Search for relativistic signals in the XMM long light curves of AGN

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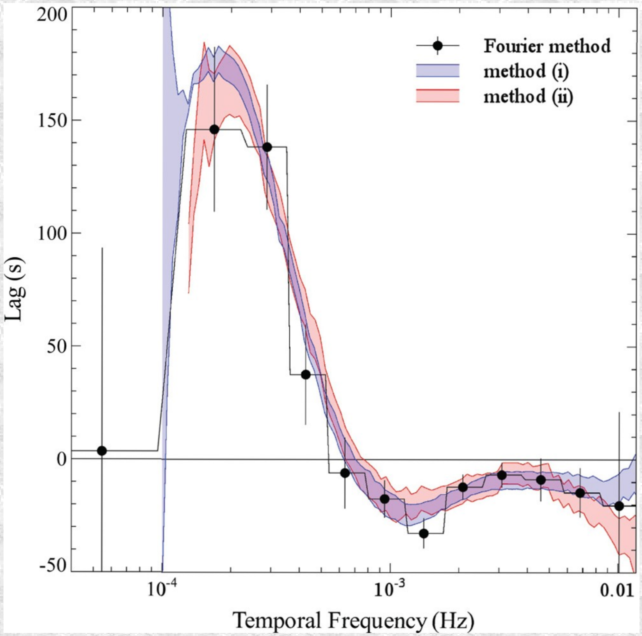
Zoghbi et al, 2010



"Negative" X-ray time lags (i.e. soft band variations lag hard band variations) at frequencies > 10^{-3} Hz have been detected in 1H0707-495.

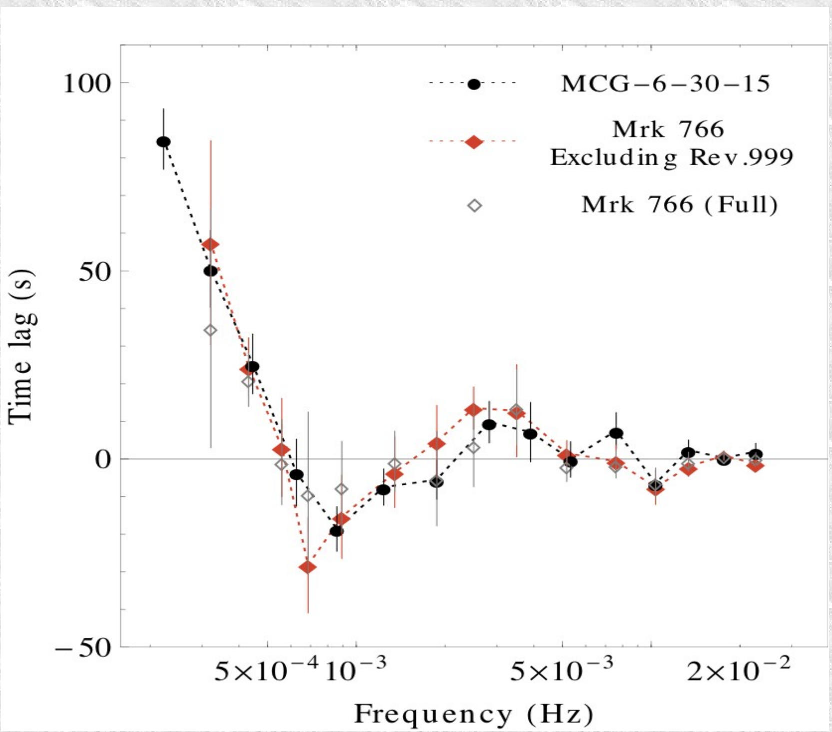
They could arise from reflection by matter lying very close to the BH (**Fabian et al 2009**, **Zoghbi et al 2010**, **2011**) or could be due to large scale distant reflectors with anisotropic geometry (e.g. an accretion disc wind; **Miller et al. 2010**).

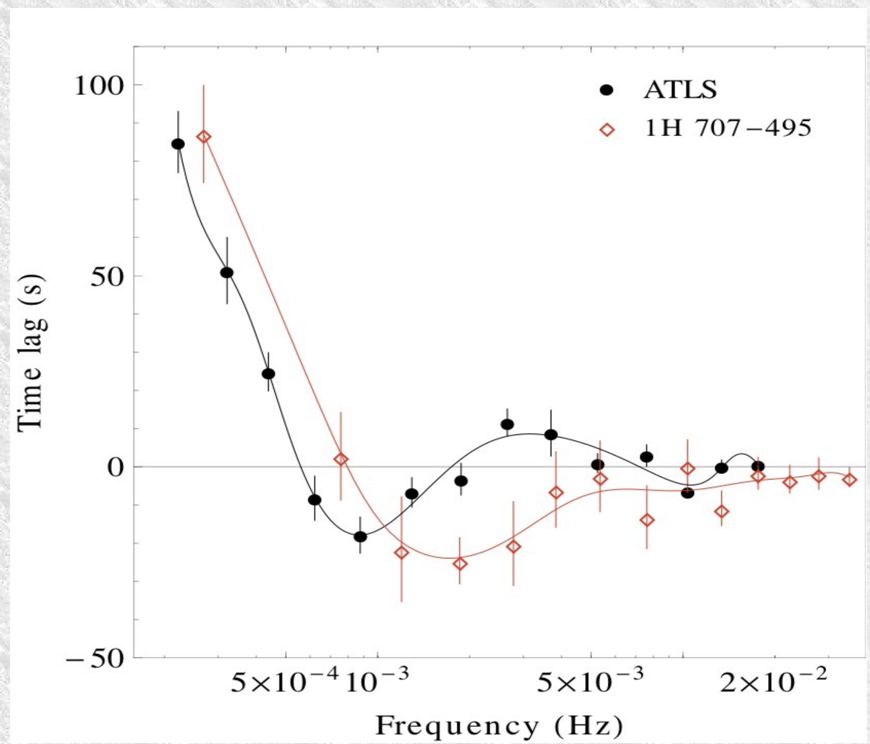
Similar negative time lags have been recently detected in MCG -6-30-15 and Mrk 766 as well. (**Emmanoulopoulos, McHardy & Papadakis, 2011**).

Our results suggest a reflector size no more than:

7 R_g in MCG-6-30-15

17 R_g in Mrk 766

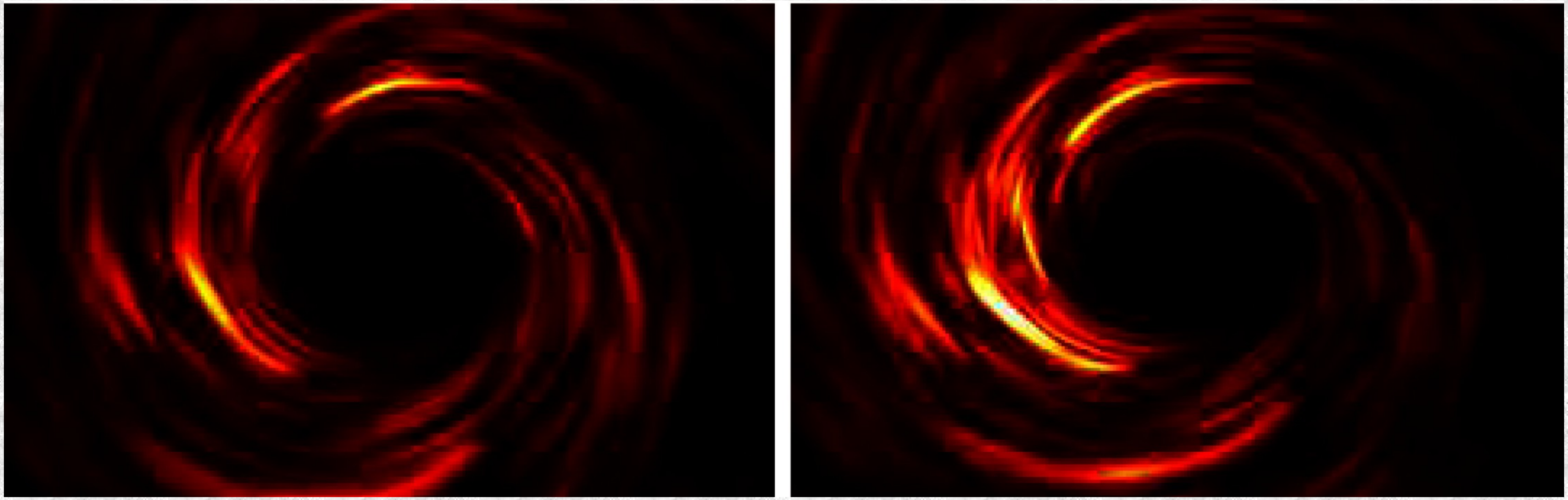




Time lags between soft and hard X-ray energy bands are a valuable diagnostic of the emission mechanism and source geometry in AGN.

At the very least, the detection of the "negative" time lags at high frequencies indicate that the "reflected" signal is variable on time scales shorter than ~ 1000 sec.

What if we indeed witness disc reflection, from the inner disc, and the disc is inhomogeneous?



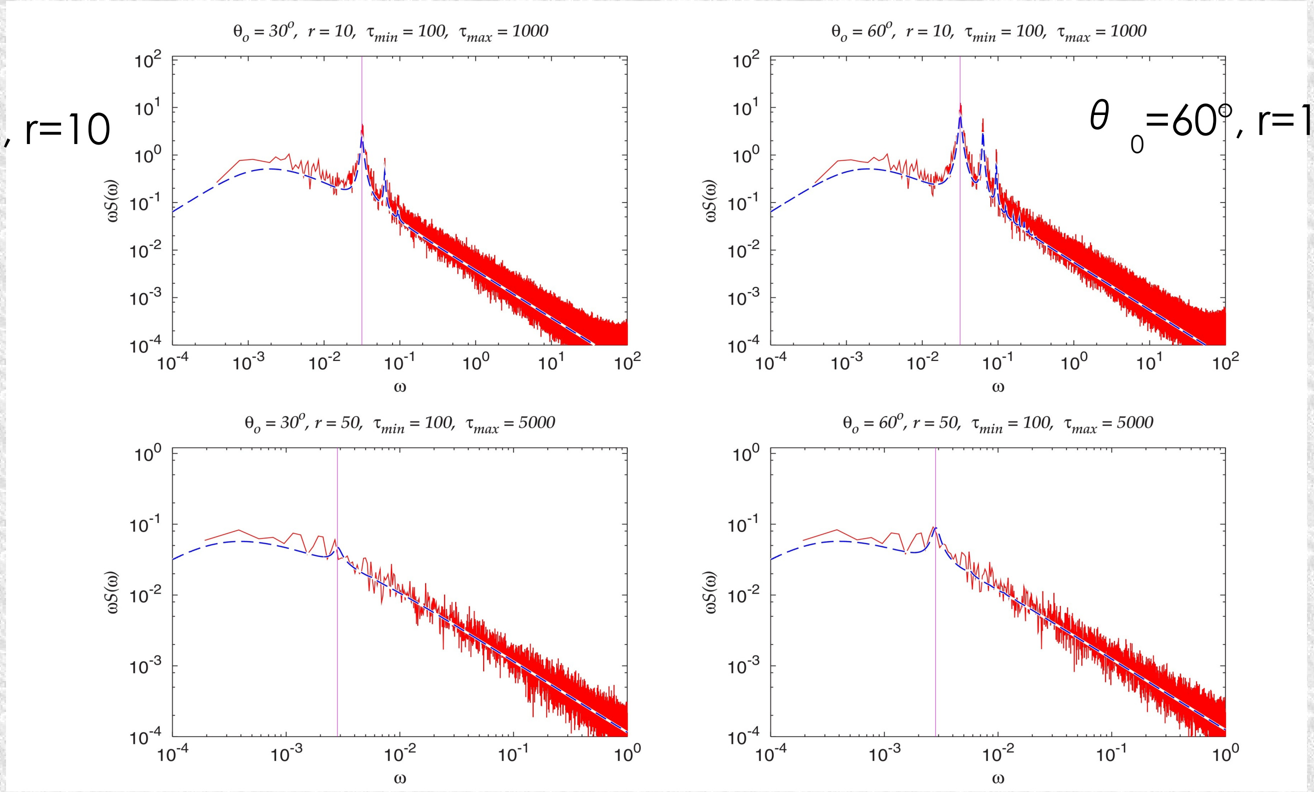
Armitage & Reynolds, 2003

Assume:

i) Reflection from the innermost part of the disc,

ii) which is inhomogeneous (there exist bright regions which survive for a few orbital periods and ten are erased by the strong shear present in the disc),

then, light curves in energy bands where the reflection signal is strong, may show signs of these "rotating reflection spots".



Pecháček et al 2005

Expected PSD in the case of:

i) "active-flares" which follow Keplerian orbits,

ii) in a narrow ring, around a Schwarzschild BH

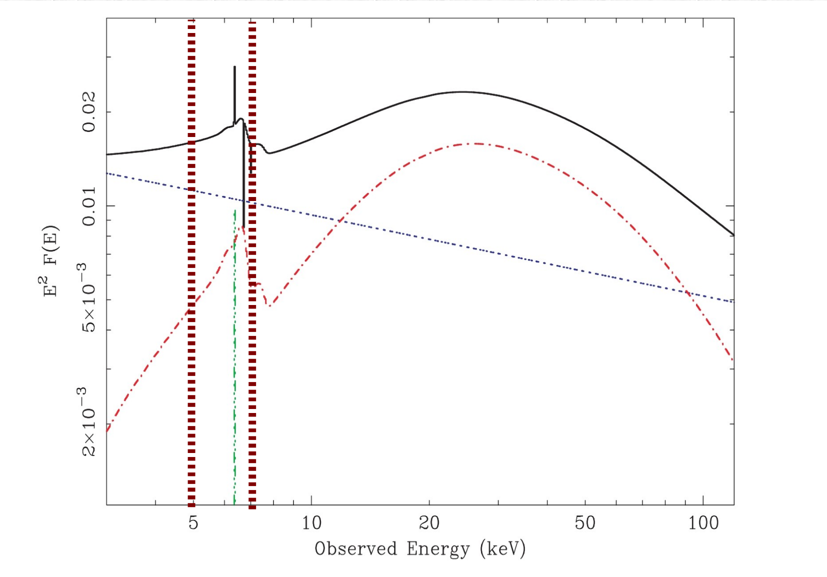
So, if:

i) Significant reflection from the innermost part of the disc,

ii) which is inhomogeneous (there exist bright regions which survive for a few orbital periods and ten are erased by the strong shear present in the disc), then,

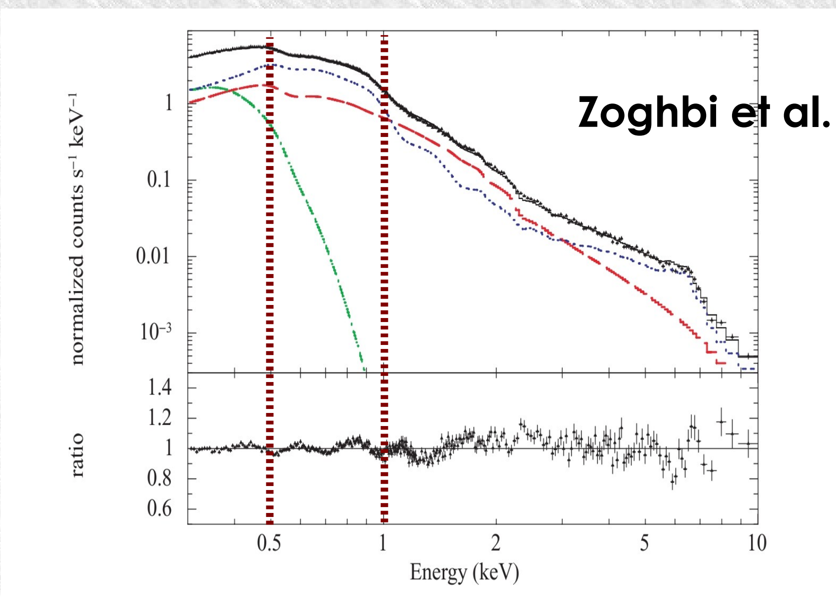
we may be able to detect high frequency "peaks" in the PSD of narrow energy band light curves.

Miniutti, et al. 2007



MCG -6-30-15:

F_{refl}(5-7 keV)/F_{tot}(5-7 keV)=0.3



Zoghbi et al. 2010

1H 0707-495:

F_{refl}(0.5-1 keV)>F_{intr}(0.5-1 keV)

So, I used long, archival XMM data:

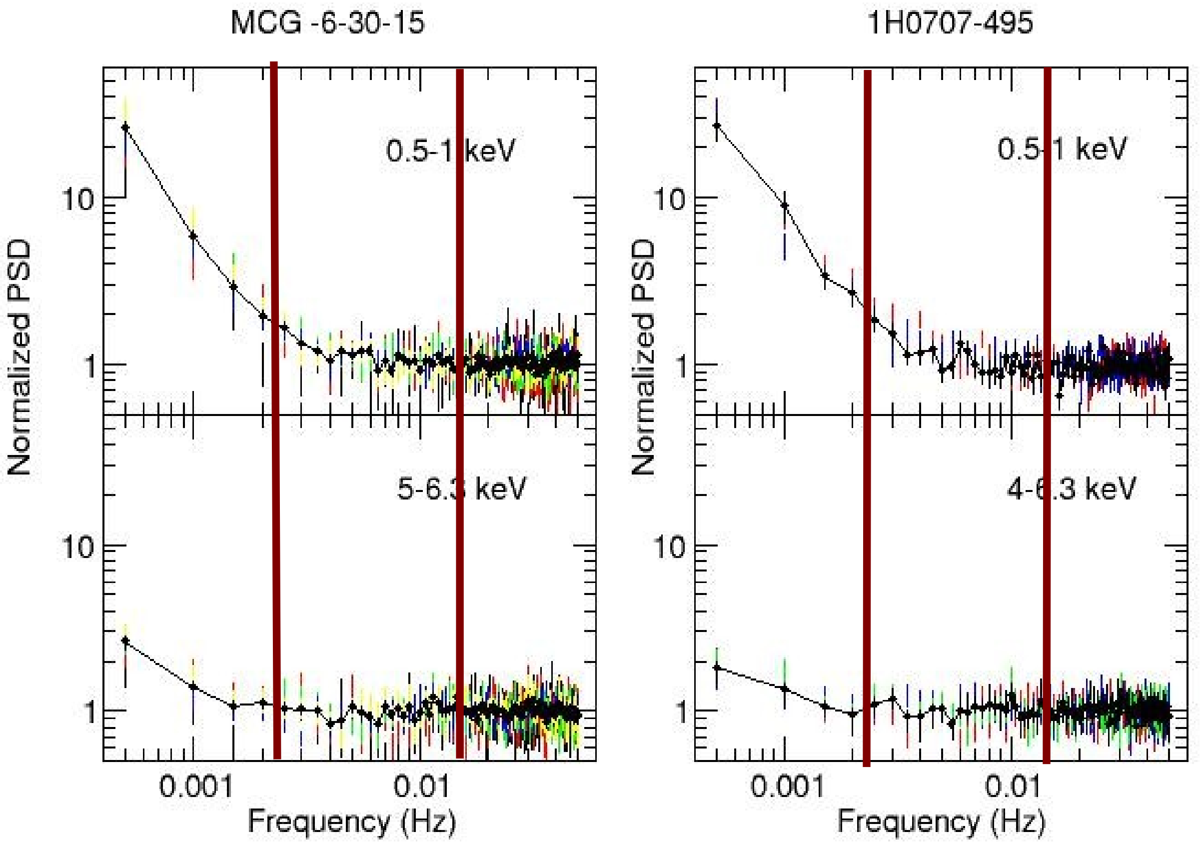
MCG-6-301-15: Orbit 108 (July 2000)

Orbits 301,302, 303 (August 2001)

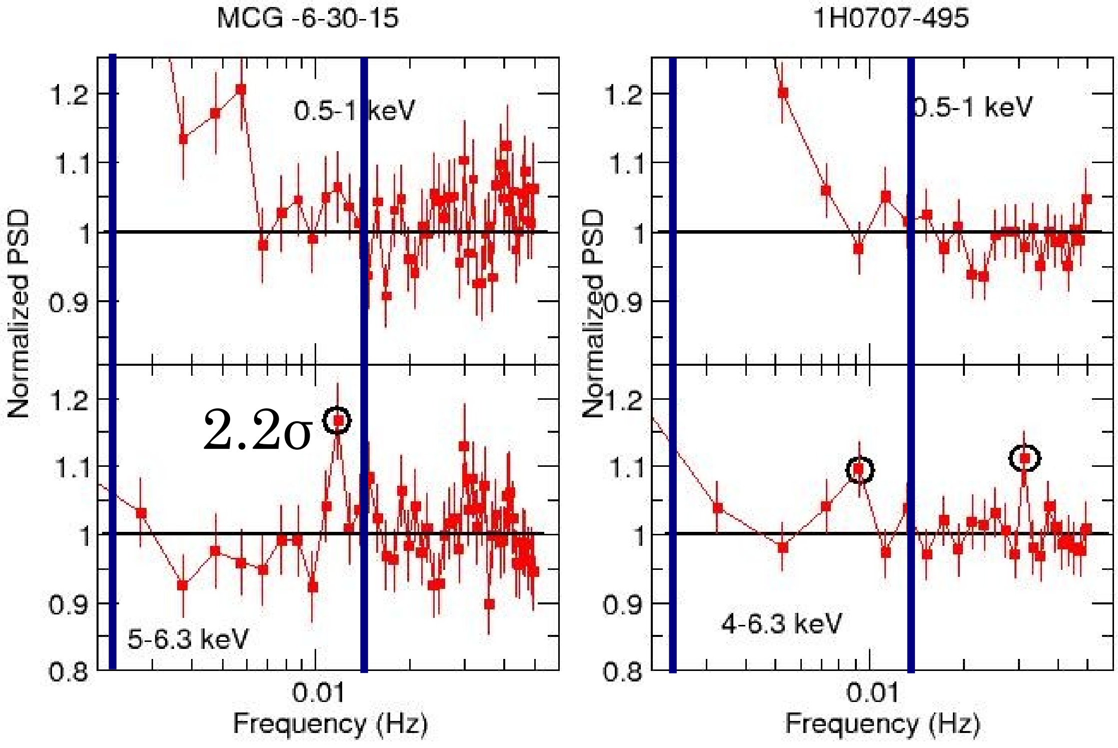
1H07078-495: Orbits 1491-1494 (Jan/Feb 2008)

To produce 10-sec binned, 2000 sec long, 0.5-1 keV and 5-6.3 keV (MCG), 4-6.3 keV (1H) band light curves.

Aim: search for high-frequency "peaks" in the PSD of these narrow band light curves.



MCG -6-30-15
1H0707-495
0.5-1 keV
5-6.3 keV
0.5-1 keV
4-6.3 keV
Normalized PSD
Normalized PSD
10
1
10
1
0.001
0.01
Frequency (Hz)
0.001
0.01
Frequency (Hz)



MCG -6-30-15
1H0707-495
0.5-1 keV
0.5-1 keV
Normalized PSD
Normalized PSD
1.2
1.1
1
0.9
0.8
2.2σ
5-6.3 keV
4-6.3 keV
0.01
0.01
Frequency (Hz)
Frequency (Hz)

Summary:

1) Negative soft lags at high frequencies have been detected in MCG -6-30-15 and Mrk 766. They look similar to the time lags detected in 1H0707-495.

2) The detection of high frequency negative lags in 3 sources so far suggests reflection from the inner disc as the most likely explanation.

3) If this is the case, and if the inner disc is inhomogeneous, we would expect to detect "peaks" in the PSD of light curves which are affected significantly by the reflection component.

No significant detections so far in MCG -6-30-15 and 1H0707-495.