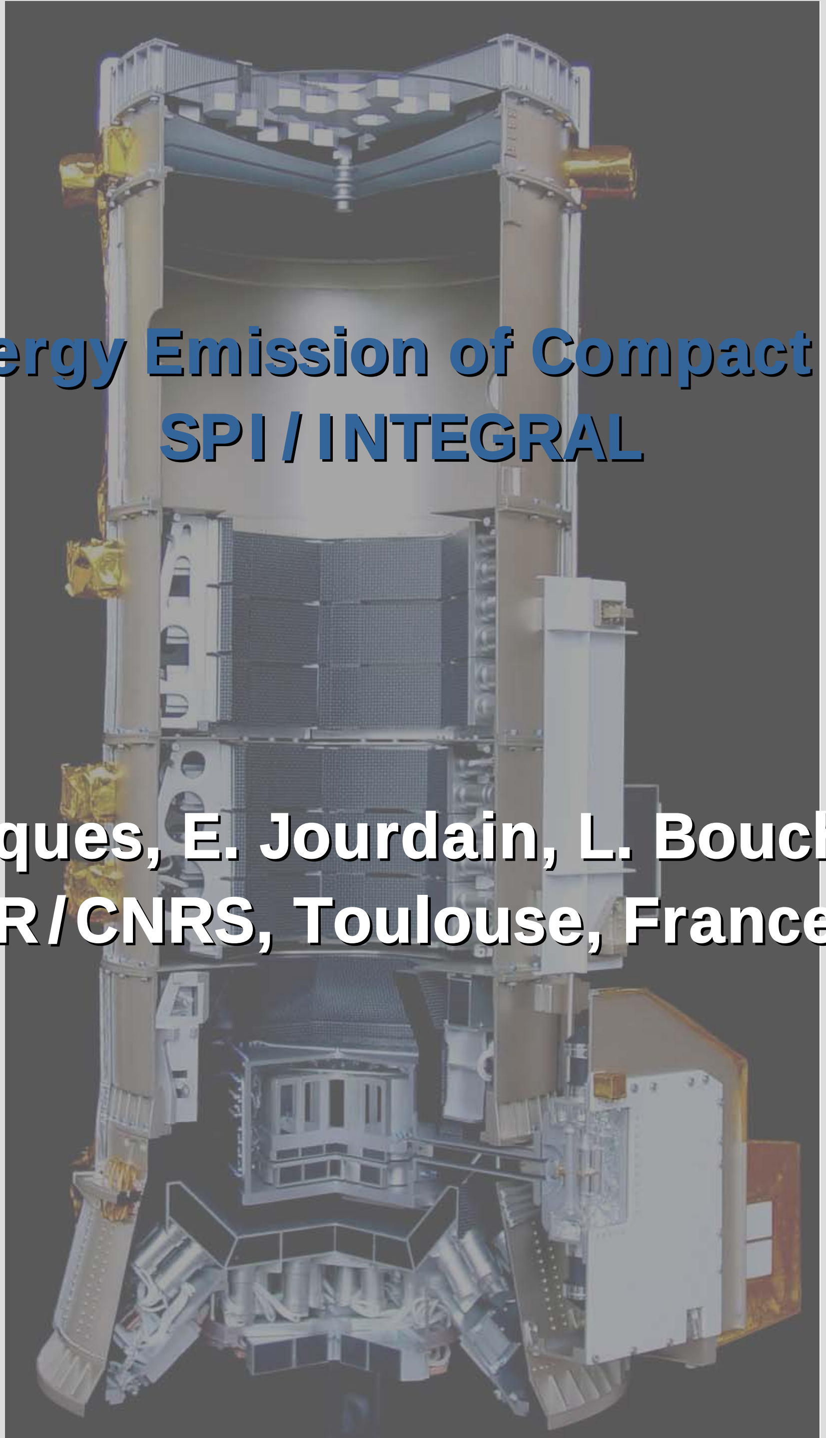


The High Energy Emission of Compact Objects with SPI / INTEGRAL

JP. Roques, E. Jourdain, L. Bouchet
CESR / CNRS, Toulouse, France

THE SPI/INTEGRAL TELESCOPE

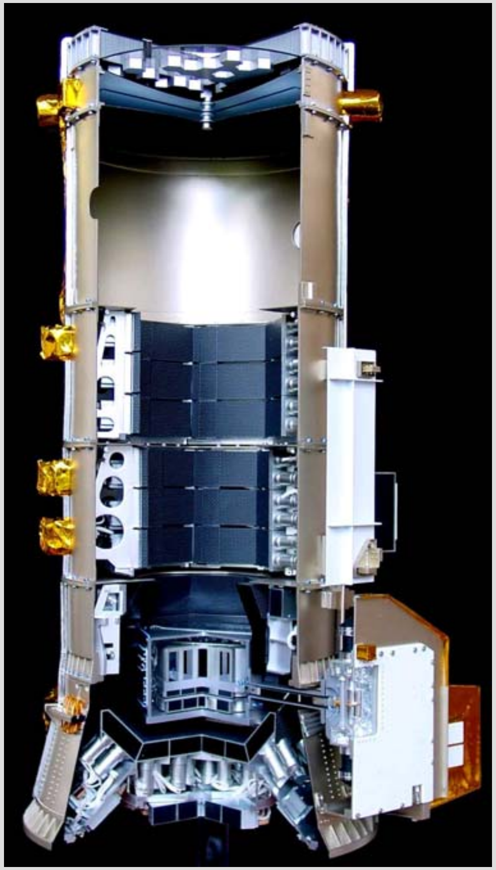
SPI

Imaging: 16° fully coded
FOV Angular resolution: 2.6°

Energy range : 20 keV-8 MeV
Energy resolution: 0.2 %

Shield: active BGO shield
Camera :19 HP Ge detectors.
Active cooling: 85 K

Timeresolution: 100 microsec



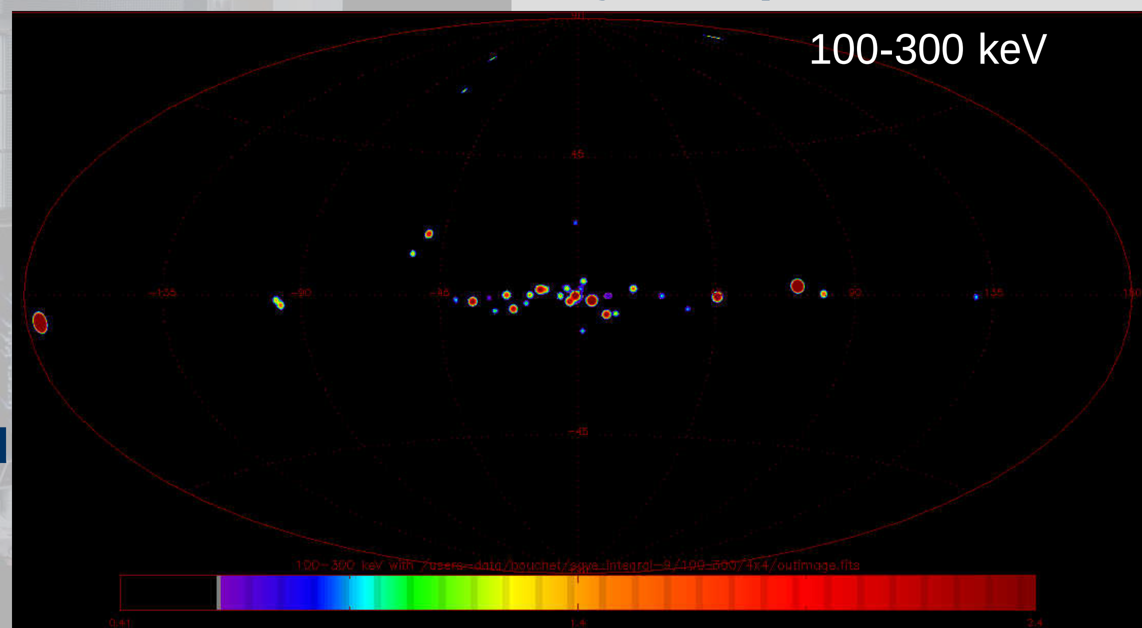
THE SKY IN HARD X-RAYS
WITH SPI / INTEGRAL

Survey Activity with INTEGRAL

SPI : extraction of source and diffuse emission fluxes simultaneously

Main goal : study of the total Galactic emission

- **Analysis of 4 years of public+CP data (~ 45 Ms)**
  (revolution 44 - February 2002 to revolution 441 - May 2006)



Results :

- **For diffuse emissions: see L. Bouchet talk**

- **~ 30 known sources detected (2σ) above 100 keV (mean / persistent flux)**

THE SKY IN HARD X-RAYS
WITH SPI / INTEGRAL

This work provides point source spectra integrated over the 4 years.

Transient phenomena are washed out.

This mixes all spectral states.

BUT

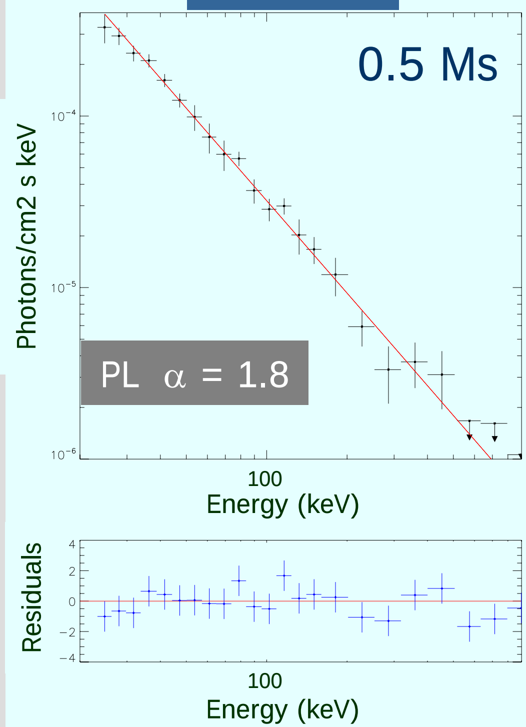
This allows a very deep survey at high energy.

THE SKY IN HARD X RAYS WITH SPI / INTEGRAL

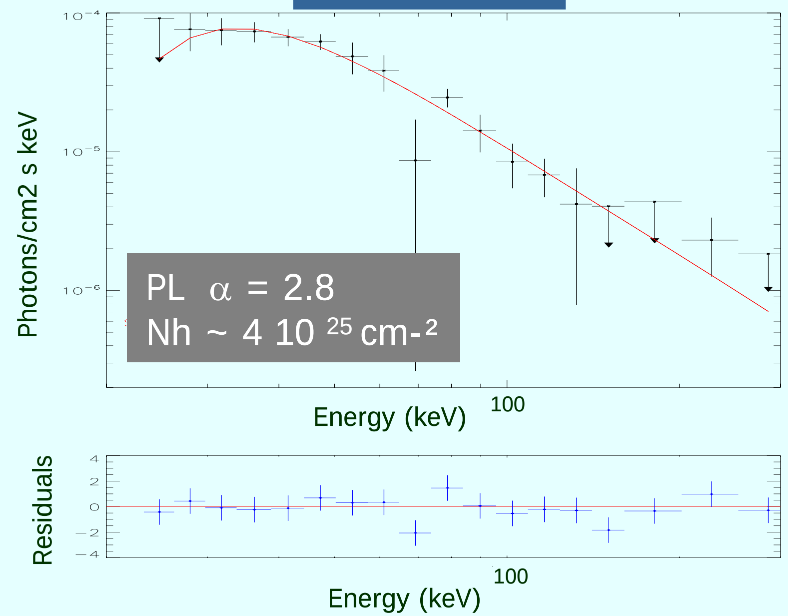
EXTRAGALACTIC CLASS

	F(100-300 keV) mcrab			σ
NGC_4151	26.09	+/-	6.29	4.15
NGC_4388	13.20	+/-	5.16	2.56
3C_273	10.81	+/-	4.54	2.38
NGC_4945	13.13	+/-	3.51	3.74
Cen_A	58.48	+/-	4.24	13.80
PKS 1830-211	4.45	+/-	1.83	2.44

CEN A

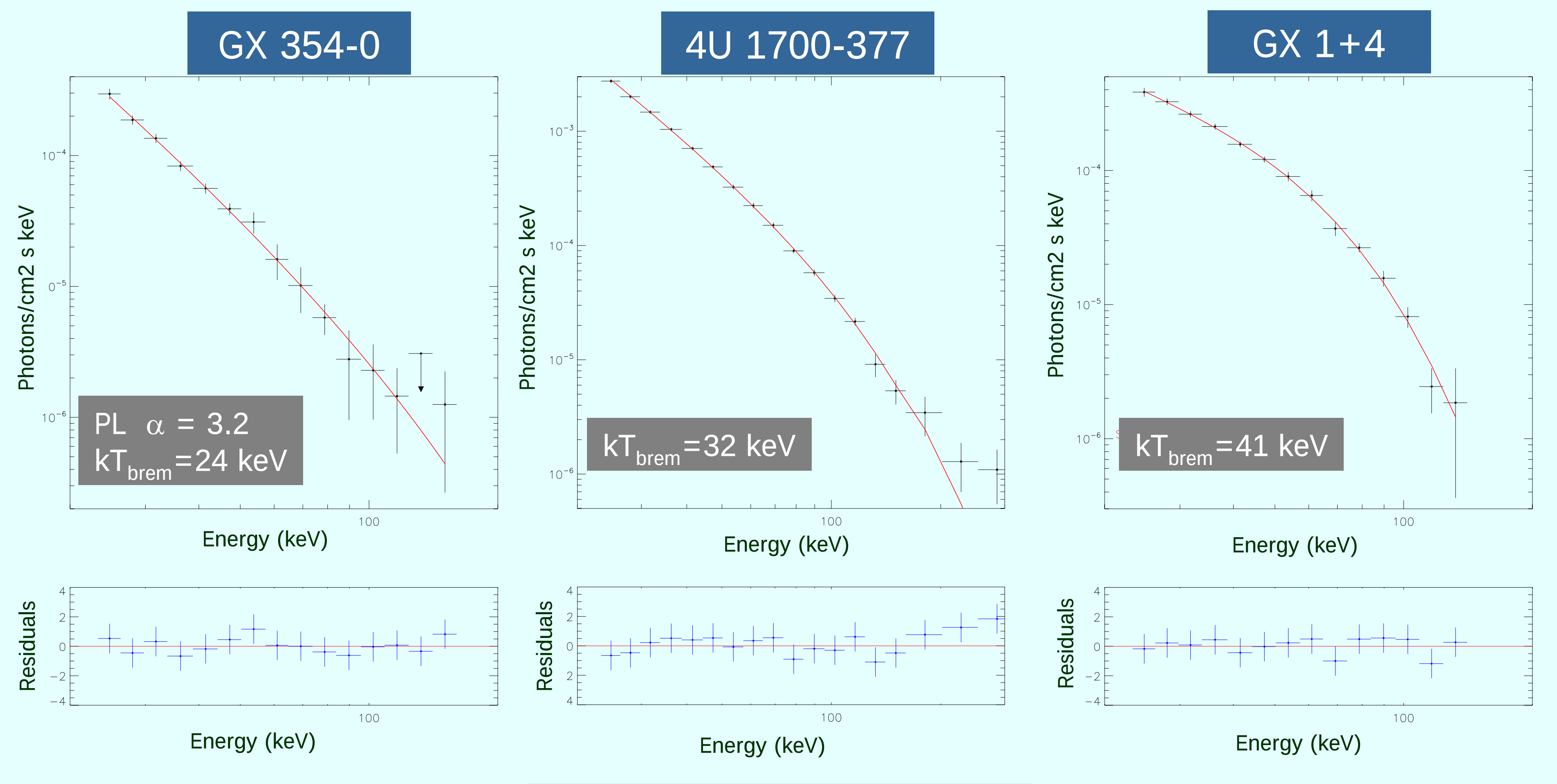


NGC 4945



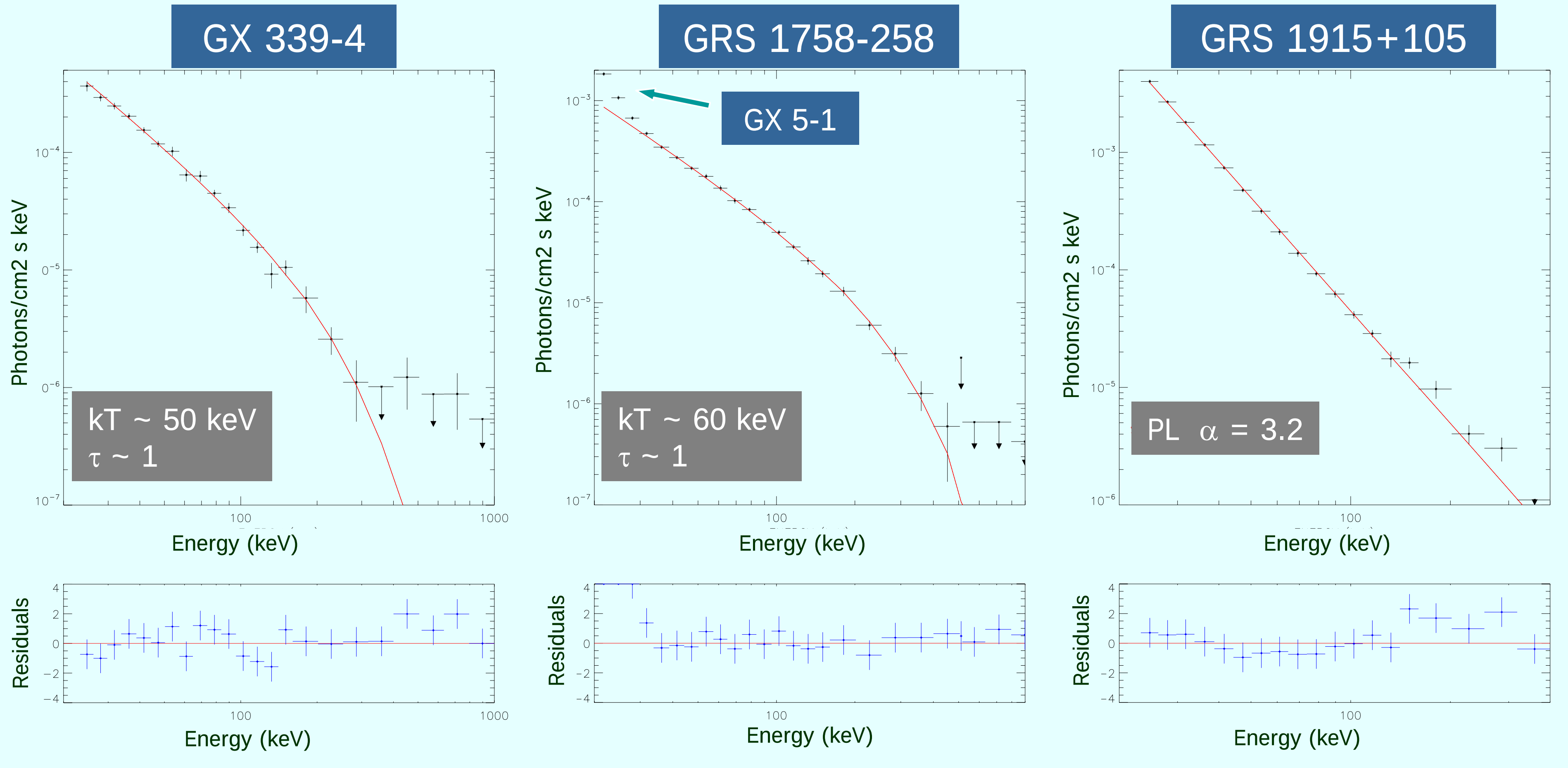
THE SKY IN HARD X RAYS
WITH SPI / INTEGRAL

GALACTIC CLASS : NEUTRON STAR SYSTEMS



THE SKY IN HARD X RAYS WITH SPI / INTEGRAL

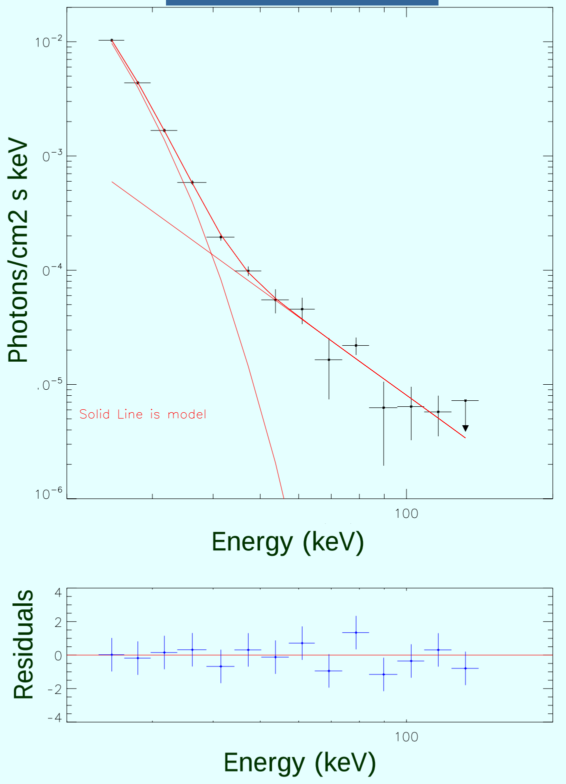
GALACTIC CLASS : BLACK HOLE CANDIDATE SYSTEMS



THE SKY IN HARD X RAYS

WITH SPI / INTEGRAL

SCO X-1



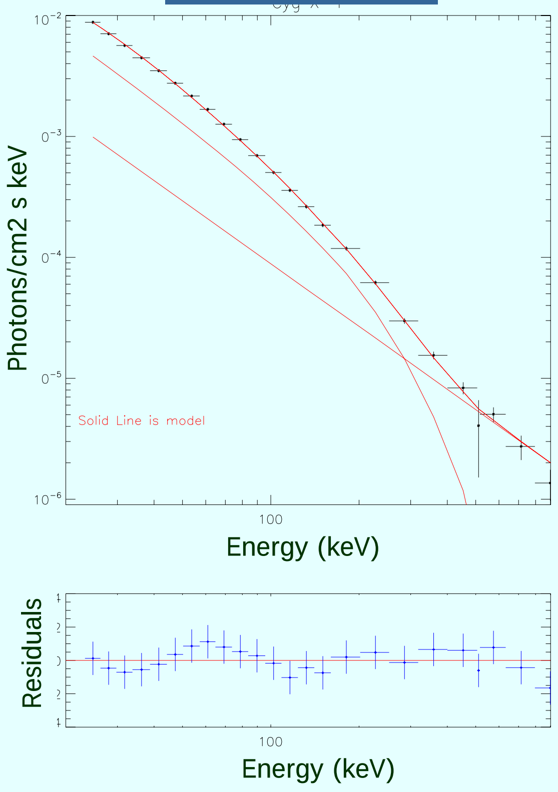
SCO X-1

Thermal Comptonization (comptt)
+ power law
photon index ~ 2
Or
kTbb =2.8 keV + power law
photon index ~ 3

Transient hard tail already observed (HEXTE, IBIS)
~ 25 – 30 % of the time

THE SKY IN HARD X RAYS
WITH SPI / INTEGRAL

CYG X-1



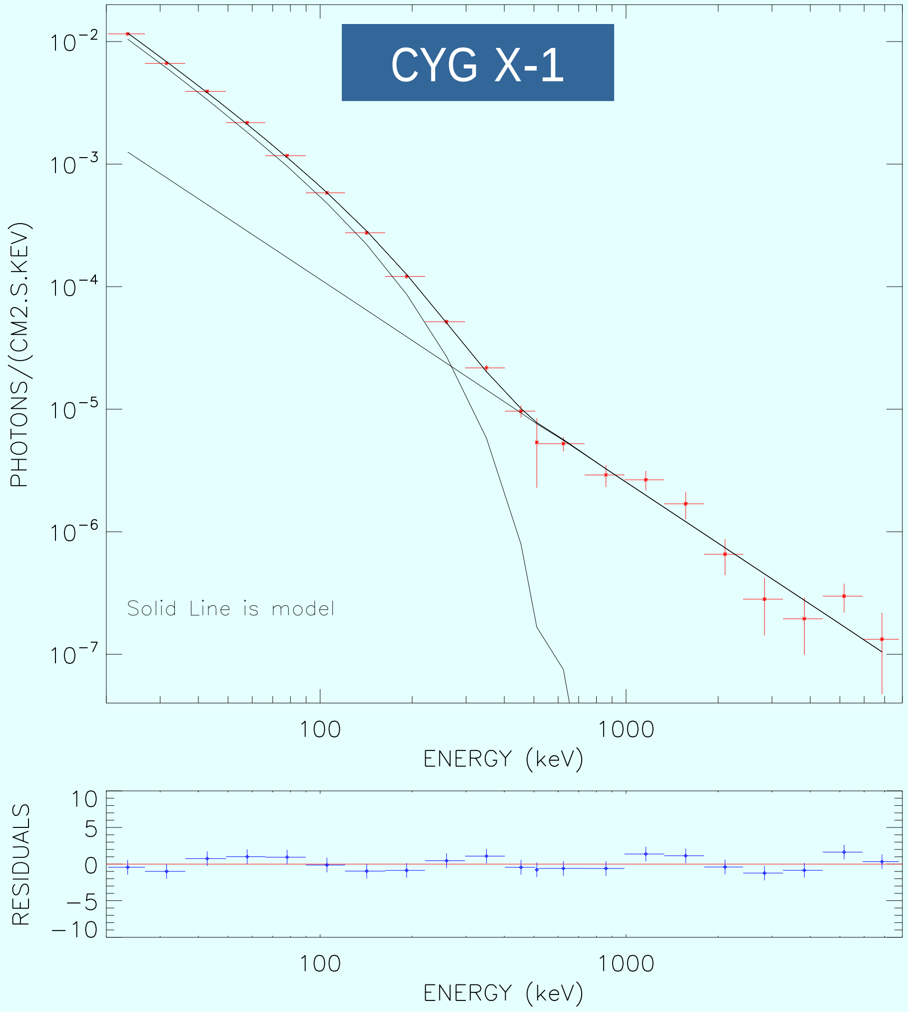
CYG X-1

Thermal Comptonisation (Comptt)
+ reflection (R=1)
kT ~ 50 keV
τ~ 1

Power law photon index ~ 1.8
Ftest ~ 4.10-6

THE SKY IN HARD X RAYS

WITH SPI / INTEGRAL

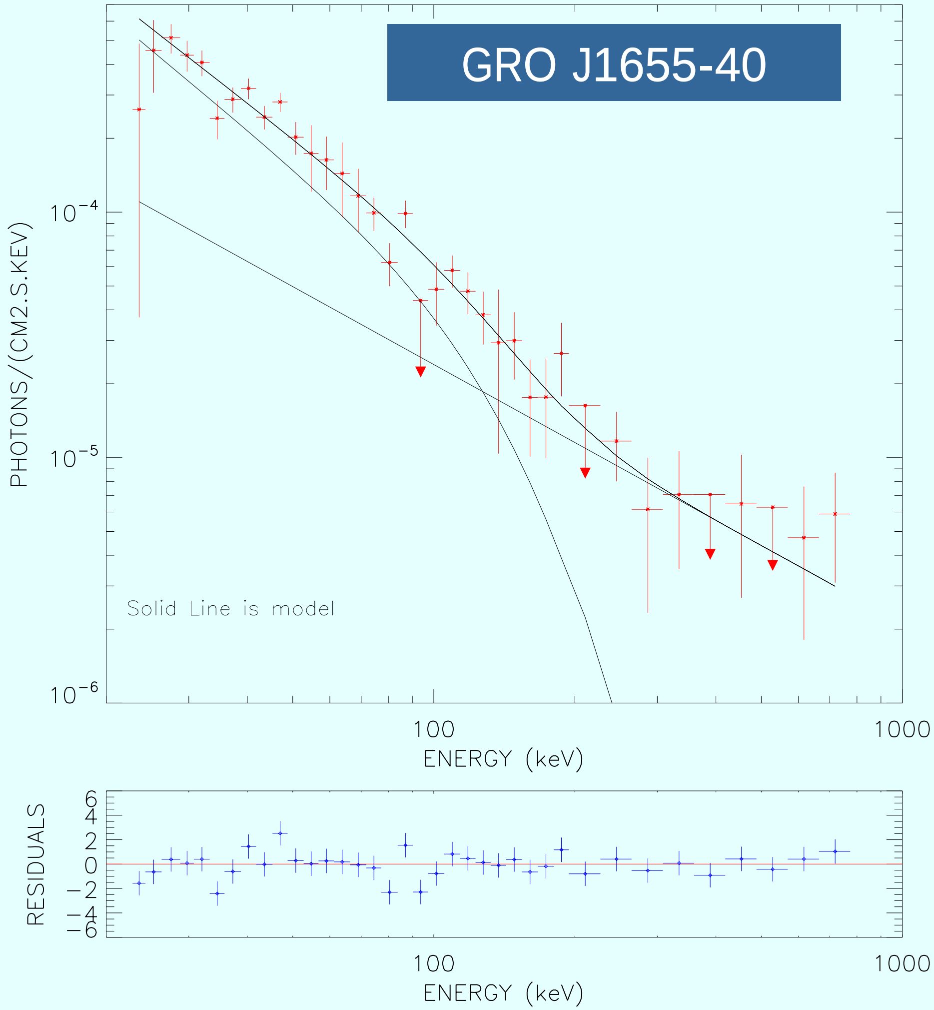


CYG X-1

Thermal Comptonisation (Comptt)
kT ~ 43 keV
$\tau \sim 1$

Power law photon index ~ 1.7

THE SKY IN HARD X RAYS
WITH SPI / INTEGRAL



GRO J1655-40

during 2005 outburst

Thermal Comptonisation (Comptt)

kT ~ 30 keV

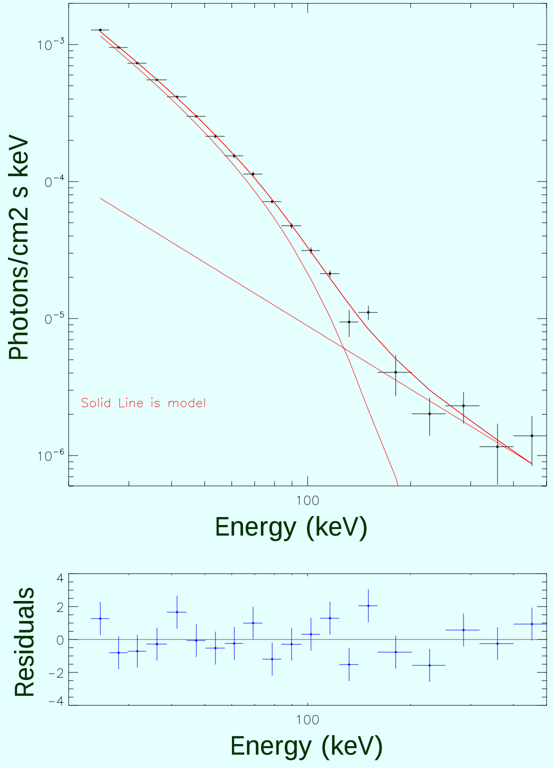
τ ~ 1

Power law photon index ~ 1.0

THE SKY IN HARD X RAYS

WITH SPI / INTEGRAL

GS1826-24



GS1826-24

Thermal Comptonisation (Comptt)
+ reflection (R=1)
kT ~ 17 keV
τ~ 1

Power law photon index ~ 1.5
Ftest ~ 4.10-4

THE SKY IN HARD X-RAYS : CONCLUSIONS

Long duration integrated spectra of individual sources :

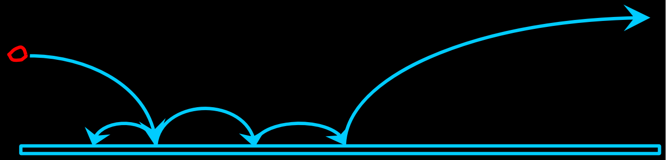
A good fraction emits above 100 keV with or without cutoff

(averaged on various states)

Which physics in this energy domain ?

Thermal emission : parameters estimation
+ Reflection : does not help

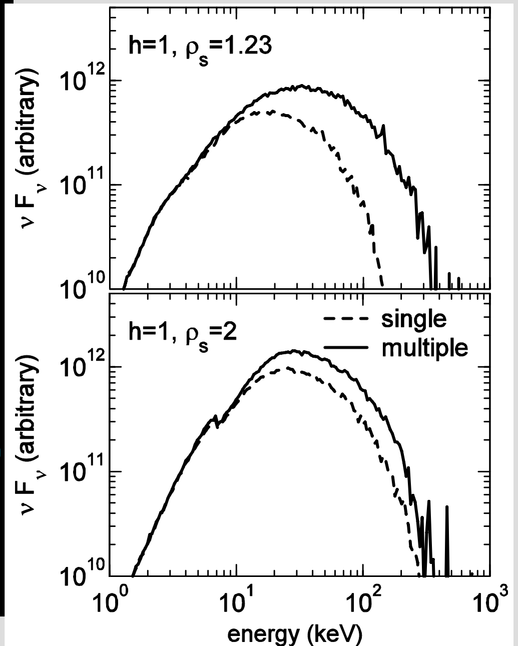
- Challenge: To determine the true reflected component shape (Comptonisation in the corona, smearing by relativistic effects, multiple reflections by light bending...)



- Transition between reflected/primary components

- Transition between thermal/non-thermal emissions

T. Suebsuwong et al., 2006



THE SKY IN HARD X-RAYS :

CONCLUSIONS

Additional component observed in BH and NS systems above ~ 100 keV up to the MeV region

Variable but detected in 4 years time-averaged spectra

Significant contribution to the total source luminosity

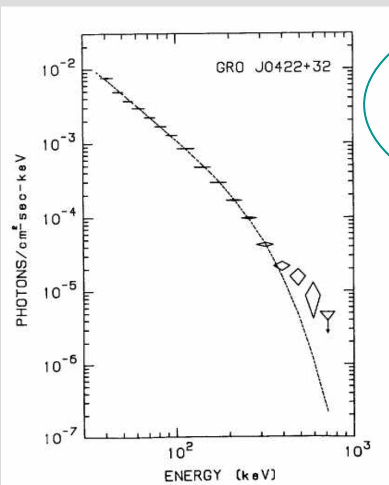


FIG. 2—Nova Persei spectrum observed by SIGMA and its Comptonization best fit (from Roques et al. 1994).

From an X-ray Nova

Nova Persei, (Sigma/Granat observation in 1992)

From BH Candidates

(Cyg X-1, GX 339-4)

OSSE/CGRO (Johnson et al., 1993)

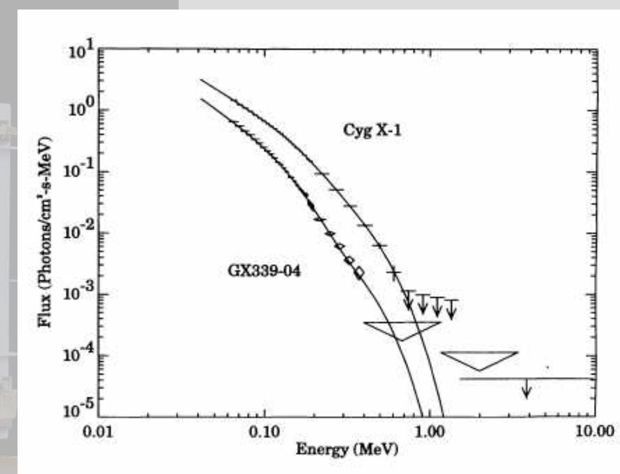


FIGURE 6. The observed spectra from Cyg X-1 and GX 339-4.

Origin ?

non-thermal comptonizing population (jet ?), 2^{nd} hotter region...

Link between thermal and non-thermal emissions ? (variability study)

THE SKY IN HARD X-RAYS :

CONCLUSIONS

Unified point of view

3C 273 : The non-thermal (jet) emission hides the thermal (corona) one (Grandi & Palumbo, 2004)

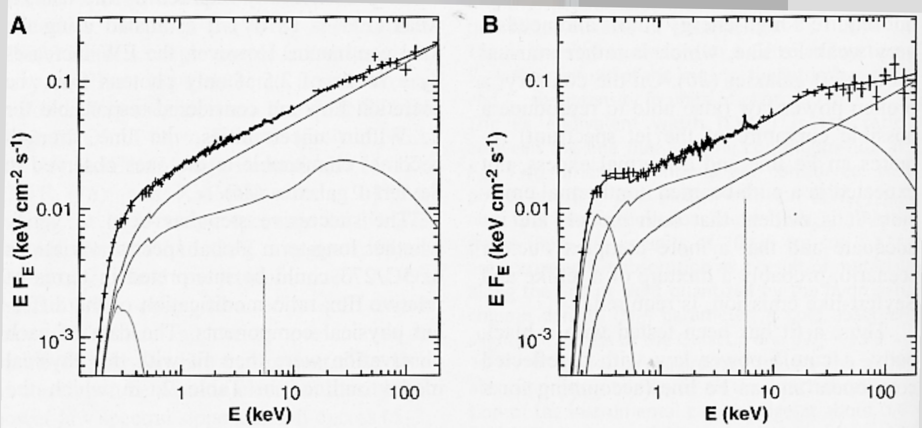
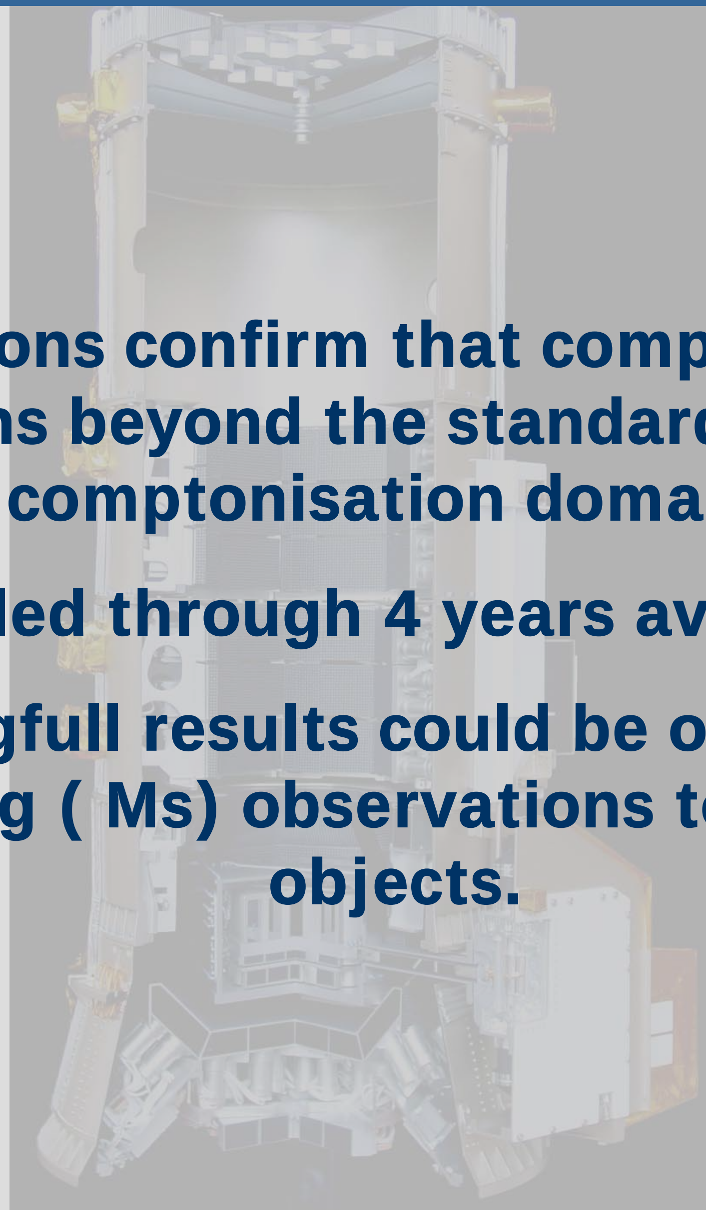


Fig. 2. (**A**) 3C 273 spectrum observed in January 1997, as untangled in its components: a jet (blue line), a Seyfert-like component (red line), a black body (green line), and the Fe line (magenta). The jet is the dominant component. The jet and the Seyfert-like flux ratios are ~3 in the 2 to 10 keV band and 7 in the 20 to 200 keV bands. (**B**) Opposite spectral configuration observed in June 2001. The Seyfert-like component (red) overcomes the jet (blue) up to 40 keV. The Doppler-enhanced nonthermal radiation can emerge only when the thermal component declines because of the high-energy cutoff. The jet and the Seyfert-like flux ratios are 0.7 in the 2 to 10 keV region and ~2 in the 20 to 200 keV regions.

Both mecanisms could be present in all source classes but the dominant process changes

THE SKY IN HARD X-RAYS :

CONCLUSIONS



SPI observations confirm that compact objects emit photons beyond the standard thermal comptonisation domain.

The is revealed through 4 years averaged spectra

More meaningfull results could be otained thanks to dedicated long (Ms) observations towards compact objects.