Obscuration in Seyfert Galaxies by Broad Line Region clouds

Francesco Ursini

Università di Firenze

G. Risaliti (INAF-Arcetri, CfA)
M. Salvati, P. Pietrini, G. Torricelli (INAF-Arcetri)

Rome, AGN X - September 12, 2012

Introduction

X-ray variability is a common feature in AGNs. Any explanation for the origin and the features of the X-ray spectrum should provide an answer to the obvious question: what causes such variability?

- **Intrinsic** spectral variability?
- **Variable X-ray absorption?**

Recent studies by our group have revealed occultations of the X-ray primary source by **Broad Line Region clouds**.

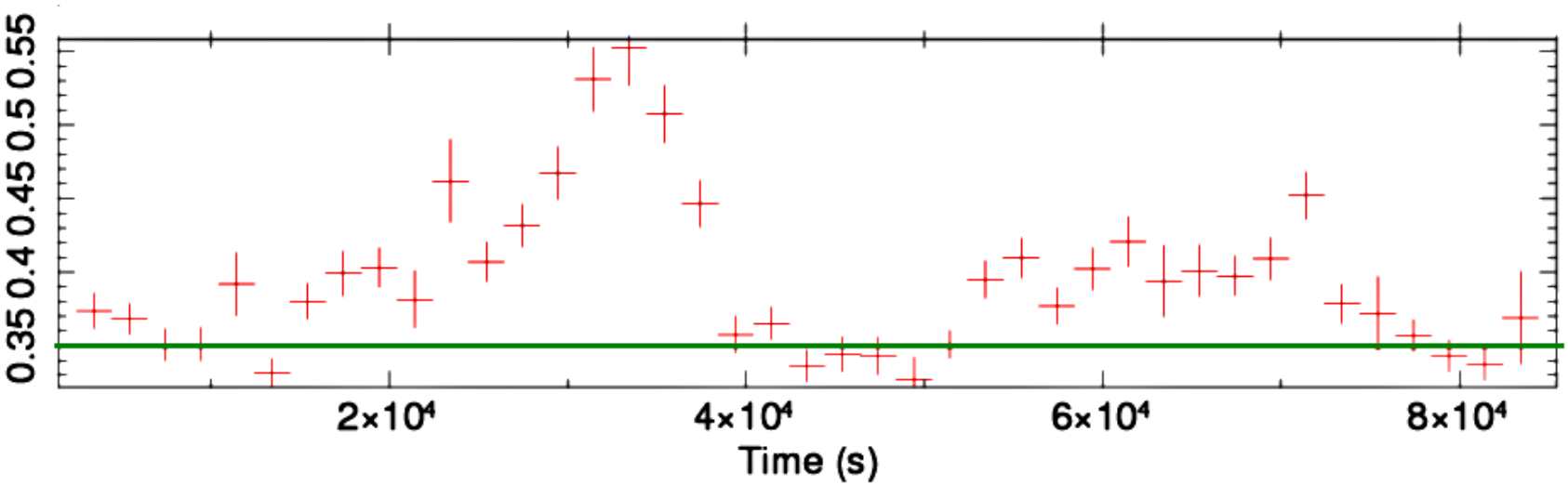
Our hypothesis:

BLR clouds may "eclipse" the X-ray primary source, even in usually unobscured AGNs, modifying their spectral properties.

Our method is based on a preliminar analysis of the **hardness ratio** (HR) light curve:

$$HR = \frac{F(5-10\ \mathrm{keV})}{F(2-4\ \mathrm{keV})}$$

The HR light curve is sensitive to variations of $N_H > 10^{22}$ cm^{-2}.



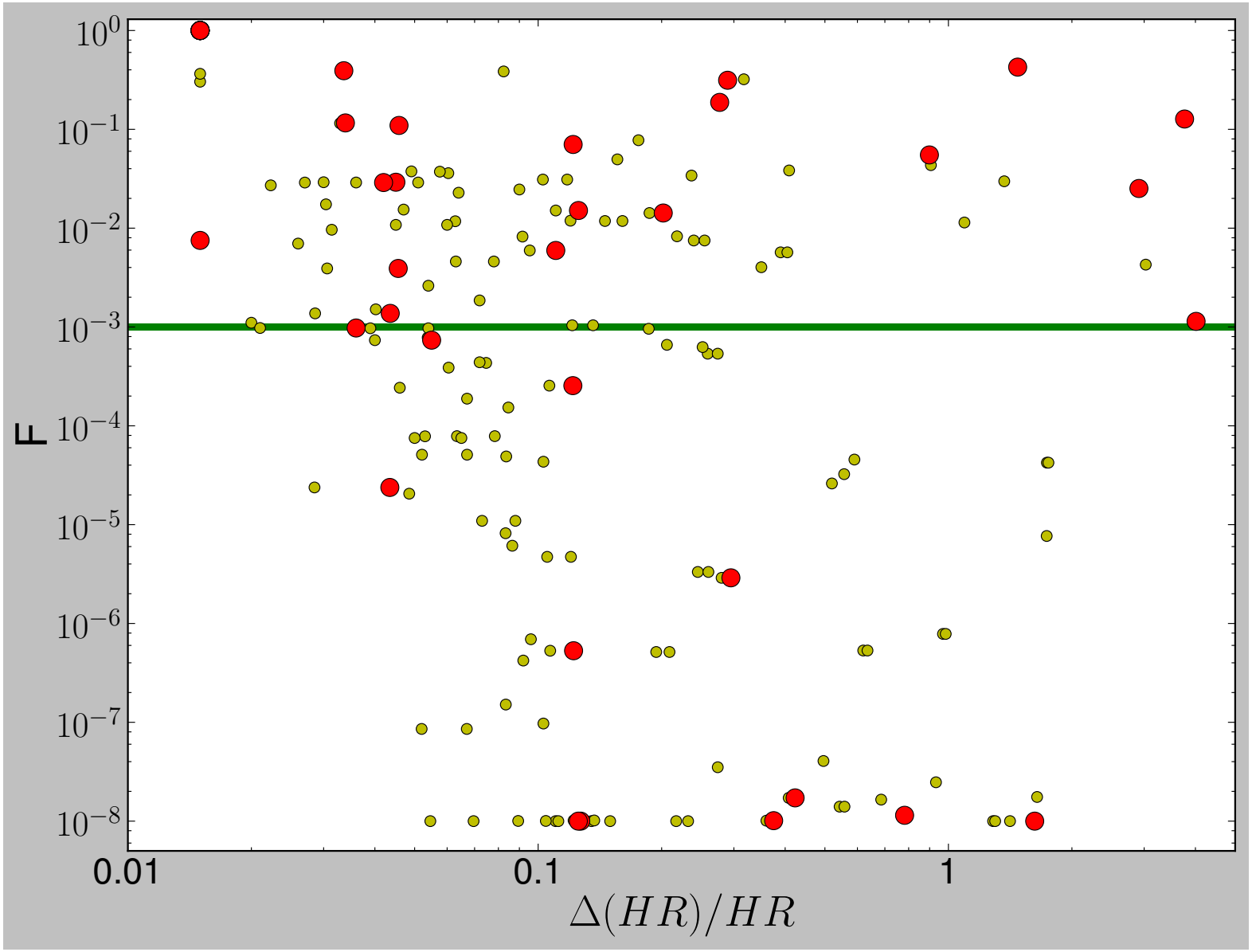
The search for X-ray occultations

Our group performed a **homogeneous analysis on a statistically representative sample of AGNs**, systematically looking for spectral variations.

Requirements

1. **high intrinsic X-ray flux**
2. **long exposure time**
3. high-sensitivity instruments

Our requirements leave us with $\sim$ 90 long archival observations of 40 bright AGNs by *XMM-Newton* and *Suzaku*.


F
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
0.01
0.1
1
$\Delta(HR)/HR$

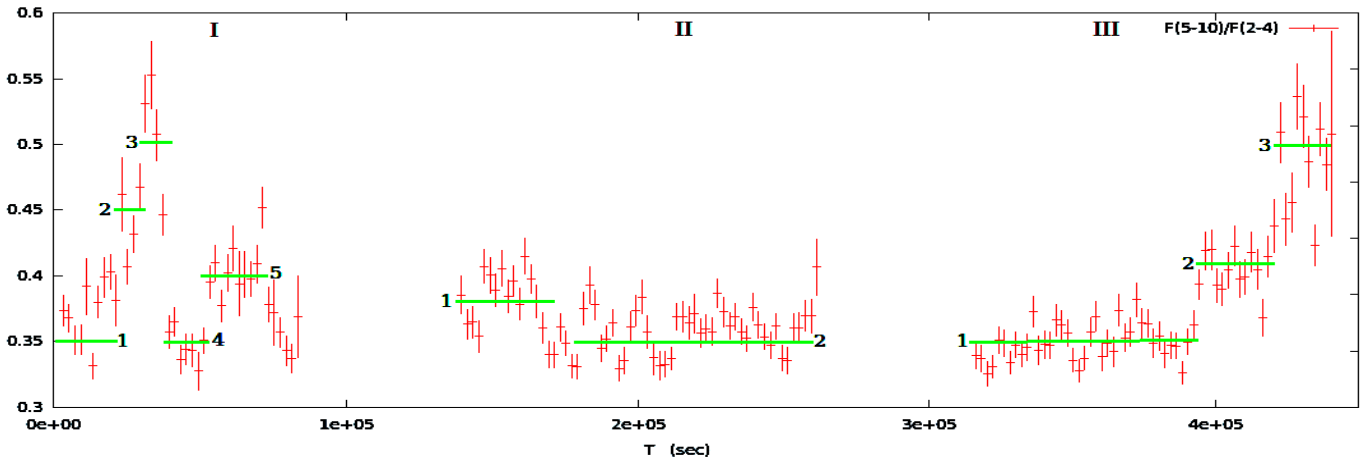
Sources

Absorption variability is found not only in type 2 AGNs (NGC 1365, Risaliti et al. 2009) but also in brighter **type 1** (Mrk 766, Risaliti et al. 2010) $\Rightarrow$ we shall focus on the latter ones.

name	type (Sy)	obs. time (ks)	**Significance** (σ)
MCG 06-30-15	1.2	86	29.53
Mrk 766	1	107	17
NGC 4051	1.5	225	15.1
NGC 3783	1	350	10.77
NGC 3516	1.2	250	9.33
NGC 3227	1.5	100	8.76
NGC 7469	1	85	5.1
Ark 120	1	186	4.72
NGC 4593	1	235	4.58
MCG 08-11-11	1.5	190	4.12
4U 0106-59	1.2	123	3.5
Mrk 509	1.2	86	3.81
ESO 141-55	1.2	80	3.3
NGC 7314	1	218	3.3
3C 111	1	240	2.88
1H 2251-179	1	286	2.65
3C 120	1	121	2.40
NGC 5548	1.5	88	2.19
IC 4329A	1	72	2
3C 382	1	240	0
Mrk 110	1	170	0
Mrk 79	1.2	65	0

Example

MCG-6-30-15 is a good illustrative case: it shows large HR variation, well explained by obscuration.

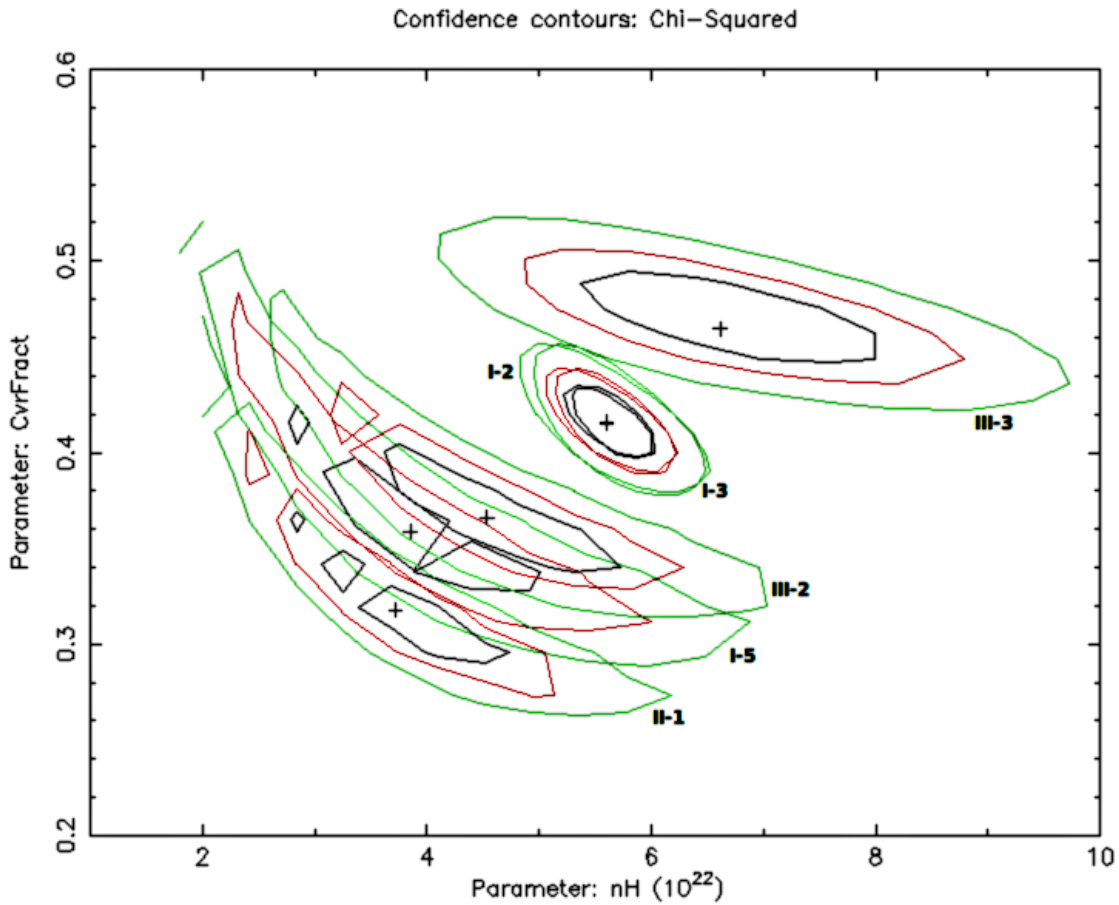


Our best-fit model gives:

- **Obscuration** (absorber with variable N_H and C_F):
  $\chi^2/\text{d.o.f.} = 2088.26/2078$ (1.005)
- **Intrinsic variability** (variable Γ):
  $\chi^2/\text{d.o.f.} = 3195.79/2346$ (1.362)

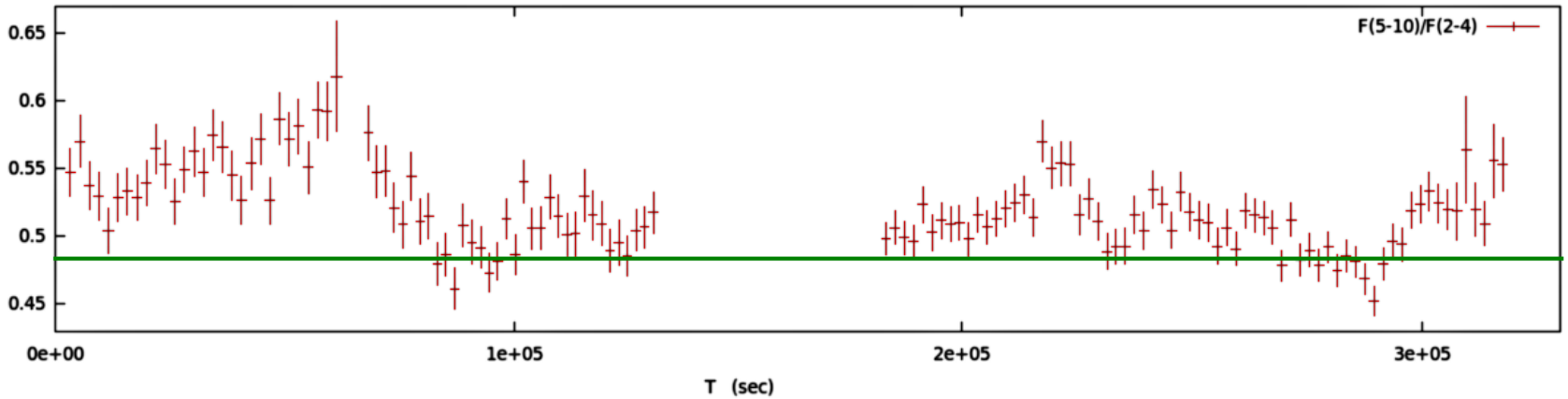
Example: Contour Plots

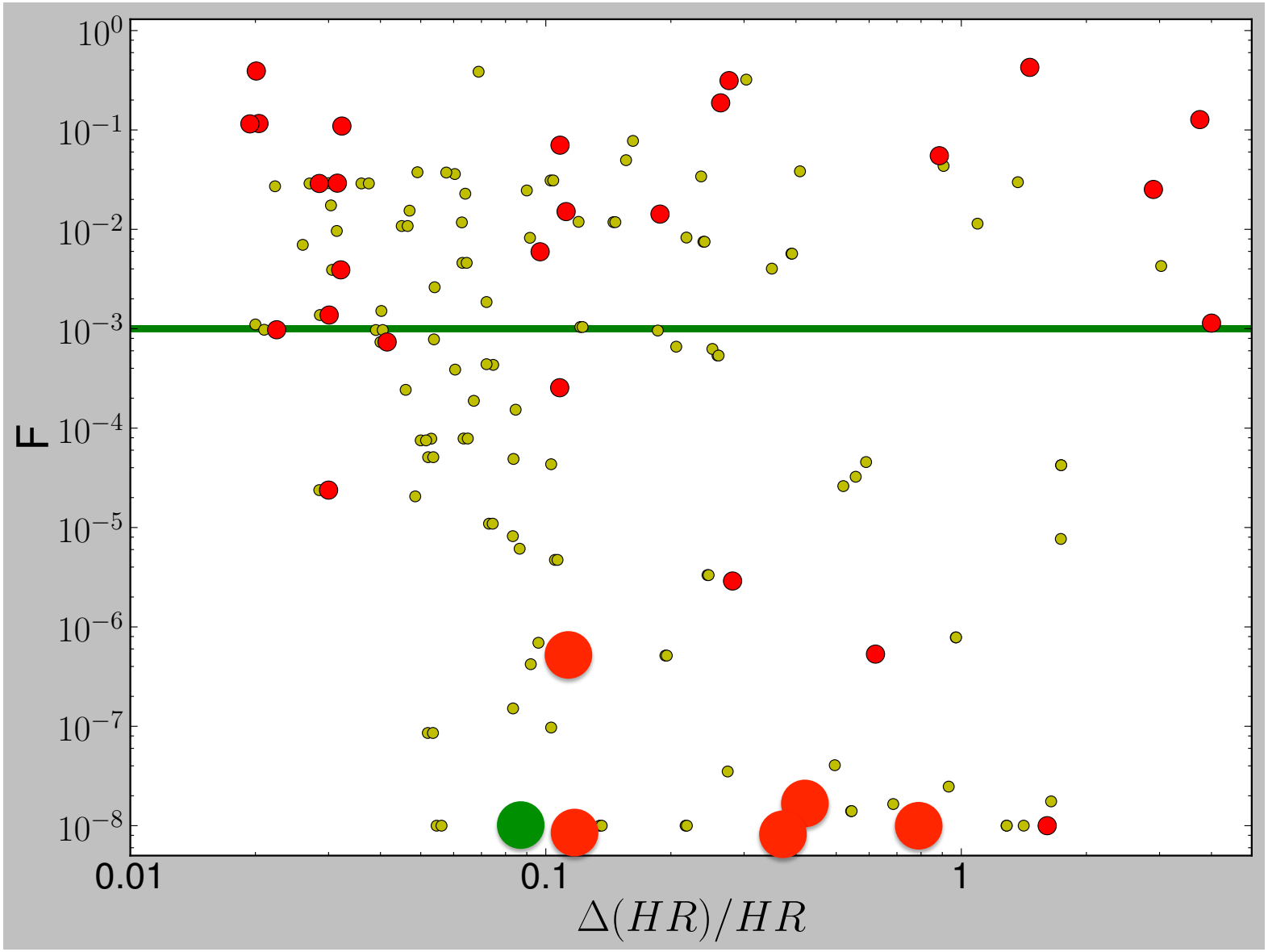
- $N_H \sim 10^{22}$ cm^{-2}, **consistent with BLR obscuring clouds**.
- Assuming Keplerian motion, we get **informations on geometrical and physical parameters**, e. g. dimension of the X-ray source $\sim R_G$.



Exception

NGC 3783 is the only case where we do find **intrinsic variation**. But **at most**, $\boldsymbol{\Delta\Gamma = 0.08}$.




F
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
0.01
0.1
1
$\Delta(HR)/HR$

Conclusions

- **X-ray spectral shape variations**, on time-scales of hours / days, are common in AGNs.
- **All the strong variations** are only explained by obscuration by clouds from the BLR crossing the line of sight.
- **We never observe** intrinsic variations with $\Delta\Gamma > 0.1$.

Thanks!