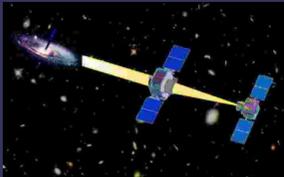


# What can we learn from the AGN radio quiet continuum with SIMBOL-X?

Pierre-Olivier Petrucci  
LAOG, Grenoble, France

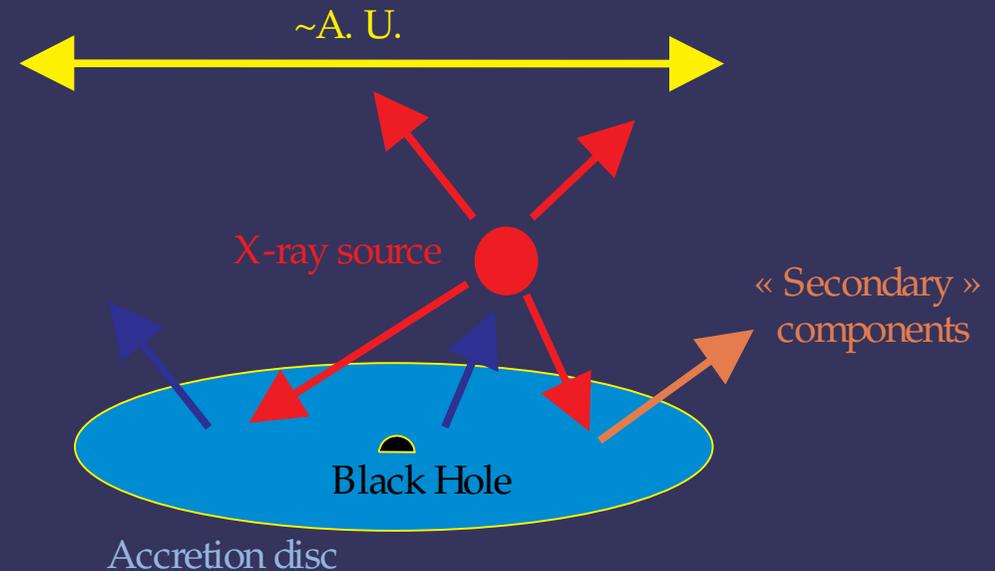


- Generalities about the RQ AGN X-ray emission
  - continuum
  - reflection component
- Expected science with SIMBOL-X
  - Spectral studies
  - Variability studies



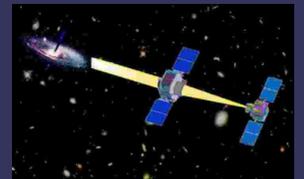
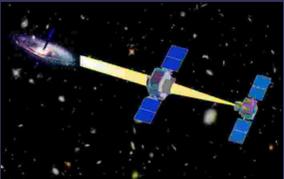
# The RQ AGN X-ray continuum: The Reprocessing/Up-scattering Model

- It supposes two phases, a hot one (the corona) and a cold one (the accretion disc)
- Part of the cold photons are compton upscattered in the hot phase to produce X-rays. Part of the X-rays illuminates and heats the cold phase



It well explains:

- ] The UV-X-ray spectra
- ] The simultaneous Opt-UV-Xray variability
- ] The reflection components



# The RQ AGN X-ray continuum: The Reprocessing/Up-scattering Model

. It supposes two phases, a hot one (the corona) and a cold one (the accretion disc)

. Part of the emission is produced in the hot phase to produce the X-rays, and the rest is produced in the cold phase

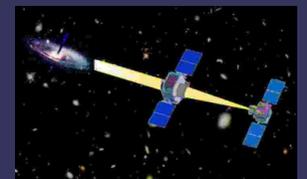
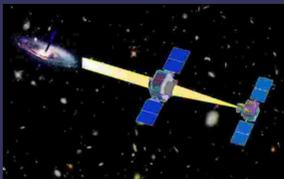
Nature of the X-ray emitting emission?  
Geometry of the emitting regions?  
Origin of the variability?  
....

Accretion disc

« Secondary »  
components

It well explains:

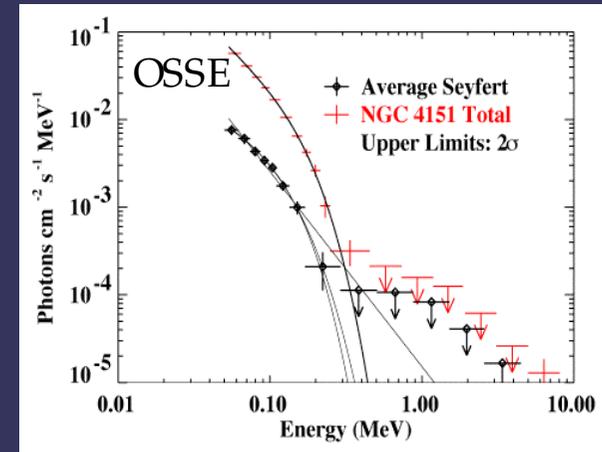
- ] The UV-X-ray spectra
- ] The simultaneous Opt-UV-Xray variability
- ] The reflection components



# The RQ AGN X-ray continuum: A Thermal Origin?

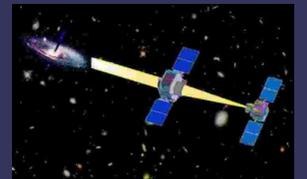
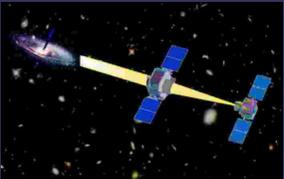
- The X-ray power law shape was first believed to have a non-thermal origin (pair cascades, e.g. Zdziarski et al. 1990)

- SIGMA/OSSE observation of NGC 4151 revealed a cut-off near 100 keV not predicted by non-thermal models (see however Petrucci et al. 2001)

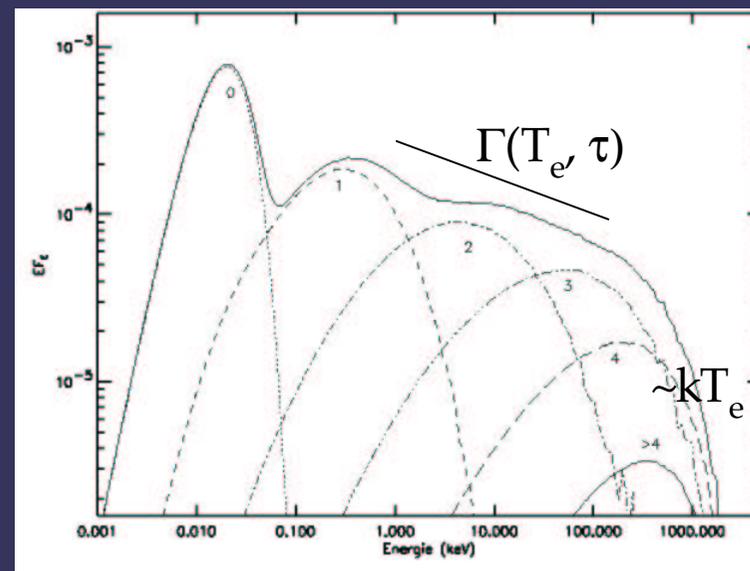
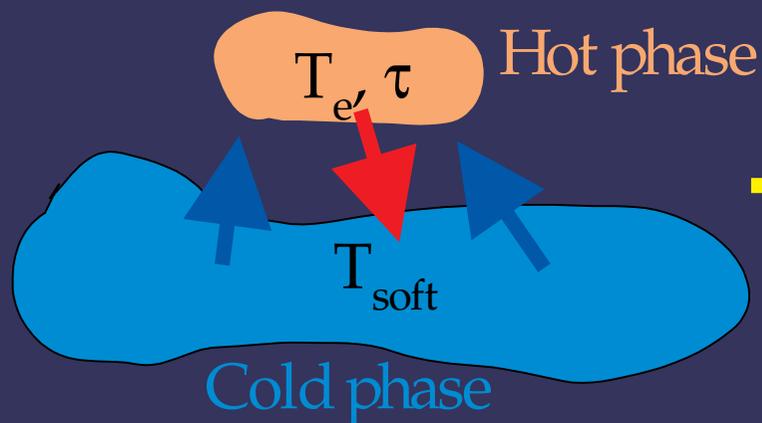


- This cut-off has been observed in a large sample of Seyfert 1 (e.g. Perola et al. 2002)

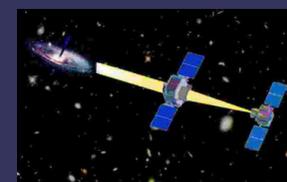
? Generally interpreted as the signature of a  
thermal plasma of a few hundreds of keV



# The Thermal Comptonization Spectrum

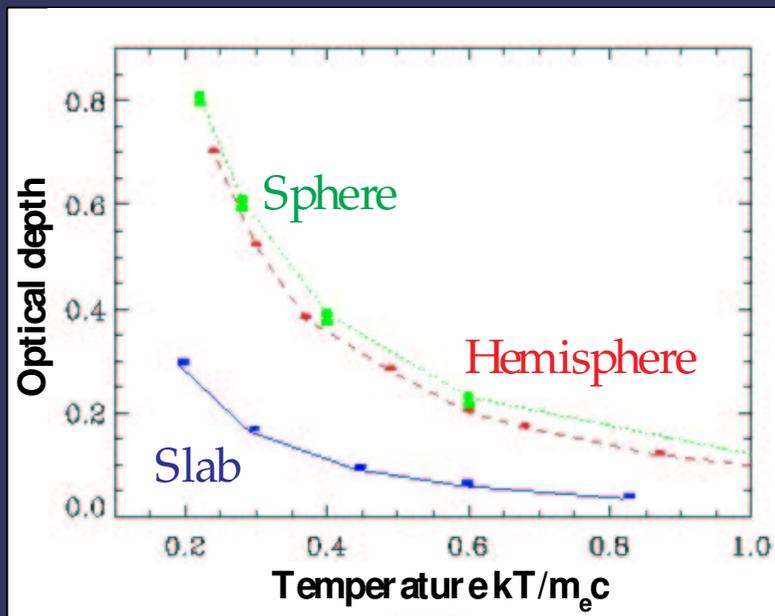


] From spectral and variability studies direct constraints on  $T_{e'}$ ,  $\tau$ ,  $T_{\text{soft}}$ , ...



# Radiative Equilibrium

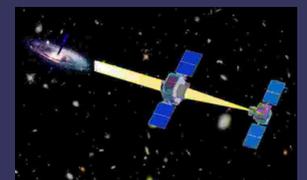
In the case of radiative equilibrium between the UV (i.e. the cooling) and the X-ray (i.e. the heating) sources,  $T_e$  and  $\tau$  follow a univocal relationship (for a given geometry)



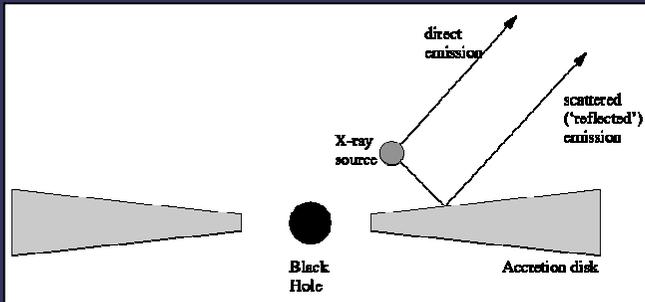
High precision  
on  $T_e$  and  $\tau$

High constraints  
on the physics

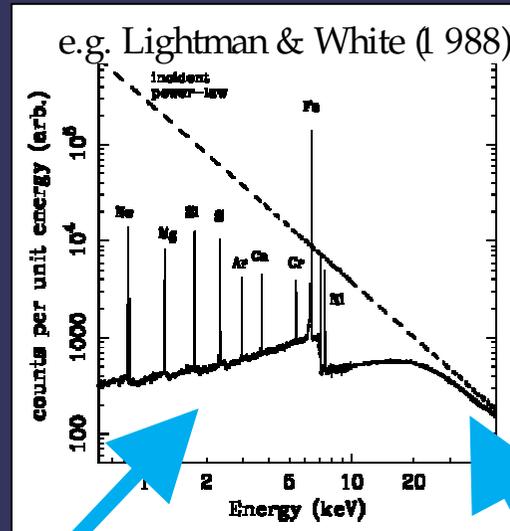
High constraints  
on the geometry



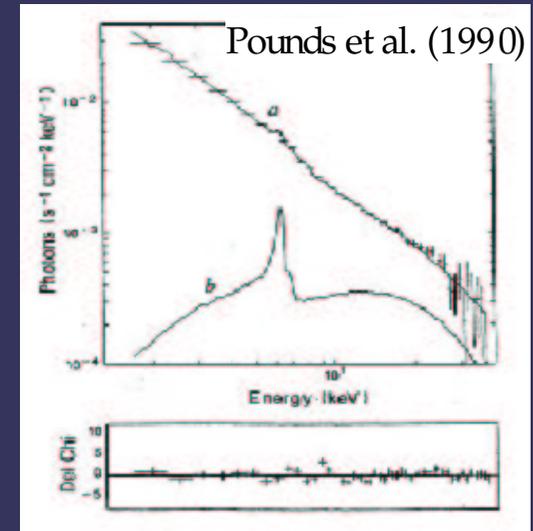
# The Reflection Components



## Simulation



## Observation

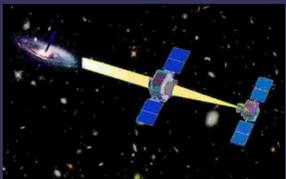


Photoelectric effects

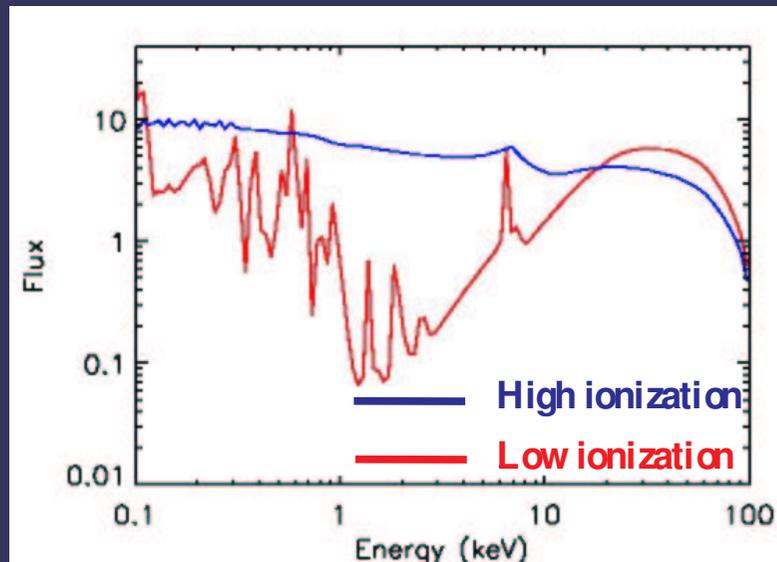
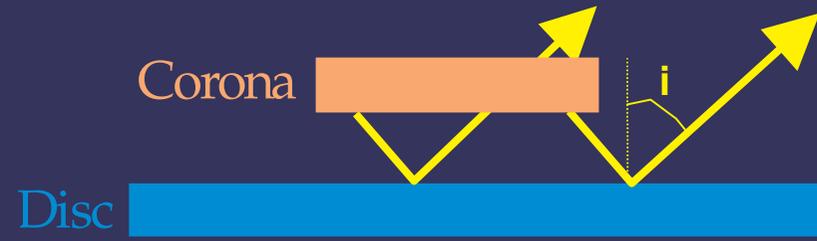
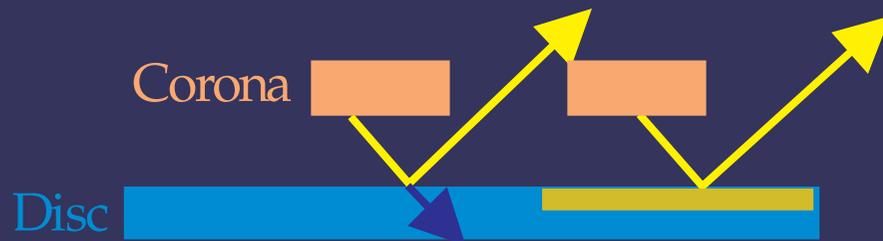
Klein-Nishina effects

It is dominated by:

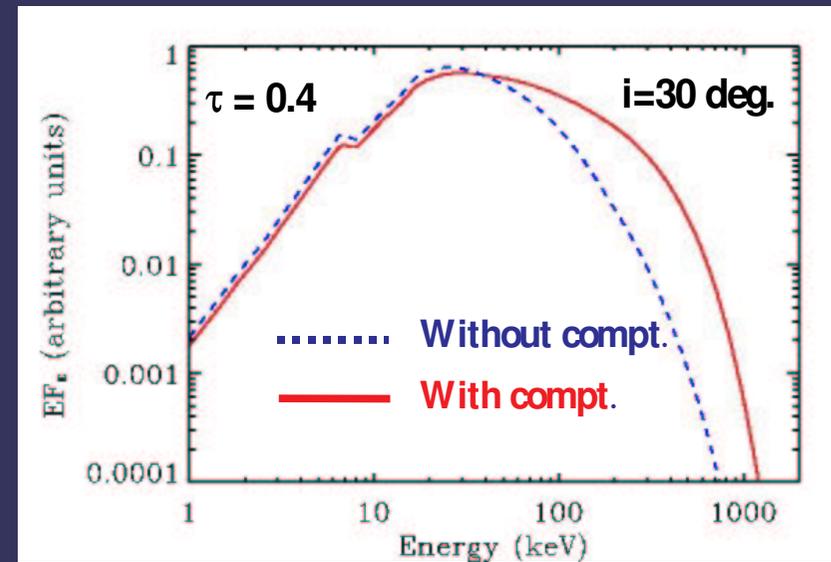
- ] a fluorescent iron line complex
- ] X-ray bump peaking near 30 keV



Its exact shape depends on the characteristics of the reflecting material (ionisation level, comptonisation, ....)



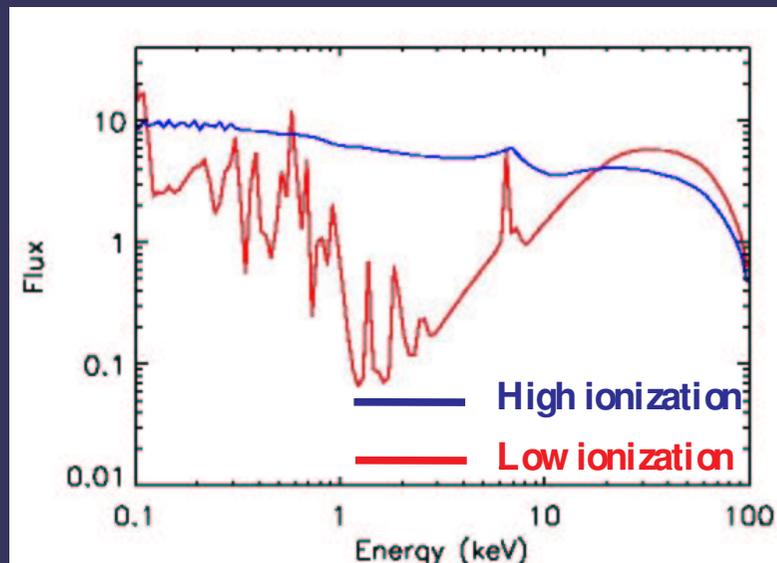
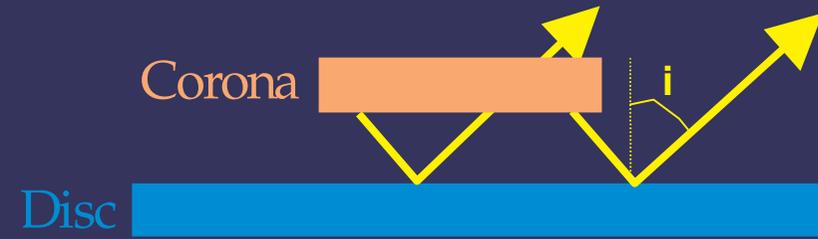
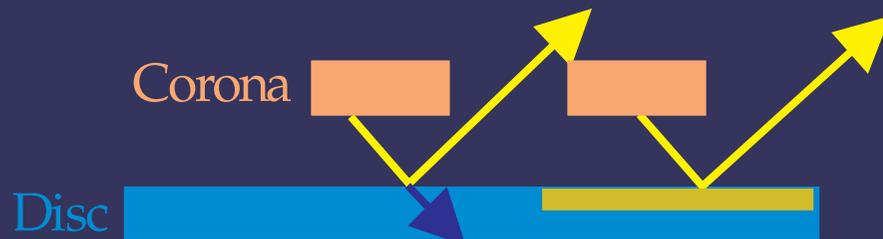
Effect of Ionisation



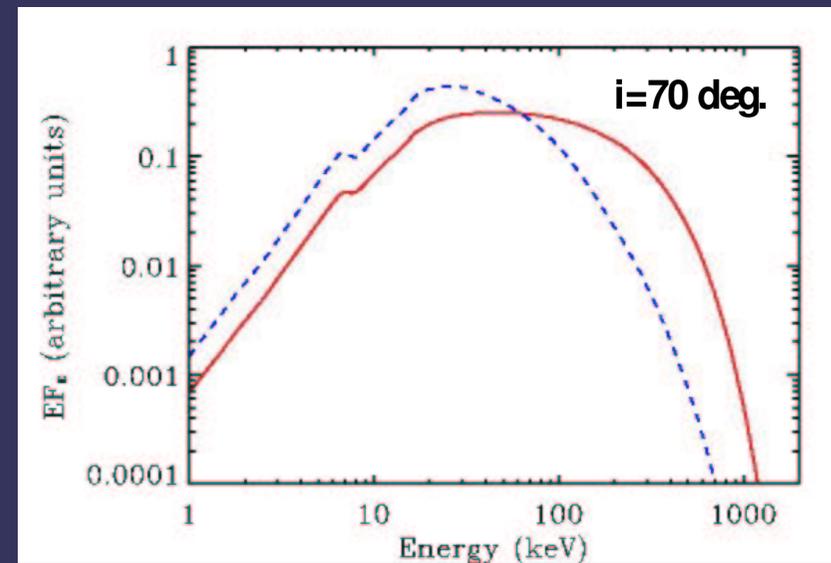
Effect of Comptonisation



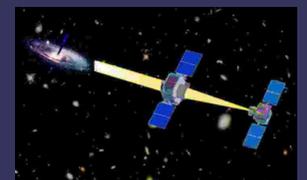
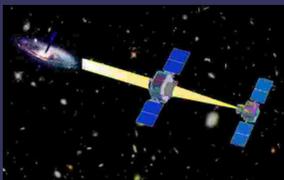
Its exact shape depends on the characteristics of the reflecting material (ionisation level, comptonisation, ....)



Effect of Ionisation

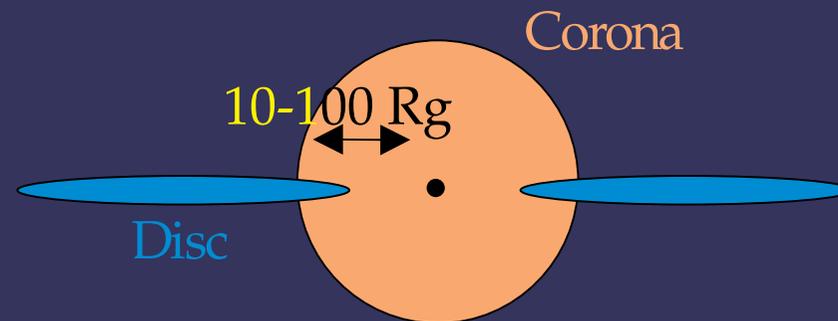
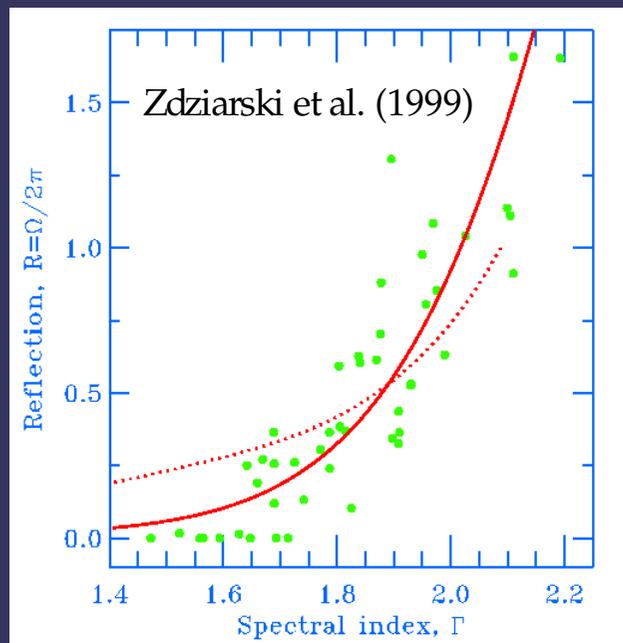


Effect of Comptonisation

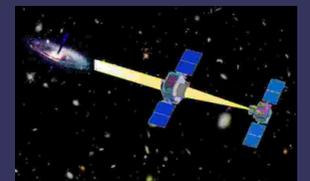
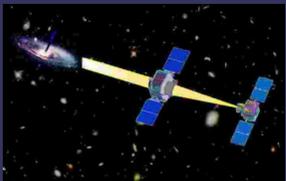


It can give also strong insights of the geometry of the emitting region:

- Rapidly/slowly variable  $n$  close/remote reflecting material
- The  $R$ - $\Gamma$  correlation ( $R = \Delta\Omega/2\pi$ )

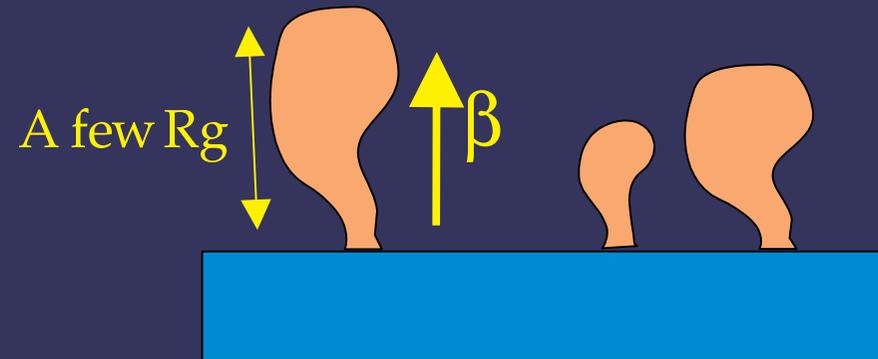
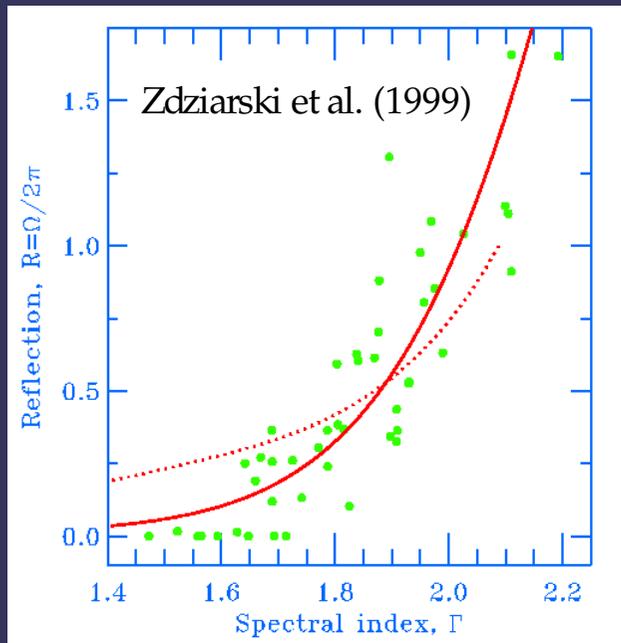


The more the disc inside the corona, the larger the cooling ( $\Gamma$  k) and the larger the reflection ( $R$  k)



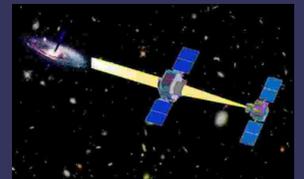
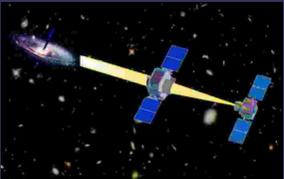
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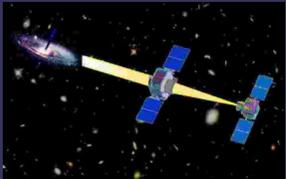


Beloborodov (1999)

If flares have relativistic velocity, the X-ray emission will be highly anisotropic (less X-rays toward the disc). The larger  $\beta=v/c$ , the smaller the cooling ( $\Gamma_m$ ), the smaller the refl. ( $R_m$ )



# The Expected Science with SIMBOL-X

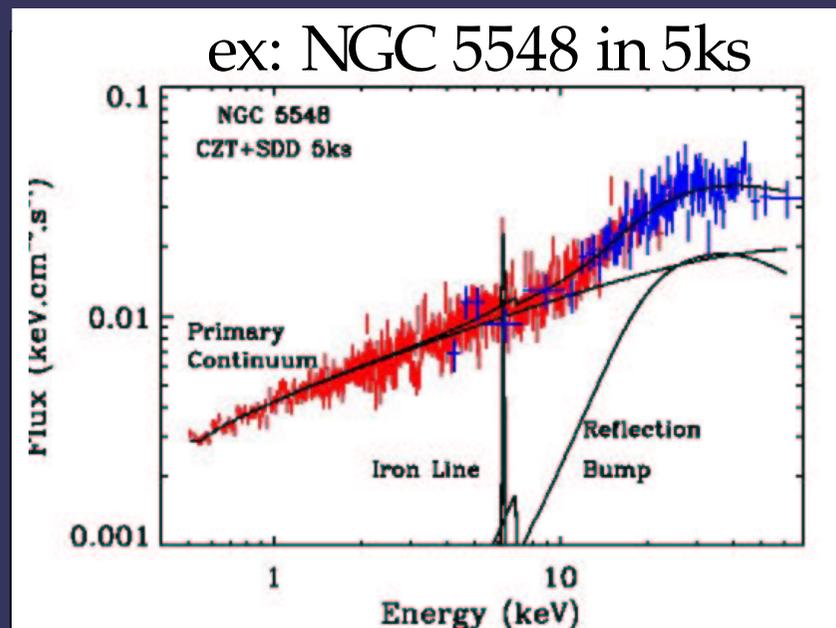


SIMBOL-X workshop, Paris 2004 March 11-12

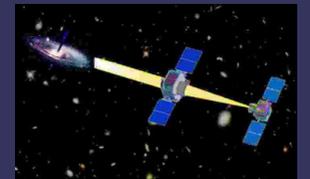
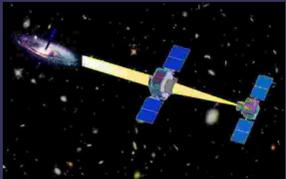


# I Spectral Fitting

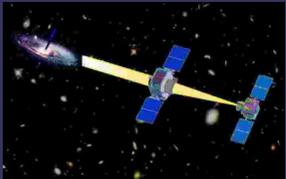
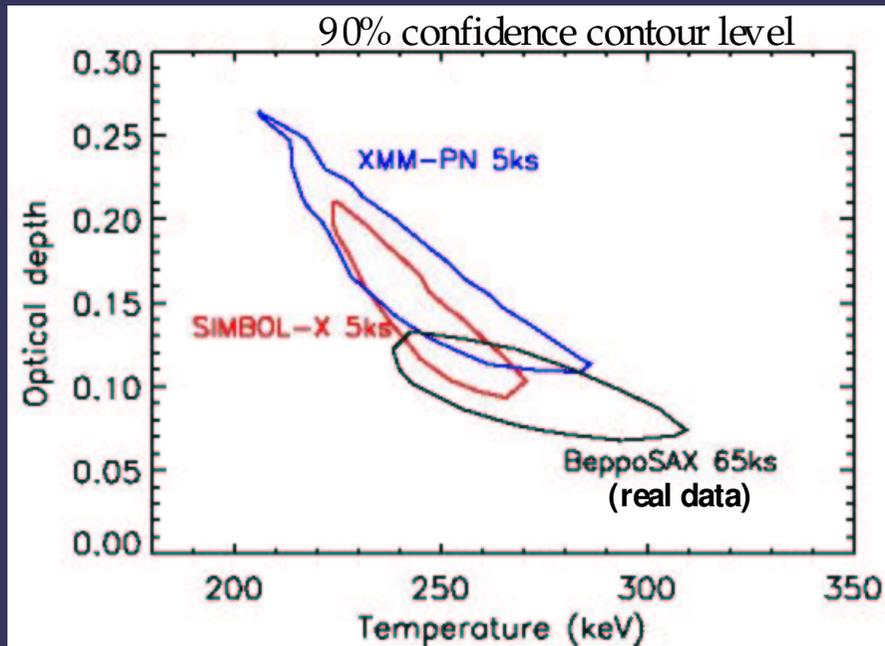
SIMBOL-X will permit to obtain very precise spectra in small time scale ( $\sim$  dynamical time scale), well constraining the main spectral features of the high energy RQ emission (continuum, Fe line, reflection bump)...



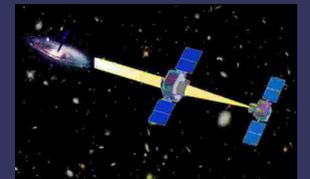
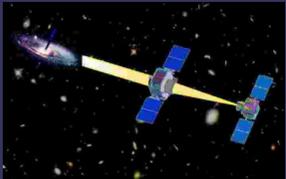
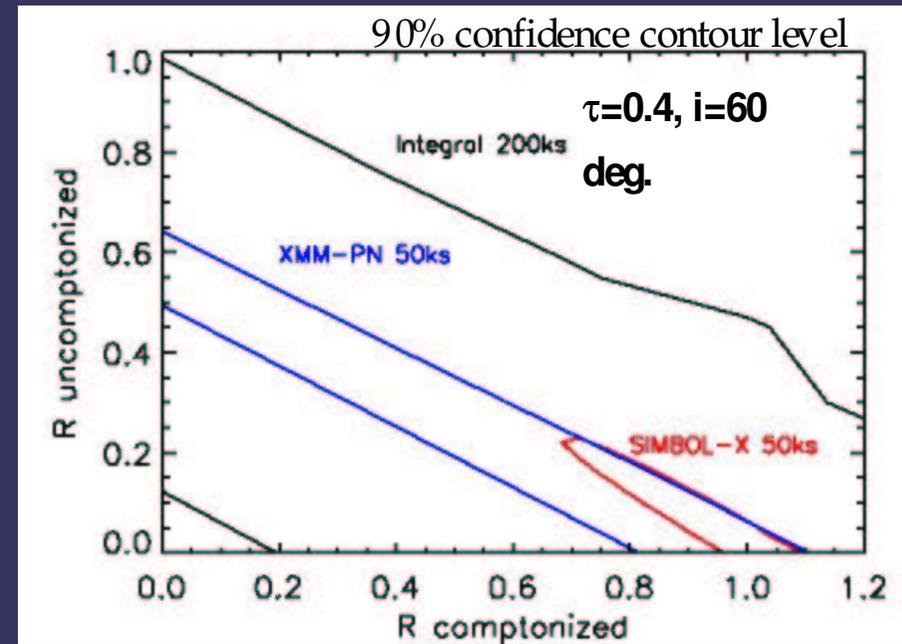
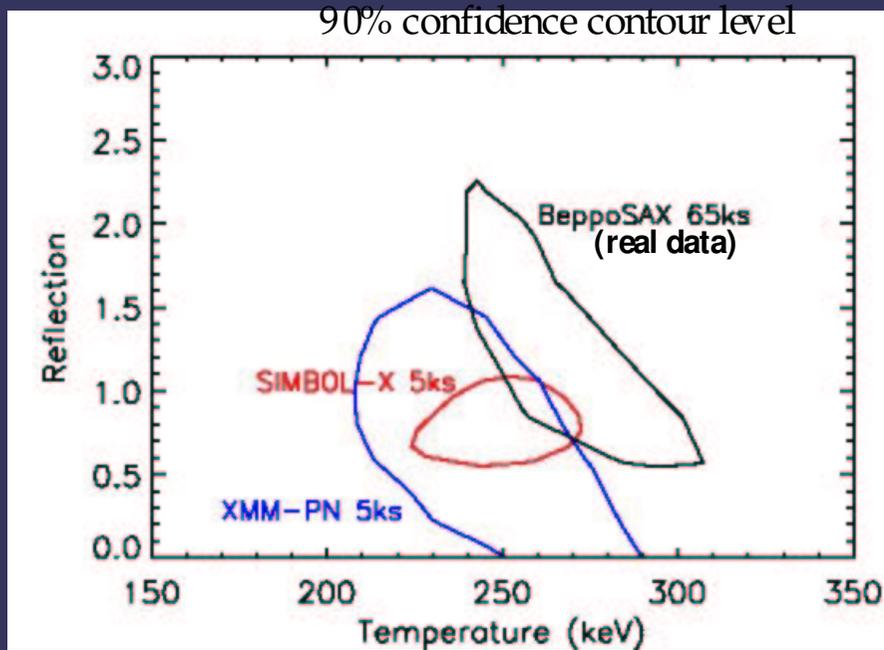
Never been done on so short a time scale!



... well better than BeppoSAX, INTEGRAL or XMM.



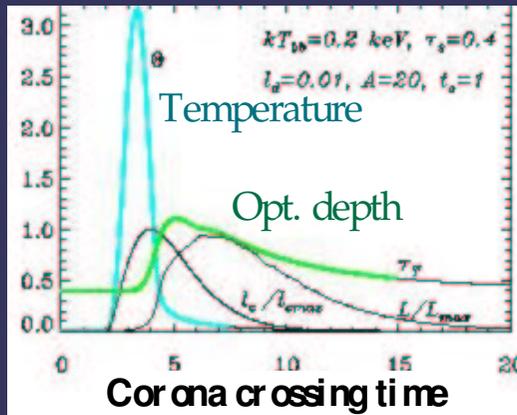
... well better than BeppoSAX, INTEGRAL or XMM.



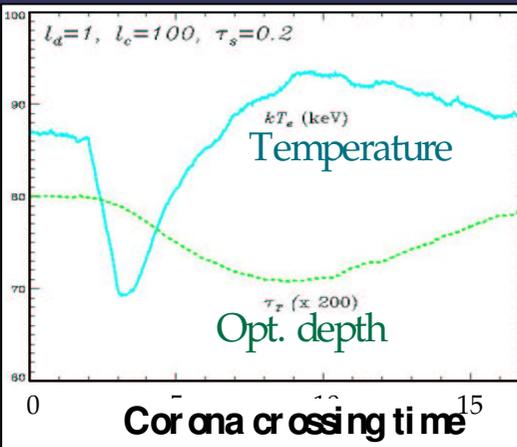
# II Spectral Variability Studies

Does the X-ray variability originate in the disc, in the corona ?

## Coronal flare

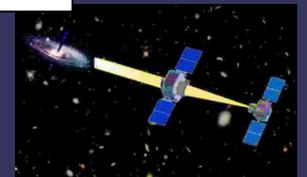
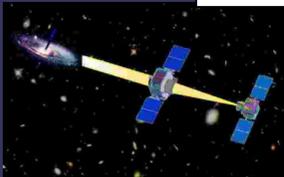
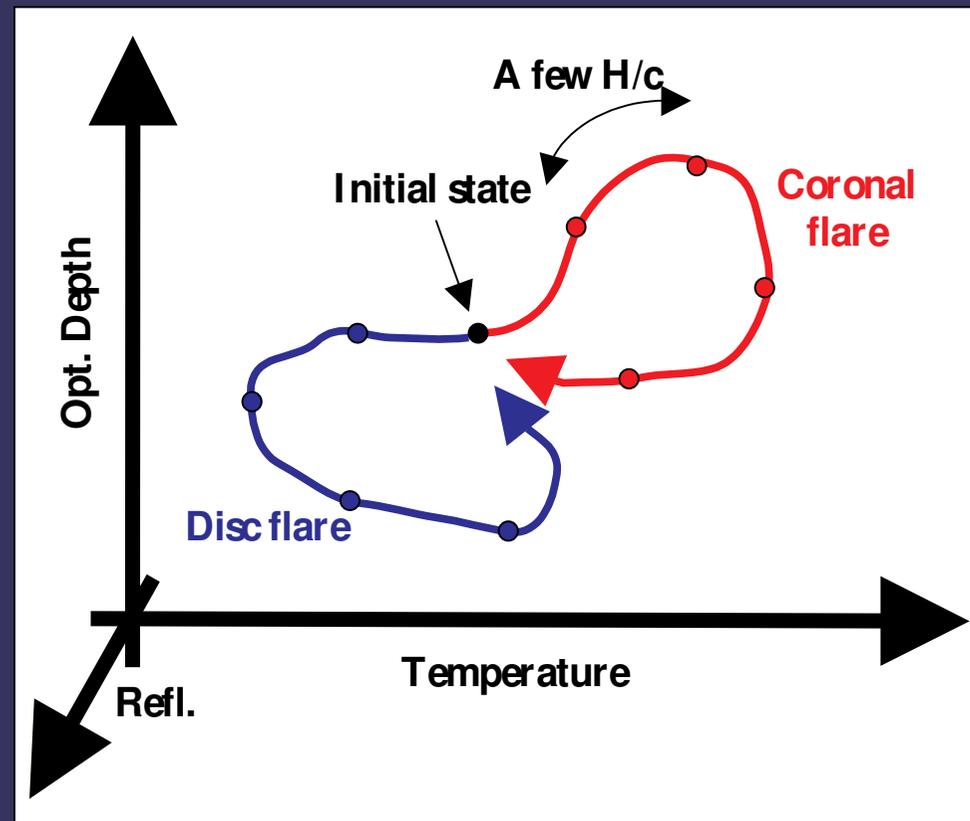


## Disc flare

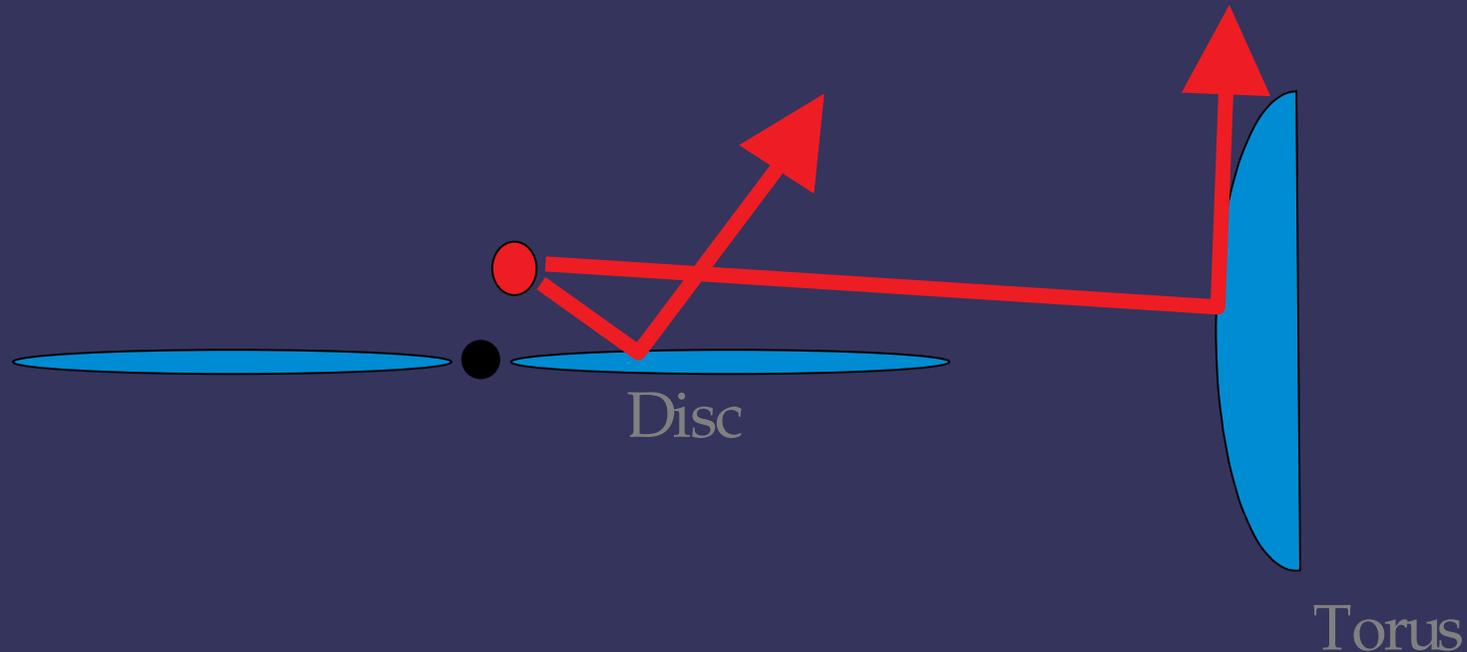


Malzac & Jourdain (2000)

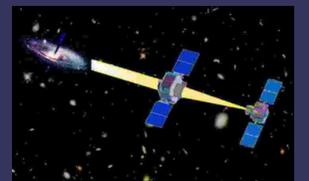
Different spectral behaviour are expected!



. Is the reflection component rapidly variable on small ( $\sim t_{\text{dyn}}$ ) time scales? What part (if any) of it is slowly variable?

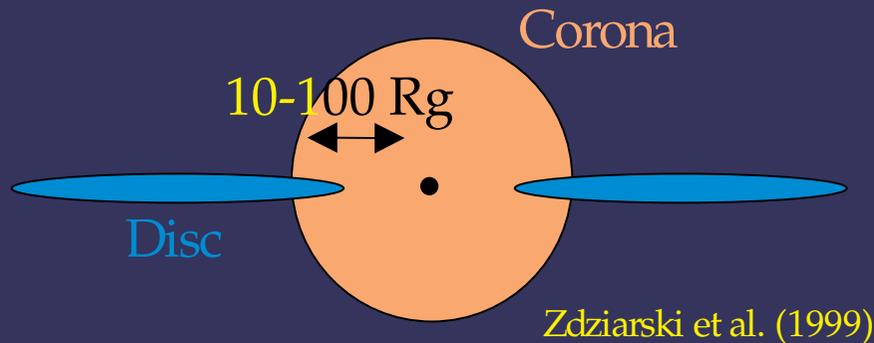


1 Reverberation mapping of the reflecting material  
(coupled with the line variability)

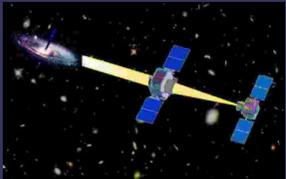
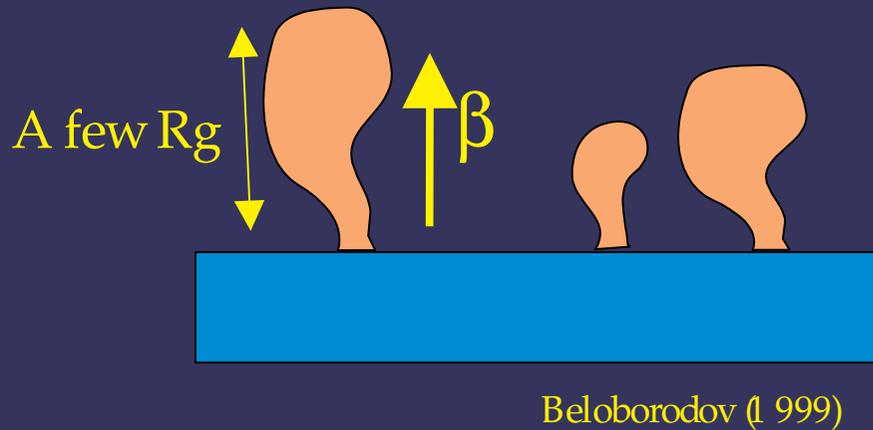


Does the R- $\Gamma$  correlation still exist on small ( $\sim t_{\text{dyn}}$ ) time scales?

Not Expected...

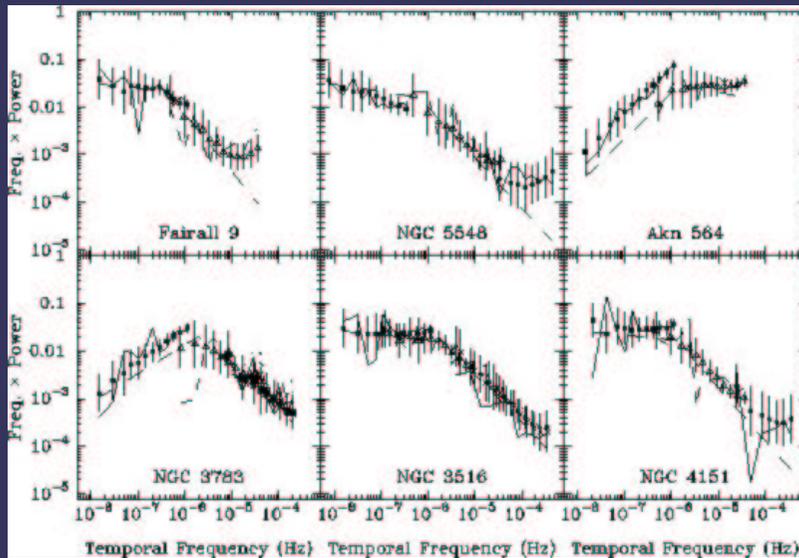


Expected...



# III Temporal Variability Studies

PSD exist below  $\sim 20$  keV for AGNs



Markowitz et al. (2002)

With SIMBOL-X we will be able:

- To produce PSD up to 70 keV !
- To look for QPOs at high energies



# Conclusion

1) SIMBOL-X will allow for the first time observations of the almost **complete** X-ray spectra of RG AGNs on **dynamical time scale!**

2) SIMBOL-X will be the only mission with such sensitivity up to 70 keV until the launch of XEUS in 2016

