UGC 11763: A NLS1 seen through the eye of the XMM-Newton satellite

Mónica V. Cardaci

Collaborators:
María Santos-Lleó (ESAC), YairKrongold (UNAM),
Guillermo Hägele (UAM), Ángeles I. Díaz (UAM)
& Pedro Rodríguez-Pascual (ESAC),

A&Asubmitted

Estallidos VII – Miraflores de la Sierra (Madrid) – January 2009

What is a NLS1?

A Narrow Line Seyfert 1 is an AGN whose spectrum have Seyfert1 and Seyfert 2 signatures:

-Seyfert 1:

- ✓ X-rays, optical and bolometric luminosities
- ✓ strong featureless continuum
- ✓ strong Fe II emission lines
- ✓ intensity ratio of emission lines

-Seyfert2:

- ✓ line widths of the emission lines

The more accepted paradigm is that they have a 10^7 $M_\odot$ black hole accreting at near the Eddington rate.

signatures of NLS1s

- ✓Hβ <2000 km/s(Osterbrock&Pogge 1985)
- ✓[OIII] λ5007/Hβ < 3 (Shuder&Osterbrock 1981)
- ✓ strong Fe II emitters
- ✓ weak emission from the narrow line region (Constantin& Shields, 2003)

X-ray

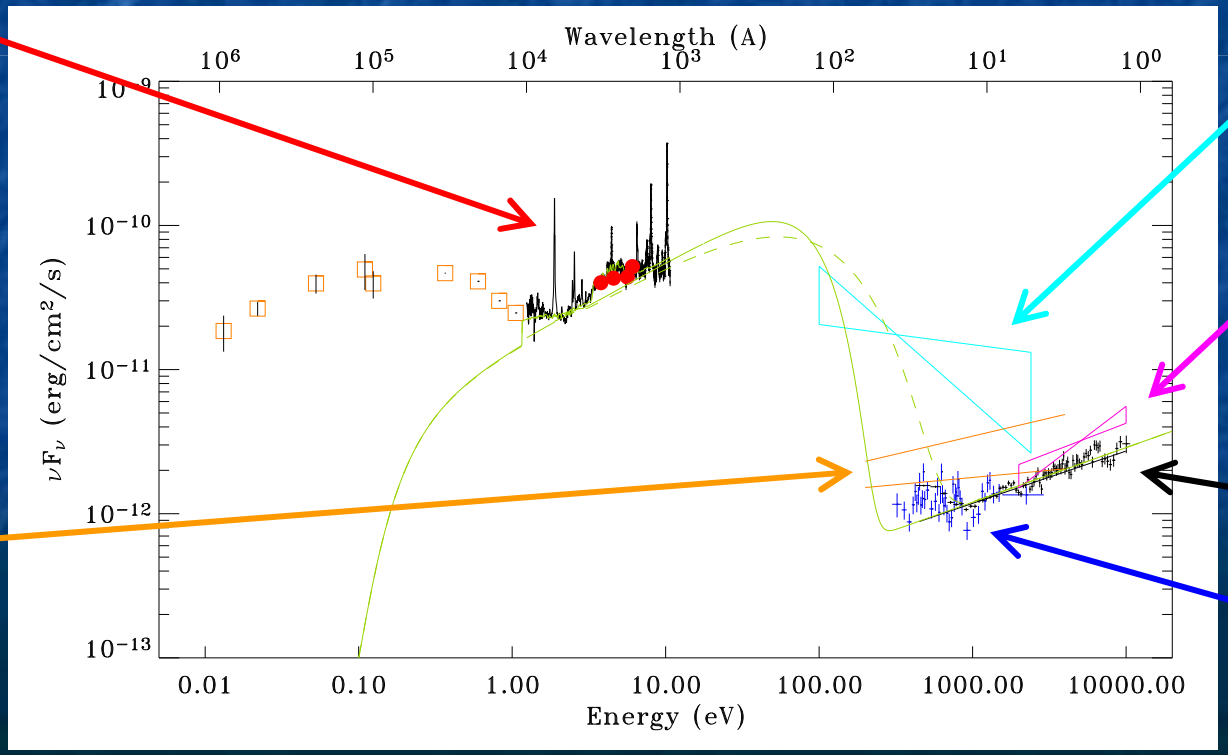
- ✓strong soft X-ray excess emission (Boller et al. 1996)
- ✓rapid and large-amplitude variability of the soft excess (Boller2000, Brandt et al. 1997)
- ✓generally steeper hard X-ray continua than Sy1s (Brandt et al. 1997)

Why UGC 11763 ?

- bright NLS1 galaxy:
  - apparent B magnitude: 14.92 (Singh et al. 1991)
  - absolute B magnitude: -23.92 (Schmith& Green 1983)
- near object: z=0.063 (Huchra et al. 1999)
- $\alpha_{2000}=21^h\ 32^m\ 27^s.8$ $\delta_{2000} = +10^o\ 08'\ 19''$
- low neutral Galactic Hydrogen content in the line of sight: $nH=4.67 \times 10^{20}\ cm^{-2}$ (Dickey &Lockman 1990)
- in the ROSAT bright sources catalog
- observed by XMM-Newton in 2003 (39 Ks)

UGC 11763

- strong infrared emission (Edelson 1986.ApJ.309.L69)
- UV bump with T=35500 K (Edelson & Malkan 1986.ApJ.308.59)



IUE & OM

Einstein

(Kruper 1990)

ROSAT

(Schartel1995)

Ginga

(Williams 1992)

EPIC-pn

RGS

Objectives

A detailed analysis of all data taken by the XMM-Newton satellite: hard and soft X-ray data (0.35-10 keV, i.e. 1.2-35.4 Å) and UV data

- Characterise the continuum emission
- Identify possible emission and absorption features in the X-ray spectra and infer the physical conditions of the material in which they are produced

Instruments

OM: UV filters

filter	U	UVW1	UVM2	UVW2
Eff. wavelength	3440 Å	2910 Å	2310 Å	2120 Å

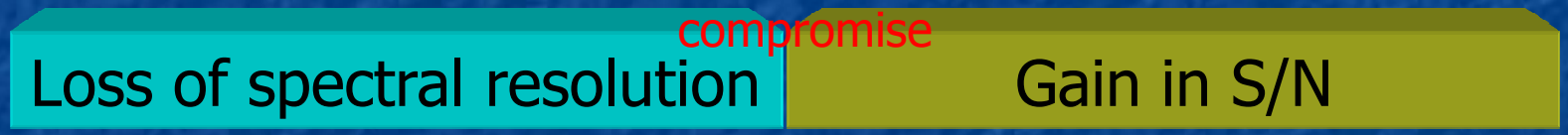
X-rays detectors

	EPIC-pn	EPIC- MOSs	RGSs
Bandpass	0.15 - 15 keV	0.15 - 12 keV	0.35 - 2.5 keV (5 – 35 Å)
Spectral resolution	80 eV at 1keV (150 eV at 6.4keV)	70 eV at 1keV (150 eV at 6.4keV)	3.2 eV at 1keV (57 – 70 mÅ)

All the XMM-Newton data are obtained simultaneously

Observations

- UGC was observed on 2003 (May 16) during 39 Ksec
- standard processing using SAS 7.0.0
- binning of X-ray data (needed due to the over-sampling of the spectra and the low count rate of them)



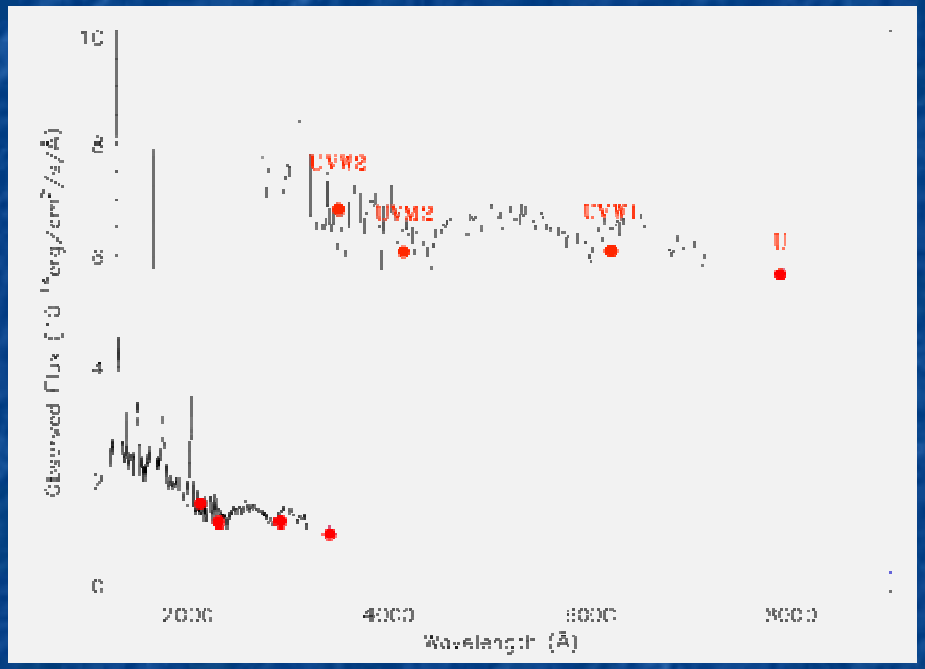
- ranges used for the fitting process:

  EPIC : 0.35 – 10 keV

  RGS : 0.41 – 1.8 keV

UV data

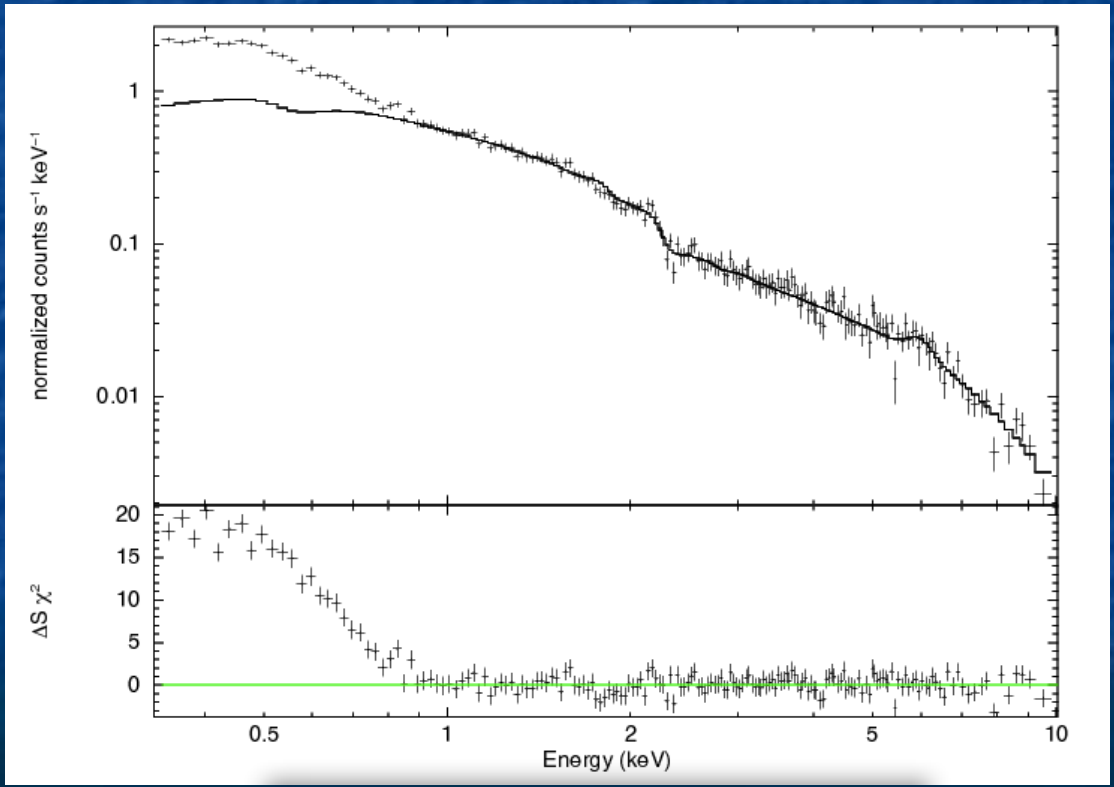
OM spectra very weak, we only can take colors in the 4 filters. Comparing this colors with the IUE mean spectrum:



Average IUE spectrum combined with the optical spectrum by deBruin&Sargent (1978) are in acceptable agreement with the XMM-data at the time of observation.

PN 2-10 keV fit

We use EPIC-pn data in the **2 – 10 keV** to find a model for describing the **hard X-ray** emission of the source



Power-law

Γ = 1.69 (+/- 0.06)

dof = 109 χ^2_{dof} = 0.99

Fe kα

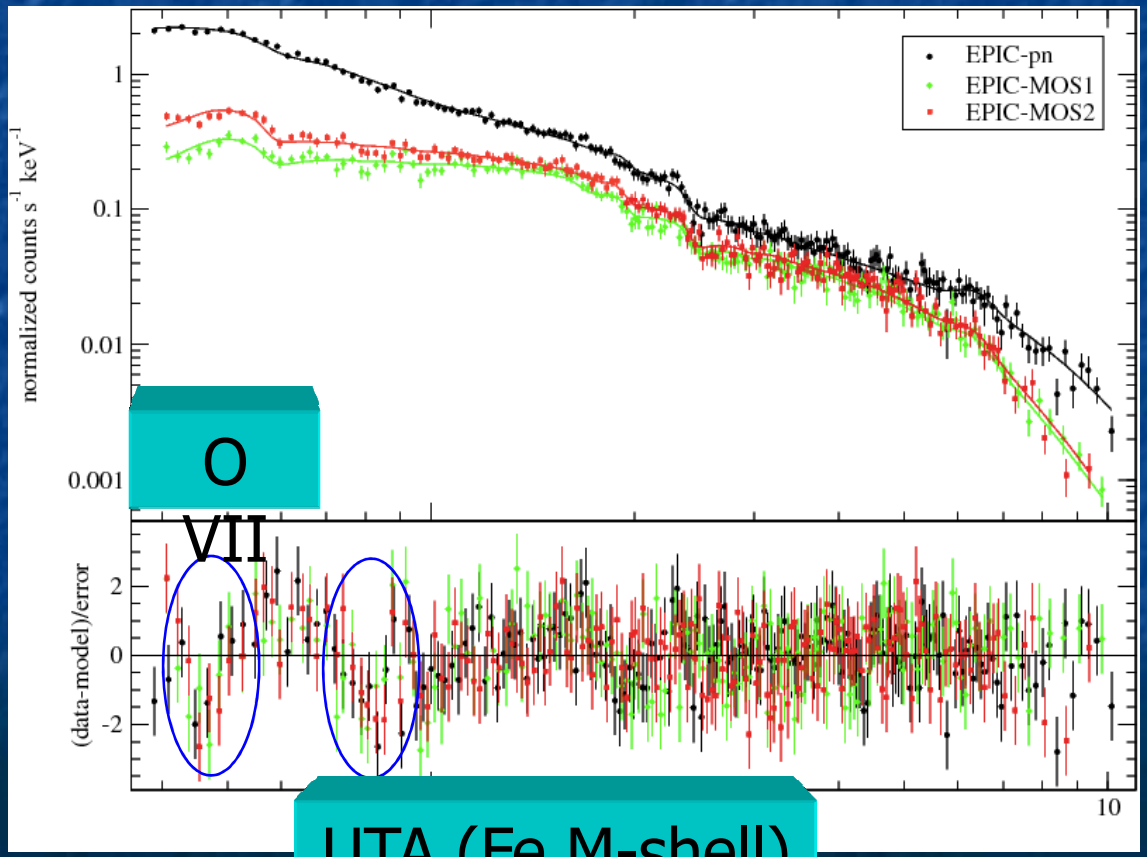
E_{line}=6.35 keV (+0.16, -0.34)

EW ≈ 0.2 keV

Soft X-rays excess

EPIC 0.35-10 keV fit

We use all the EPIC data in the **0.35 – 10 keV** to find a model for describing the continuum **X-ray** emission of the source



Power-law, Bbody, Fe

$\Gamma \sim 1.62$ (+/- 0.02)

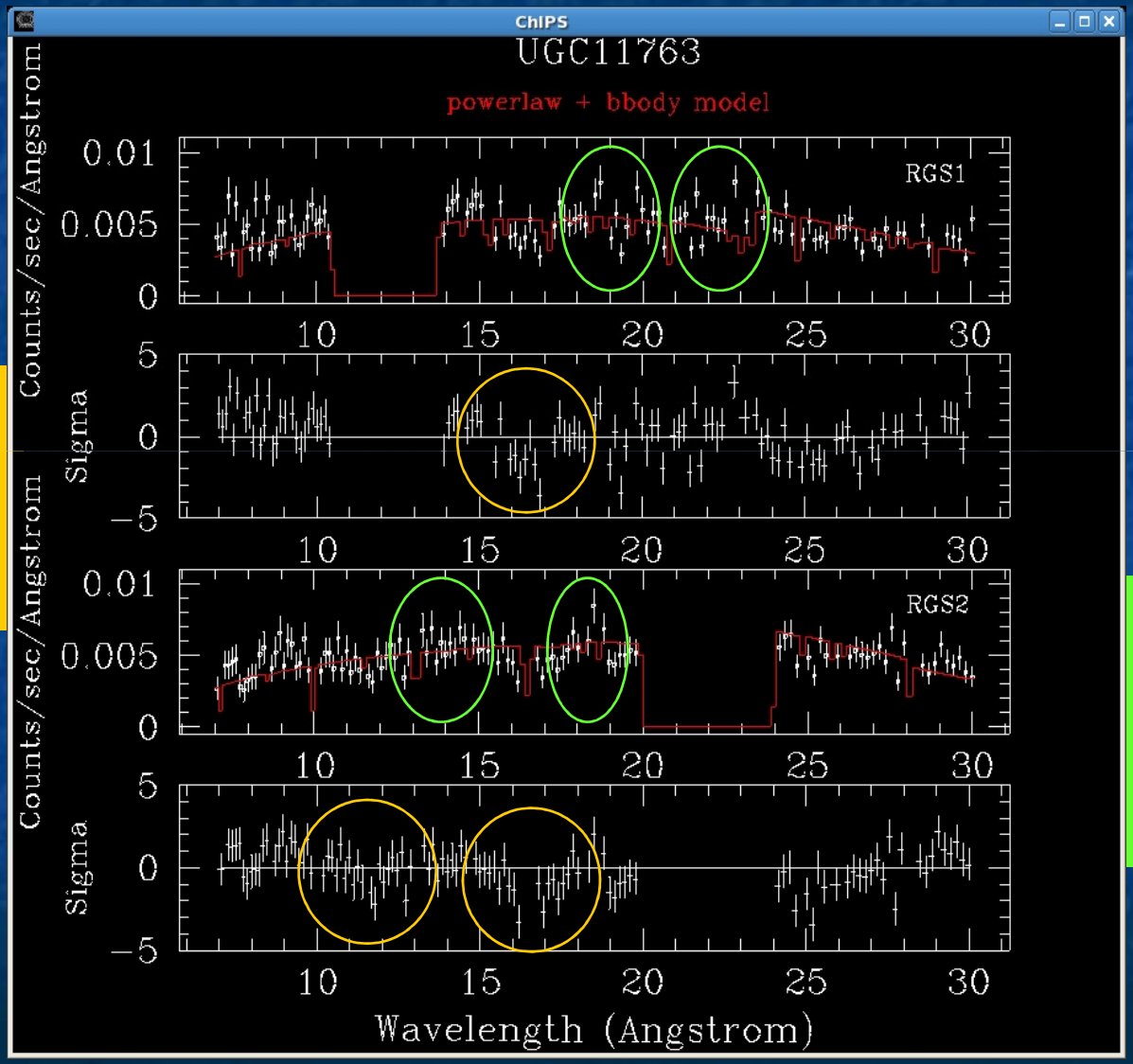
kT ~ 0.090 (+/- 0.002) keV

E_{line} 6.4 (+0.2, -0.3)

dof = 509

$\chi^2_{dof} = 0.97$

Epic model in RGS spectra



Warm absorption features

(UTA)

line features:
Oviii Lα
OviiHeα
Fe xviii
NeixHeα

All X-ray spectra fit

THE MODEL:

- ✧ power law to describe the hard X-ray spectra
- ✧ black body to account for the soft excess
- ✧ Fe kα line (weak and wide but significant)
- ✧ warm absorber components to characterize the broad UTA features (**PH**otoinised**A**bsorption**S**pectral**E**ngine model, Krongold et al. 2003)
- ✧ Gaussian profiles to model the emission signatures

PHASE code parameters

- ○ ionization parameter U: ratio between the density of ionizing photons andthedensity of hydrogen atoms.
- ○ column density of the absorbing media
- ○velocity of the material

Best fit model

Parameters:

- power law (hard X-ray emission): $\Gamma \sim 1.72$ (+0.02, -0.01)
- black body (soft excess): kT ~ 0.1 (+/-0.003) keV
- partially ionized media with 2 distinct ionization states:

LIC: log U ~ 1.5 (+0.2,-0.4), nH ~ $10^{21.1\ (+/-\ 0.2)}$ cm^{-2}, vel ~ 500 km/s

HIC: log U ~ 2.5 (+0.1, -), nH~ $10^{21.52\ (+/-\ 0.02)}$ cm^{-2}, vel ~ 500 km/s

- narrow emission lines (added only in the RGSs models)

O vii Heαf (λ 22.1 Å): 21.97 Å
O vii Heαr (λ 21.4 Å): 21.41 Å
[O viii Lα (λ18.7 Å): 18.9 Å]
Fe xviii (17.6): λ 17.5 Å
Neix(blend ofλλ 13.3, 13.5, 13.9 Å): 13.5 Å

λ not well constrained

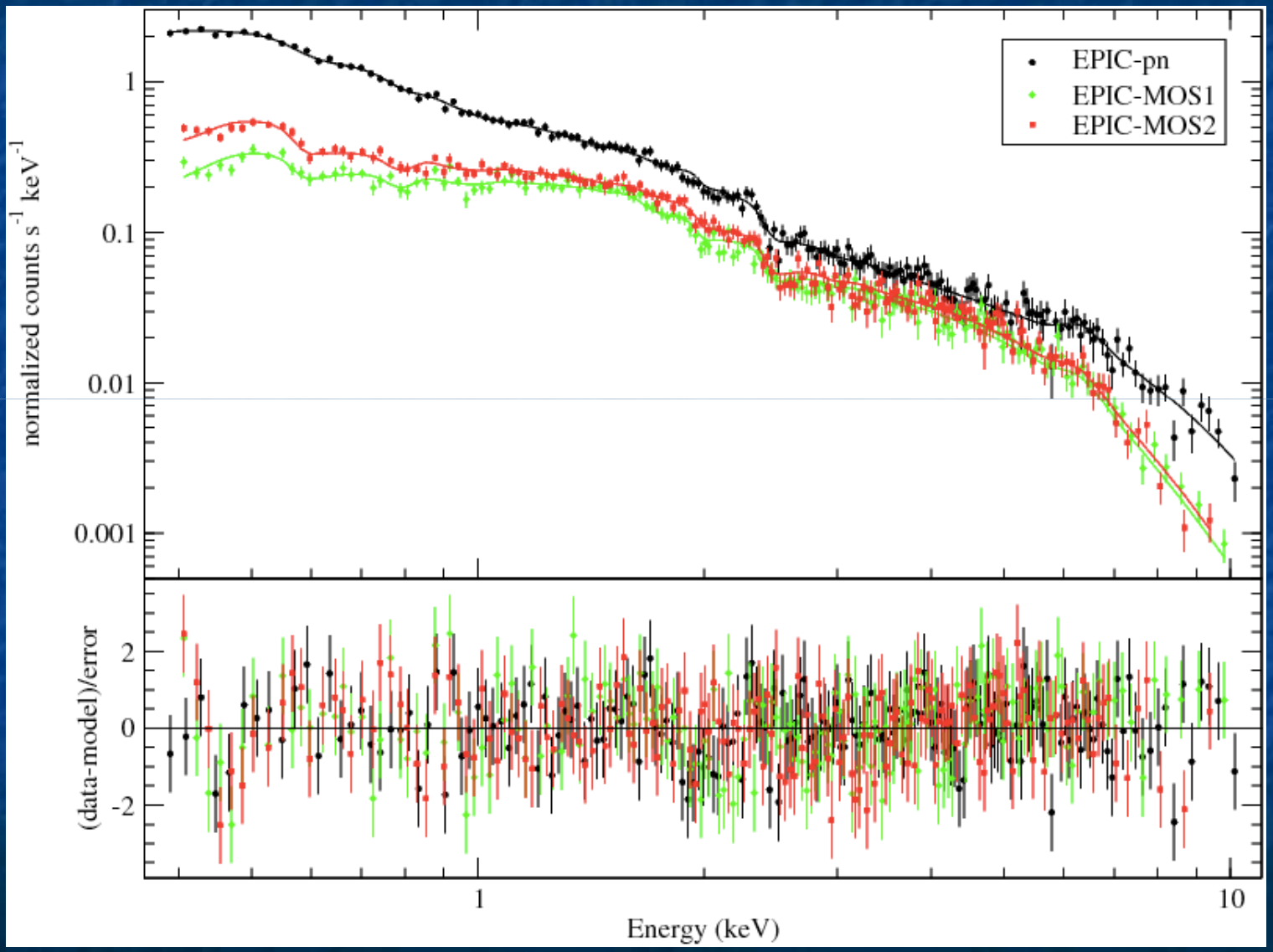
low significance

σ not well constrained

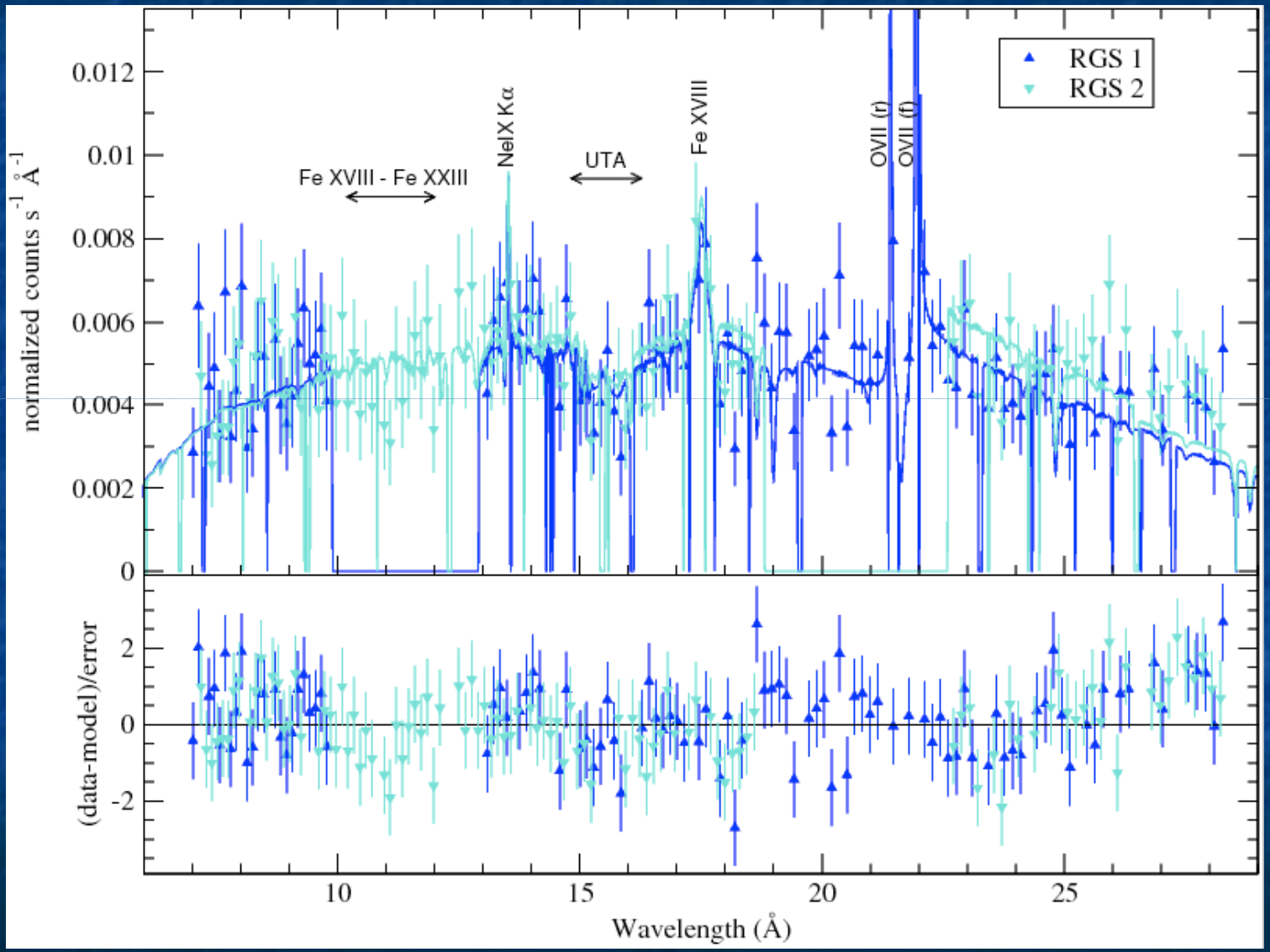
- Fe Kα weak and broad emission line: 6.36 keV (EW~200 eV)

X^2_{dof} = 0.9; dof = 703

Best fit model



Best fit model

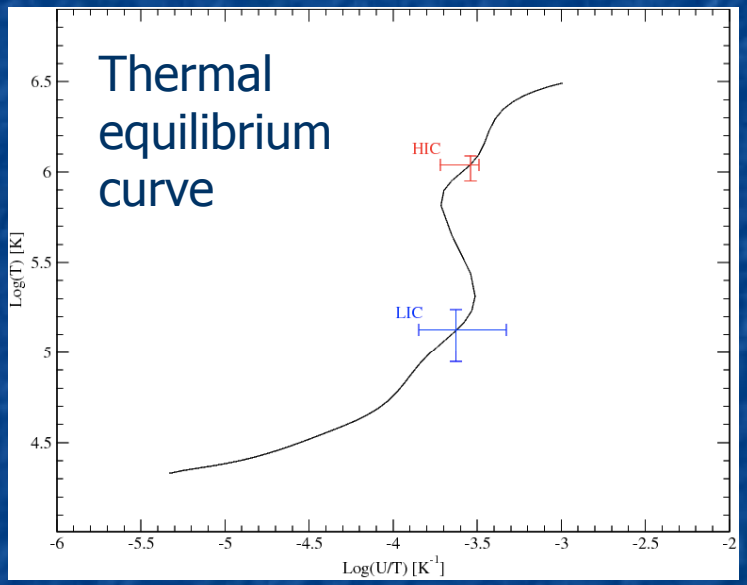


Results

- the hard X-rays power law has a rather standard spectral index for Sy1 galaxies (Piconcelli et al. 2005) and it is in agreement with that found using others instruments (Ginga, Williams et al. 1992; EXOSAT, Singh et al. 1991)
- this object shows an excess of soft X-ray emission over the hard power law (common feature in Sy1 X-ray spectra)
- the fluorescence Fe Kα line found is weak and broad (large errors in the line parameters) $\Rightarrow$ we consider this line has a very low significance
- soft X-rays band show strong signatures of ionized absorbing material. Two absorbing components are required to fit the data.

Results

Are the LIC and HIC part of a multiphase media?



points where heating and cooling processes are in equilibrium

log(U/T) is inversely proportional to gas pressure

vertical lines indicates isobaric conditions

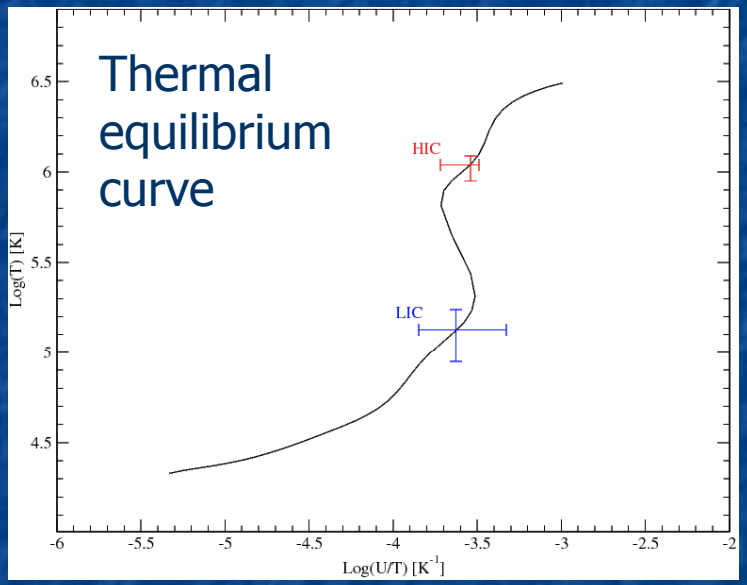
LIC & HIC lie in stable parts of the curve

consistent with having the same gas pressure

yes.... could be....

Results

Additional supports to the multiphase hypothesis



WA in other Seyfert galaxies are cooler: T ~few 10^4 K

and UTA produced by Fe VII-Fe XII

LIC temperature is 1.3 x 10^5 K

UTA formed by Fe XIII-Fe XV

Only gas a such temperature could coexist in pressure equilibrium with the HIC component

Summary and Conclusions

- we have analyzed all data taken by the XMM-Newton satellite of UGC 11763
- Joining the Optical-UV and X-ray information we built the SED
- continuum emission characterized by a power law and a black body
- continuum is absorbed by ionizing material
- two absorbing components (LIC and HIC) that are consistent with being in pressure equilibrium -> two phases of the same media
- UTA of higher ionization than those found in other AGNs
- emission lines, among them an unusual Fe XVIII emission line

A deeper observation is required to further study the properties of the absorber/emitter in this source