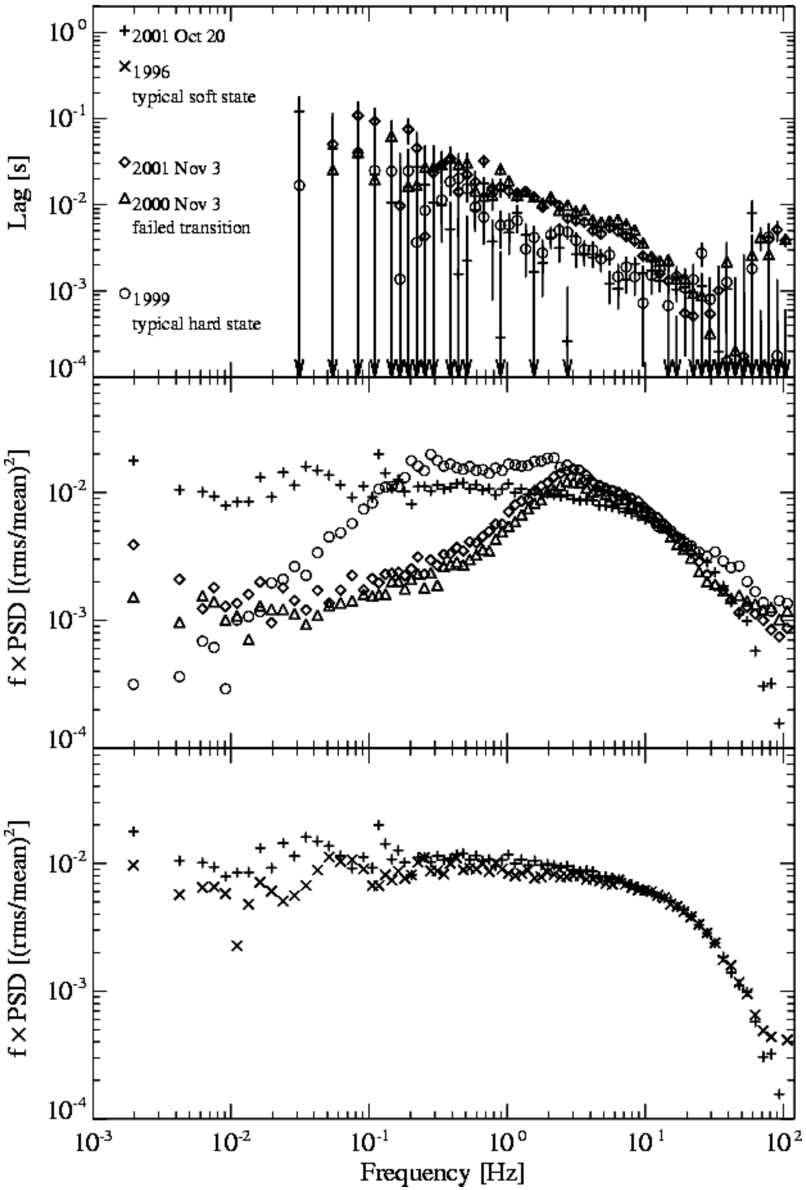
Time lag comparision

Positive lags are observed in GB[Arevalo06]

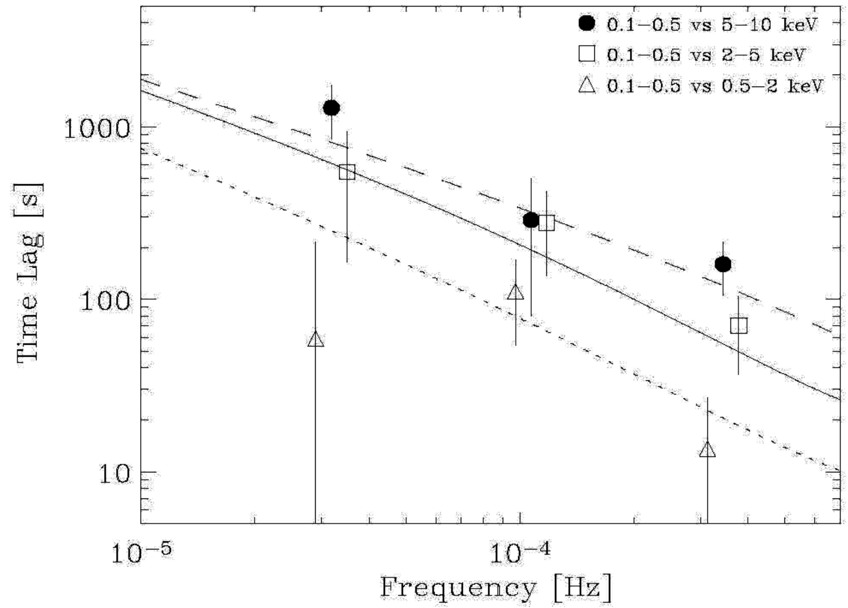
In NLS1s positive lags are detected on the shortest frequencies, however also negative lags are observed in NLS1s which are due to reverberation

Frequency dependent time lags

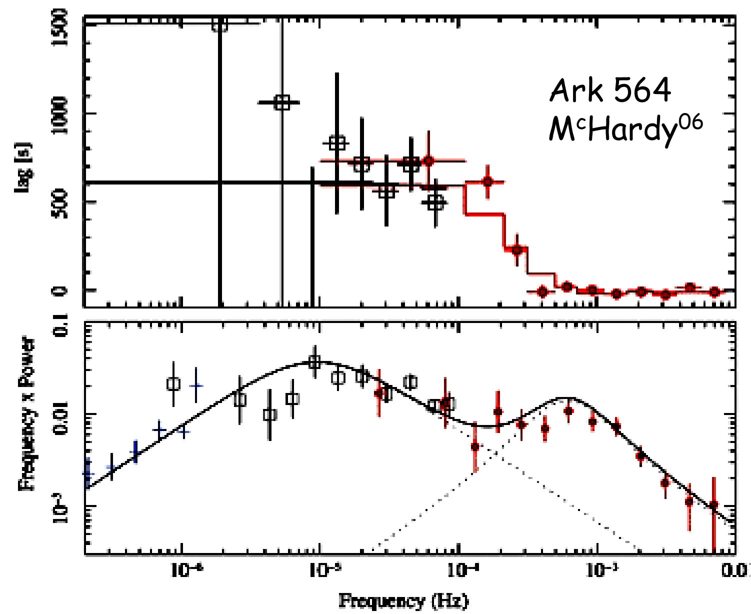
Cygnus X-1
Pottschmidt[03]



NGC 4051
Arevalo[06]



Ark 564
McHardy[06]

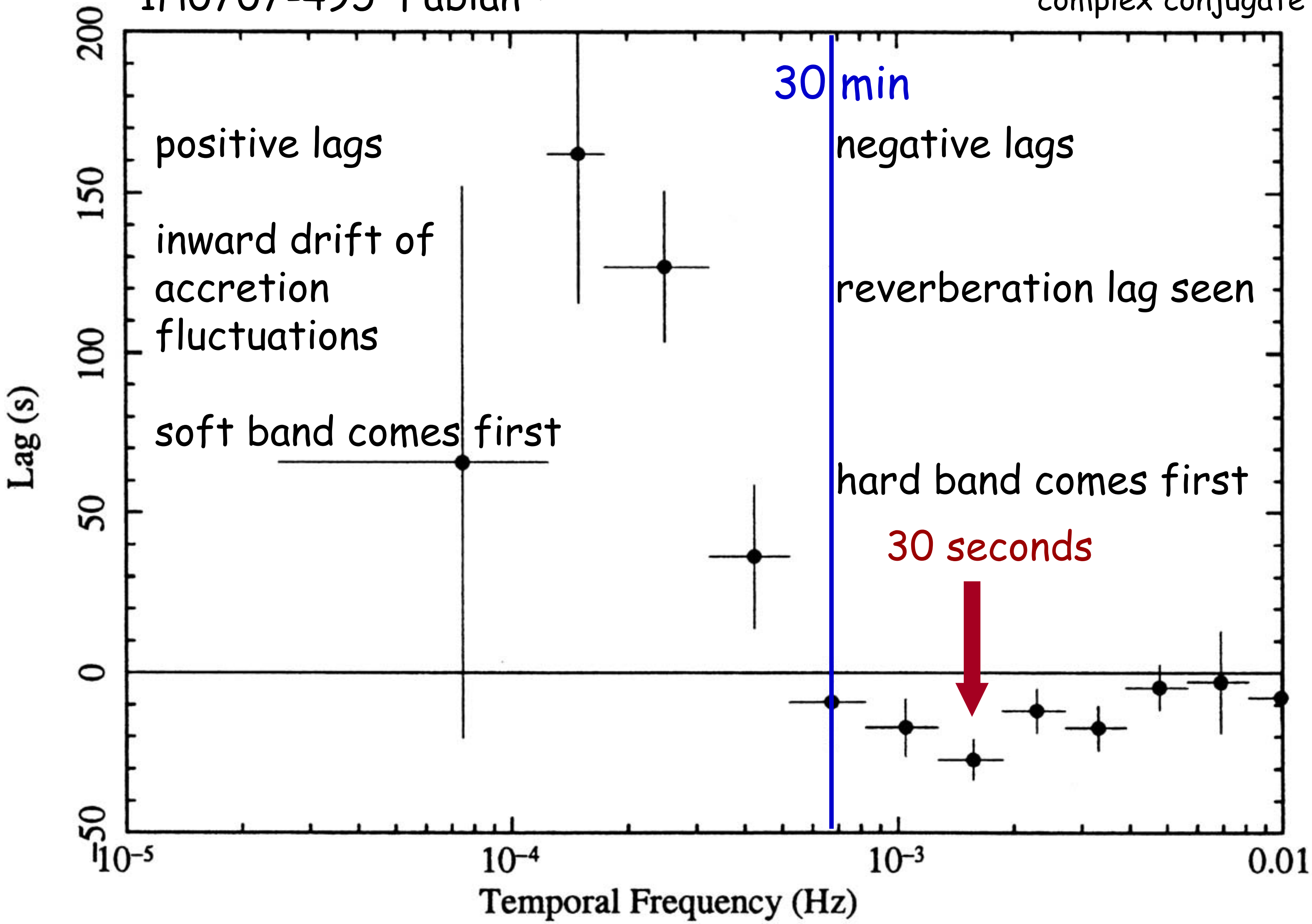


Frequency dependent lags

1H0707-495 Fabian[09] Nature

$S*(f)\cdot H(f)$

complex conjugate of the FFT



Key interpretation is that slower variations, lower frequencies in the plot come from larger radii wehre there may be significant viscous time delays as M_dot variations propagate in

This is the opposite sense to a inverse Comptonization lag produced by upscattering of photons and is explained by reverberation.

Summary

X-ray observations on the disc temperature and the luminosity allow to measure black hole masses and accretion rate, independent from optical line width relations

The NLS1s are accreting at luminosities close or above the Eddington luminosity L_{min}/ L_{edd} ~ 1-2 and show the steepest photon indices in ROSAT obs. und the strongest MCD emission in XMM-Newton observations and are Super Soft AGNs

The black body temperature is high: 90-120 eV and exceeds the limit from standard geometrically thin accretion discs

The objects have relatively low black hole masses of ~10^6 M_{sun} and are rapidly growing in mass with ~ dM/dt ~ (1-20) (L_E/c^2)

When the high accretion rates are ceased NLS1s become normal Seyfert 1s within a few 10´s Million years

NLS1s are the most rapdily growing black holes in the universe

at high accretion rates NLS1s and Galactic BH binaries shares steep soft X-ray spectra, the X-ray variability of NLS1s is more pronounced compared to GB in their high states, in SS Novae the X-ray variability is similar to NLS1s, and in GB mostly positive lags are seen, while negative lags are seen in NLS1s

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