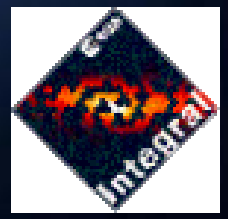
Bulk Compton motion in the luminous quasar 4C04.42?

High-z QSOs with INTEGRAL

A. De Rosa
on behalf of the INTEGRAL/AGN survey team



INTEGRAL

(INTErnational Gamma-Ray Astrophysics Laboratory)

Astronomical satellite for observing the gamma-ray sky launched on October 17, 2002

Imager IBIS

- angular resolution of 12 arcmin
- point source location accuracy of a few arcmin
- energy range between 15 keV and above 1 MeV

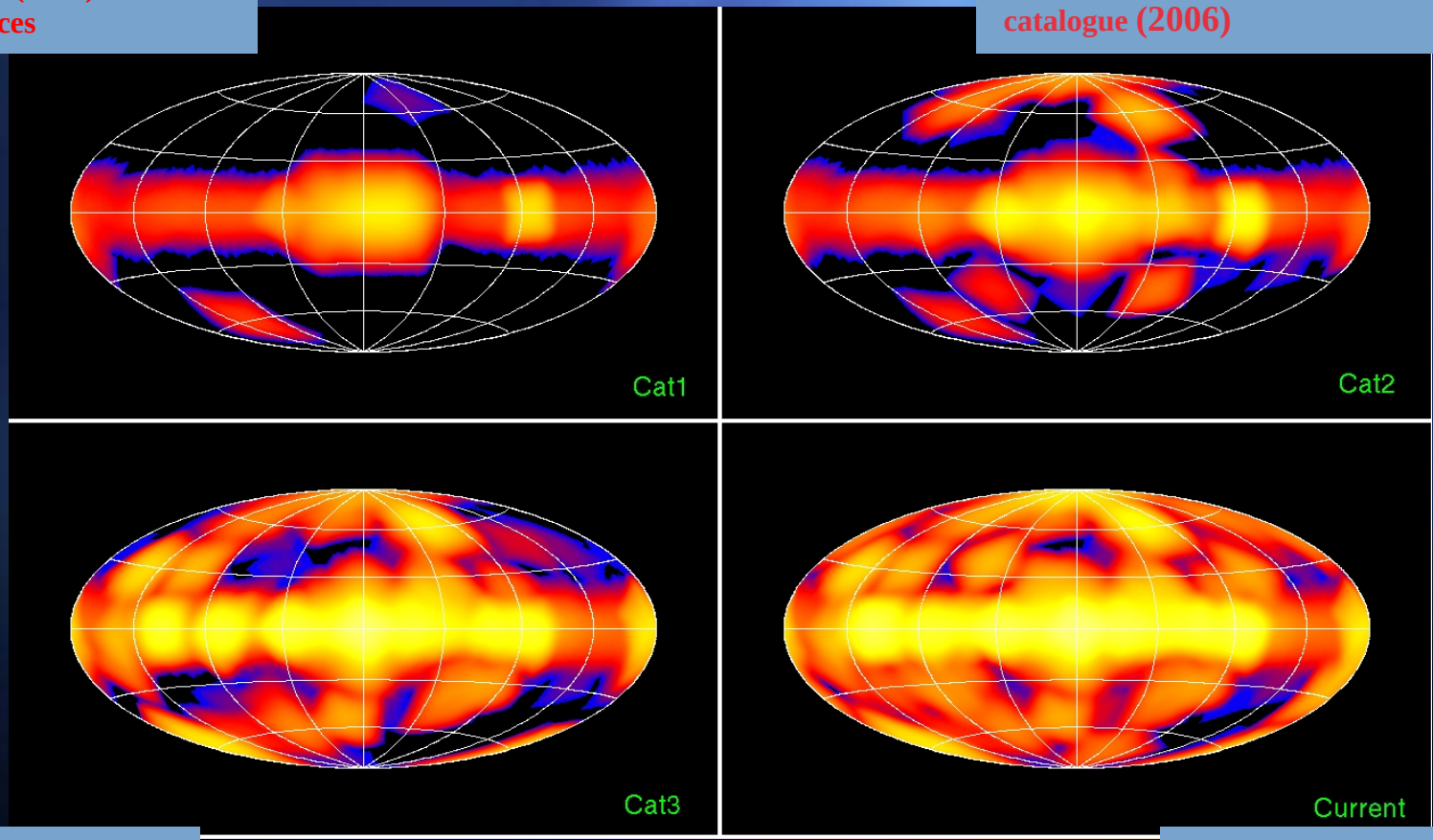
3 surveys provided so far, 4th on-going

http://www.integral.soton.ac.uk/projects/ibis_survey/data_access/access.html

25000 pointed science windows: 57 Ms
Spans a duration of 1250 days

1st catalogue (2005)
126 sources

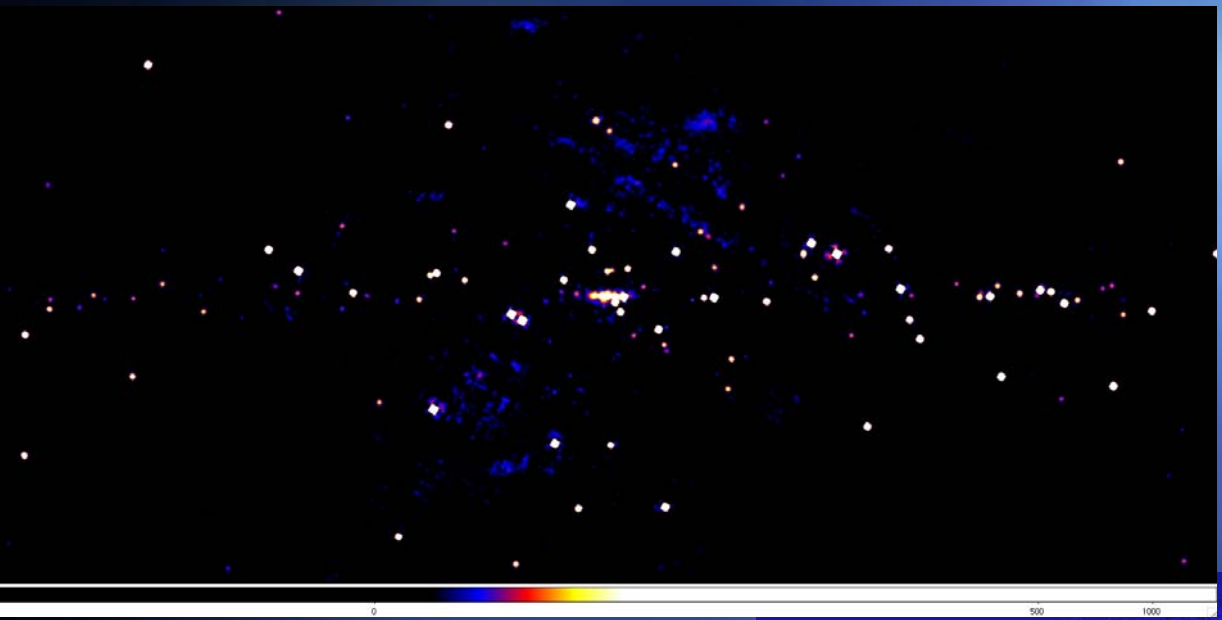
2nd catalogue (209 sources) + 1st HE catalogue (2006)

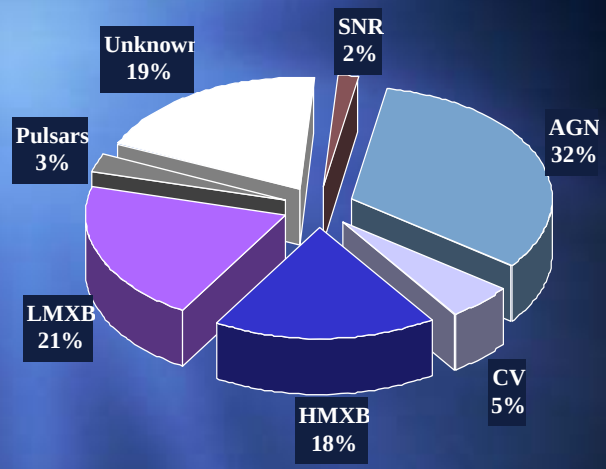


3rd catalogue (2007)
421 sources

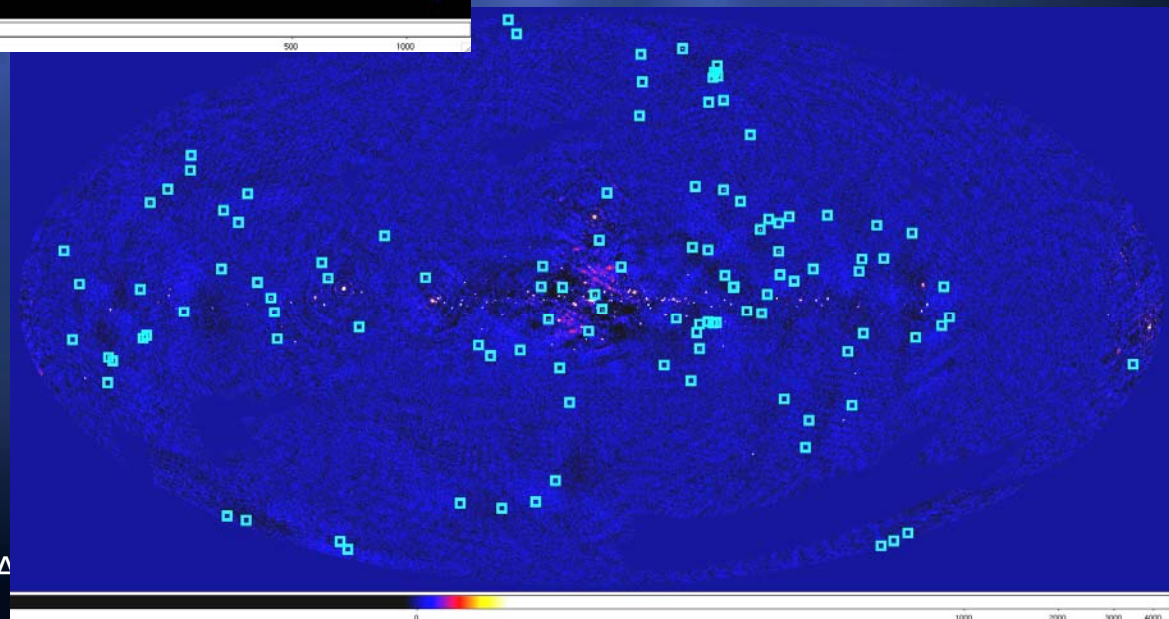
4th LE and 2nd HE catalogue on going

The sky according to IBIS





AGN distribution
(131 sources)

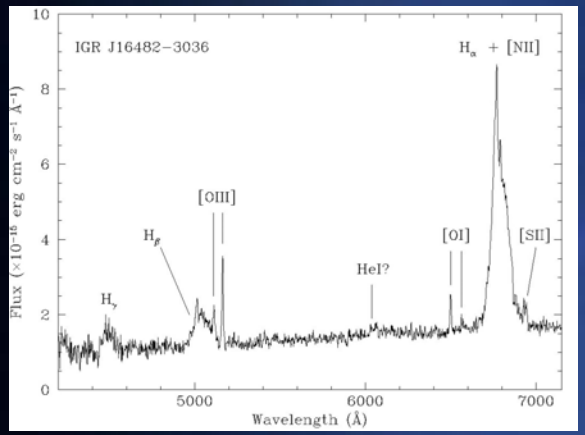


Optical spectroscopy of most likely counterparts

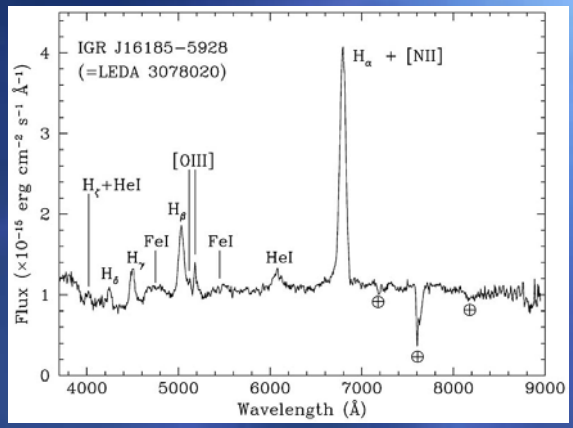
http://www.iasfbo.inaf.it/extras/IGR/main.html

Telescopes: Loiano-Bologna Italy, South Africa, CTIO-Chile, La Silla Chile, CASLEO Argentina

Sey1



Narrow-Line Sey1

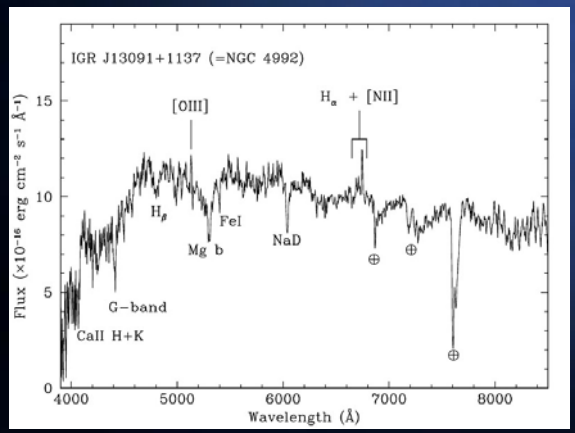


Masetti et al. 2004, 2006 2008

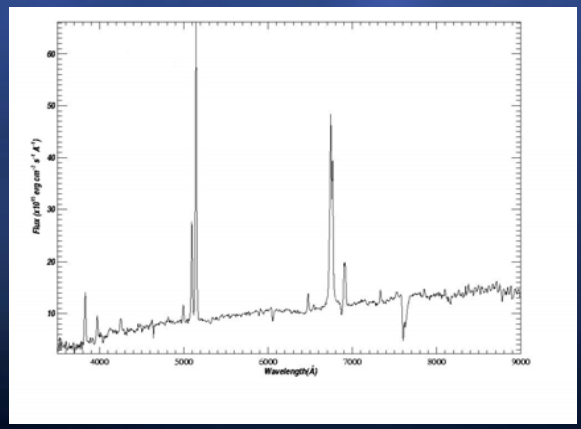
A first catalogue of 60 AGN (Bassani et al. 2006)

82% Seyferts
Sey2/Sey1=1

X-ray bright optically dull AGN



Sey2



Gamma ray selection favours broad line sources

The IBIS complete sample of AGNs

The IBIS AGN total sample: 131 objects

58 type 1 (circles)

60 type 2 (squares)

13 blazars (triangles)

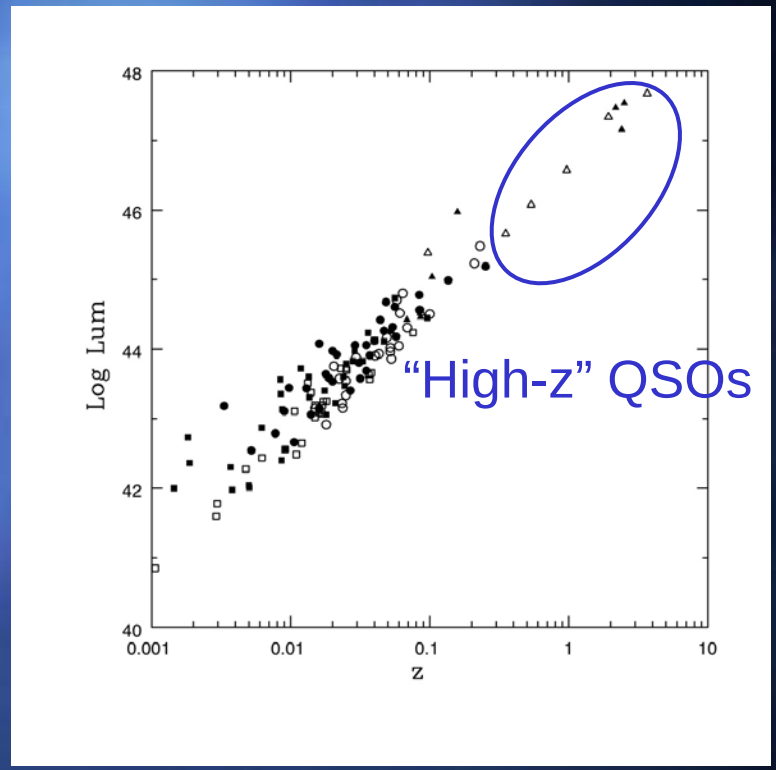
The INTEGAL AGN complete sample

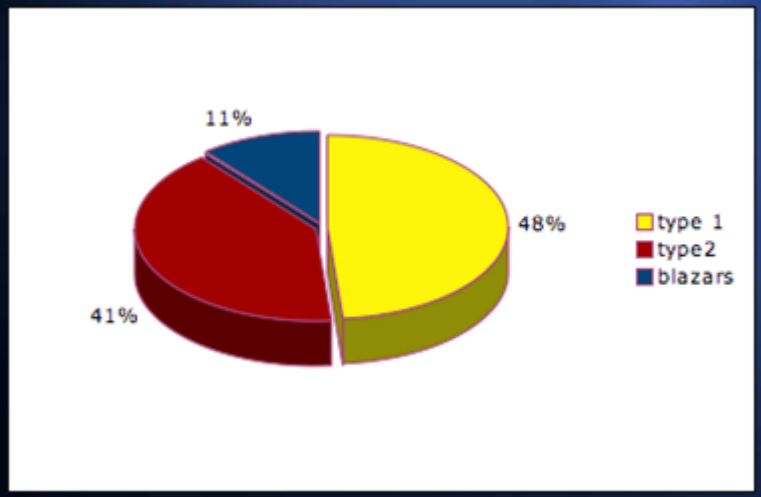
74 objects: 36 type 1

30 type 2

8 blazars/QSO

+ 21 AGN candidates





BAT complete sample:

24 AGNs 19 Seyferts

3 blazars

1 qso

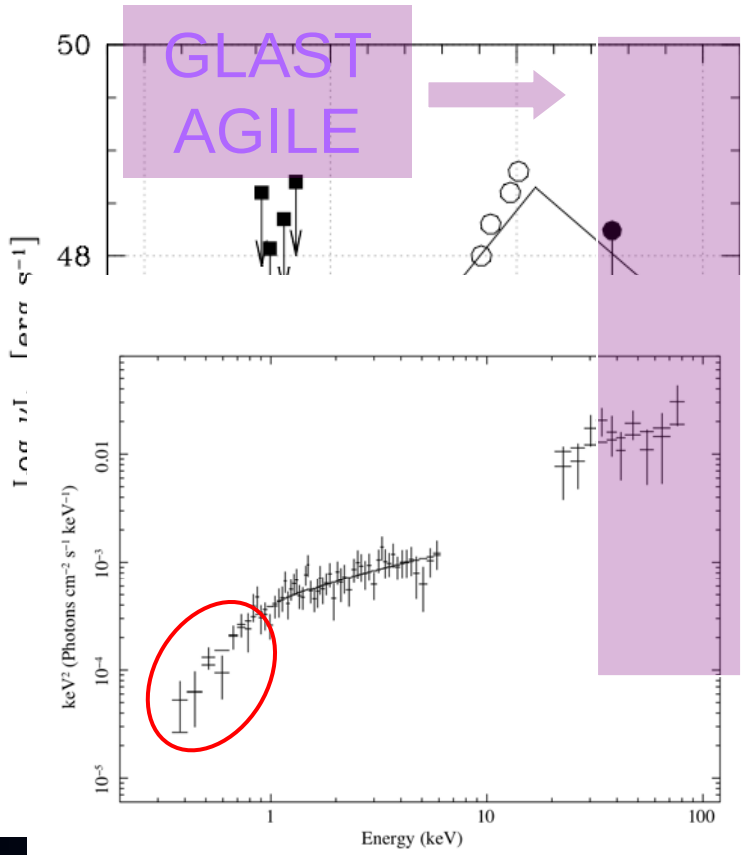
1XBONG

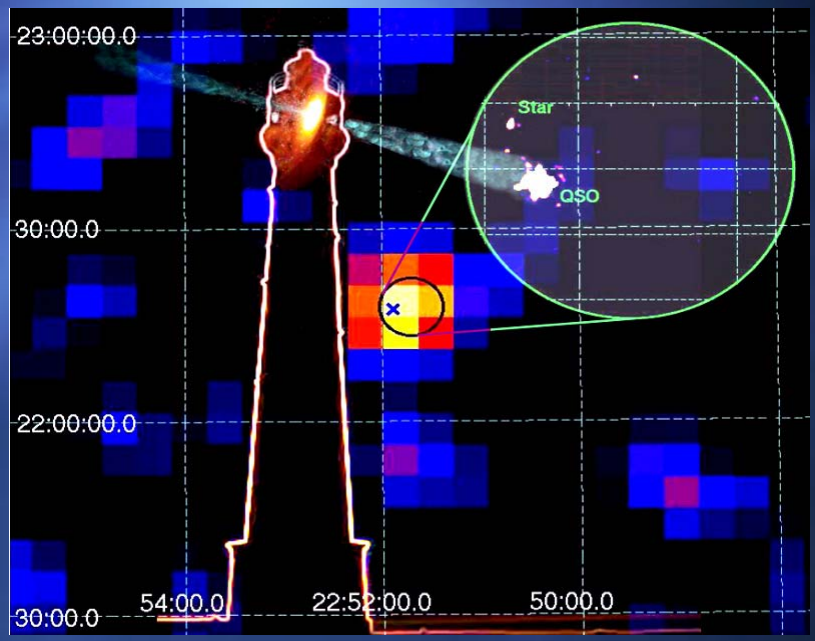
High-z INTEGRAL QSOs: the sample

	Source	z	Reference
✓	PKS1830-211	2.507	De Rosa et al. 2005, Zhang et al. 2008
	Swift J1656.3-3302	2.4	Masetti et al. 2008
✓	IGR J22517-2218	3.668	Bassani et al. 2007
	QSO B0836-710	2.172	-
✓	4C04.42	0.965	De Rosa et al. 2008
	1RXS J19245	0.352	-
	IGR J03184-0014	1.93	-
	QSO B0212+735	2.367	-
	PKS 2149-307	2.345	-
	PKS 0537-286	3.104	Possibly detected in 20-200 keV
	QSO 0723+679	0.884	Possibly detected in 20-200 keV

IGR J22517+2218, z=3.668 a gamma-ray lighthouse

Bassani et al. ApJL 2007





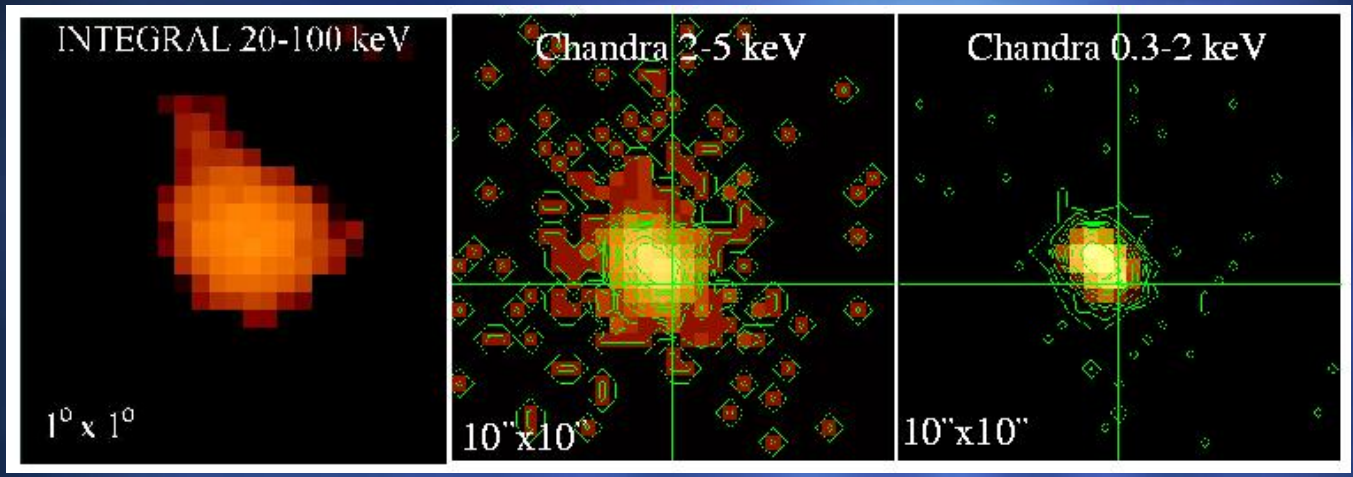
- X-ray radio-loud
- Blue quasar candidate: High energy peaked FSRQ? (see ROXA J081009 Giommi et al. 2007)

$\Gamma = 1.5 +/- 0.2$

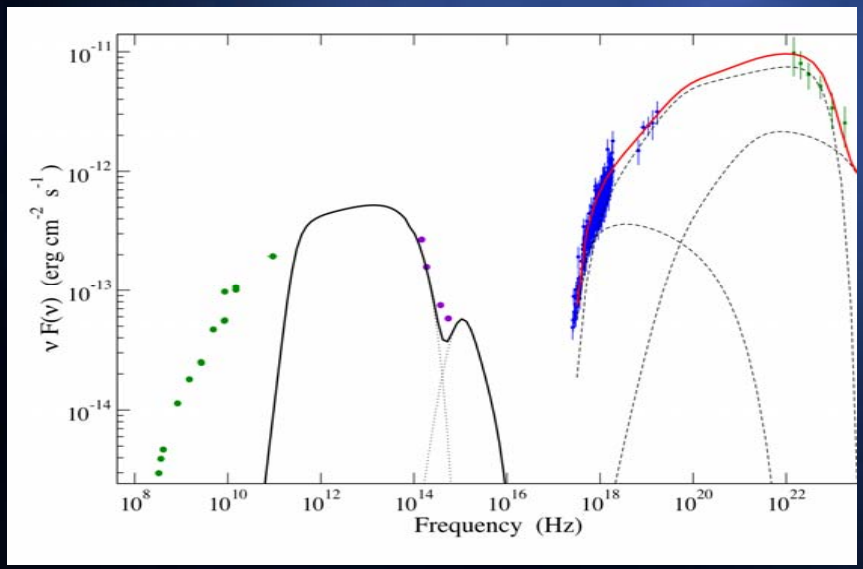
$N_H = 3 +/- 2 \times 10^{22}$ cm^{-2}

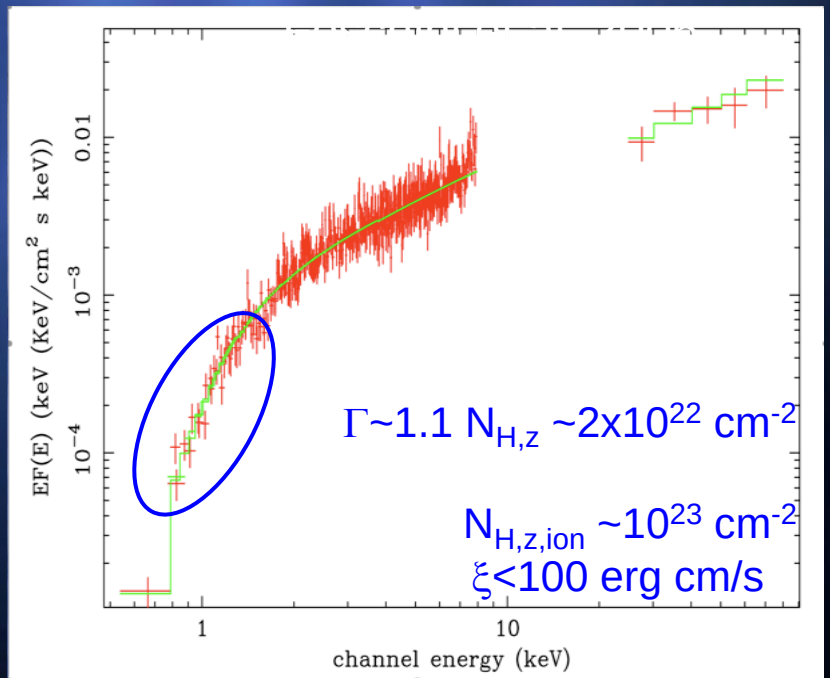
$\Delta\Gamma = 0.5$ $E_0 = 1.2$ keV

PKS 1830-211, z=2.507



De Rosa et al. 2005





The FSRQ 4C04.42, z=0.965

- Radio loudness parameter Kellerman et al 1989
  $R=S_{5Ghz}/S_{4400A}$ ~1000
- INTEGRAL above 20 keV with

F(20-40 keV) = 7.6×10^{-12} cgs

F (40-100 keV) = 18.8×10^{-12} cgs

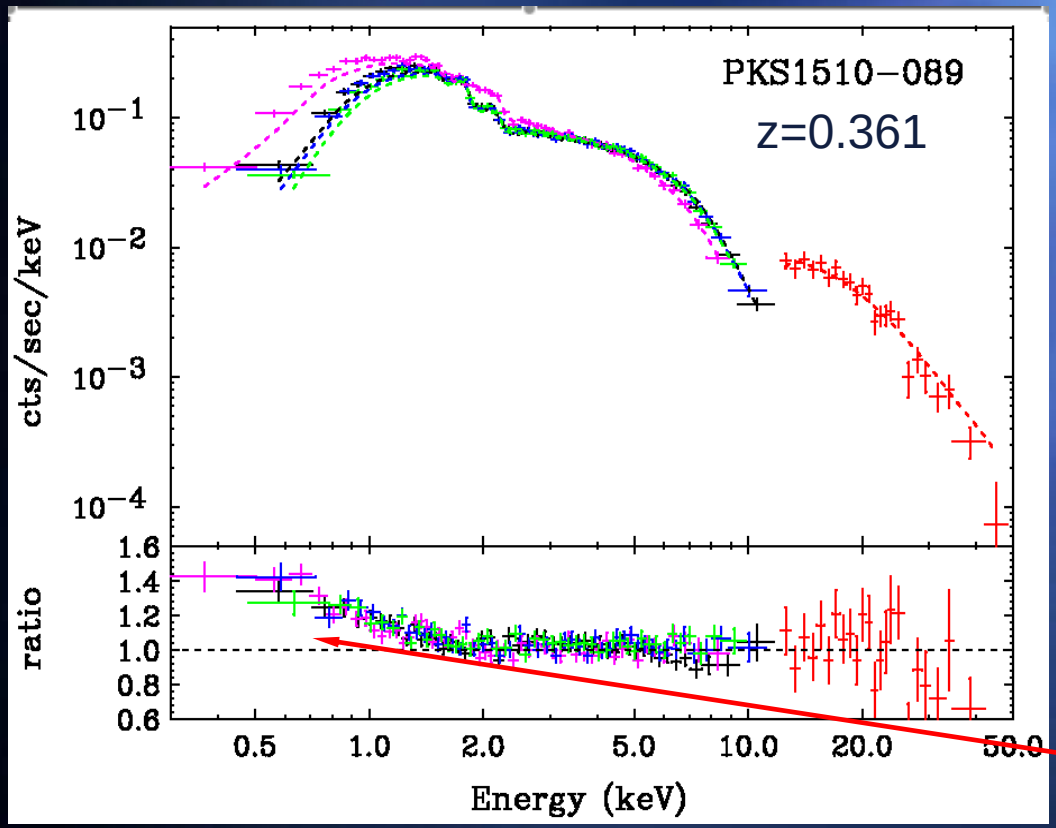
- MOJAVE: VLBA @15GHz, 1-2Jy all radio frequencies

XMM & INTEGRAL

Inst.	Exp(s)	cts (s^{-1})
XMM-MOS1 (thin)	11515	0.173±0.005
XMM-MOS2 (thin)	11527	0.213±0.006
XMM-pn (thin)	8842	0.173±0.005
INTEGRAL-isgri	100000	0.12 ±0.02

Broad band spectral analysis

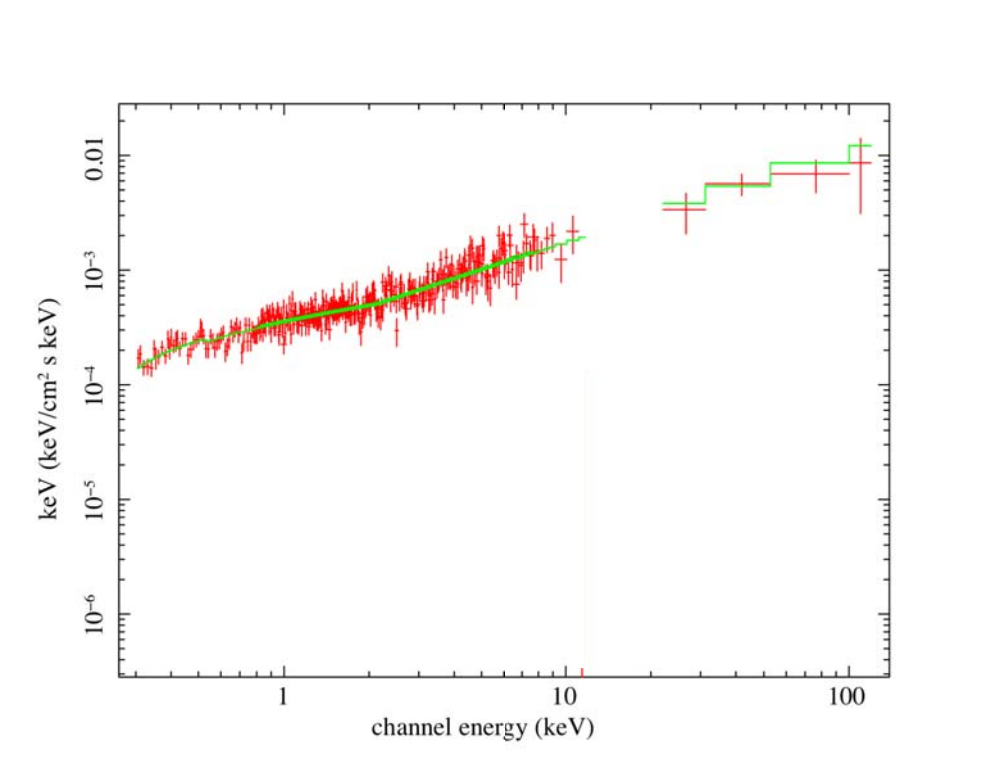
SUZAKU - Kataoka et al 2007



- Continuum power-law fit extrapolated below 2 keV
- Γ=1.21±0.06

Excess of emission below 2 keV obs frame

I. Broken power-law



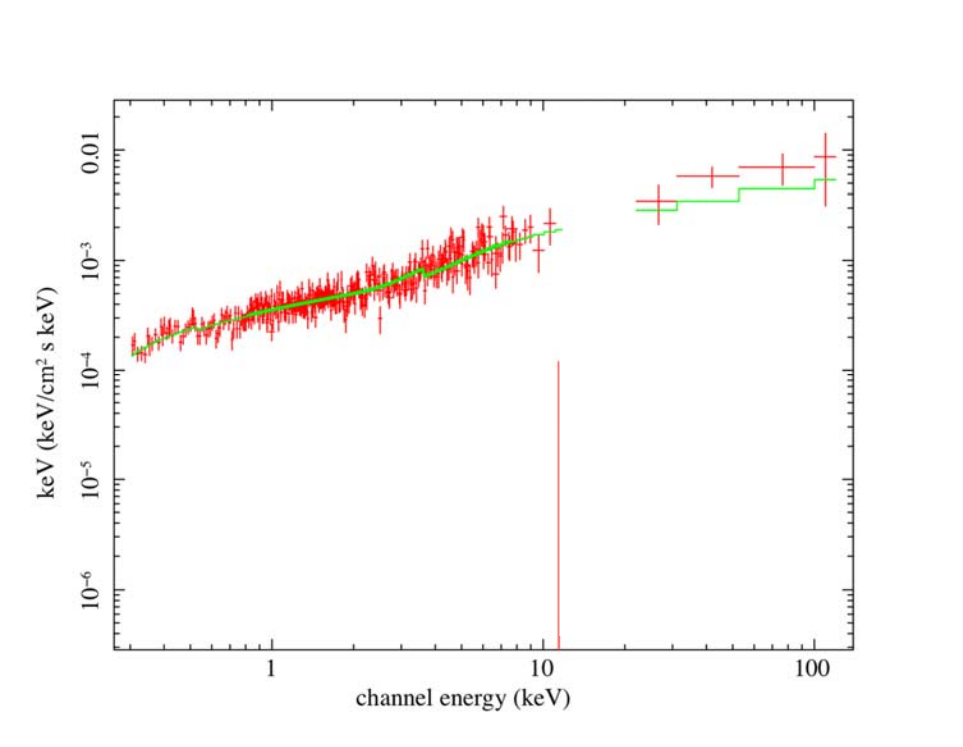
Γ_1=1.59±0.05,

Γ_2=1.17±0.09,

E_{bkn}=2.2±0.4 keV

χ^2/dof=364/363

II. Partial covering absorption



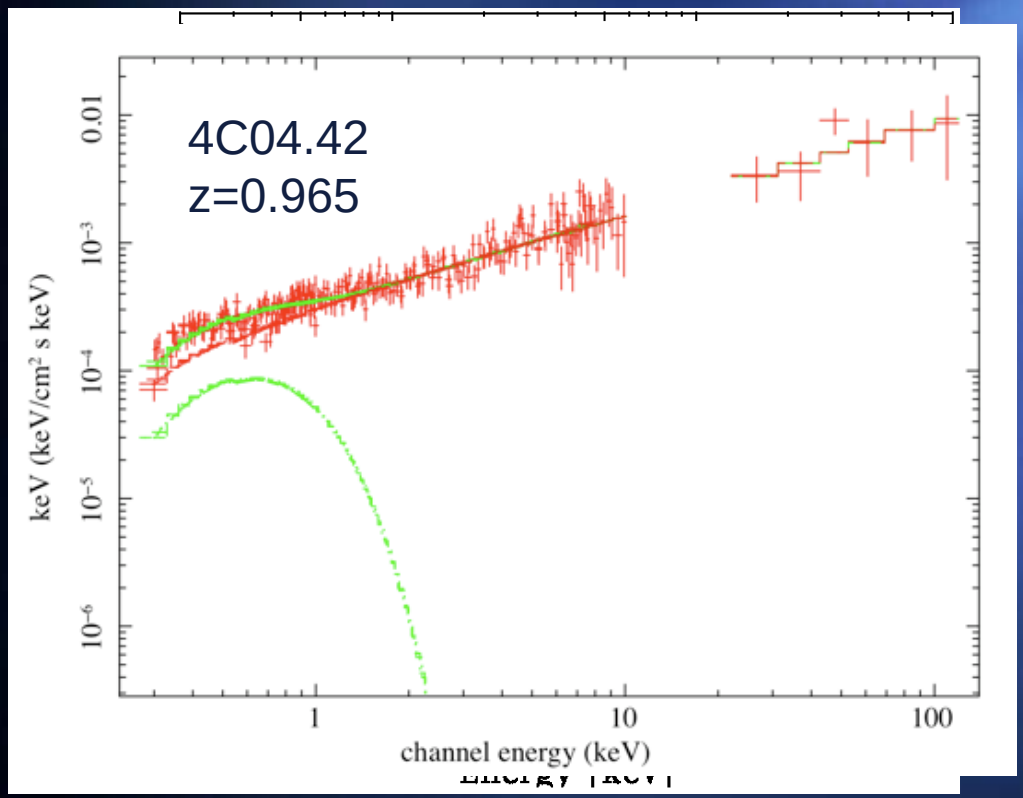
Γ=1.57±0.04

f_{cov}~0.5

$N_{H,z}$~7x$10^{23}$$cm^{-2}$

χ^2/dof=375/363

III. Thermal black-body



kT_{BB}=0.15±0.02 keV

L_{BB}= 10^{45} erg/s

χ^2/dof=383/366

Kataoka et al. 2007

L_{BB}= 3x10^{44} erg/s

The (missing) Spectral Energy Distribution

Synchrotron

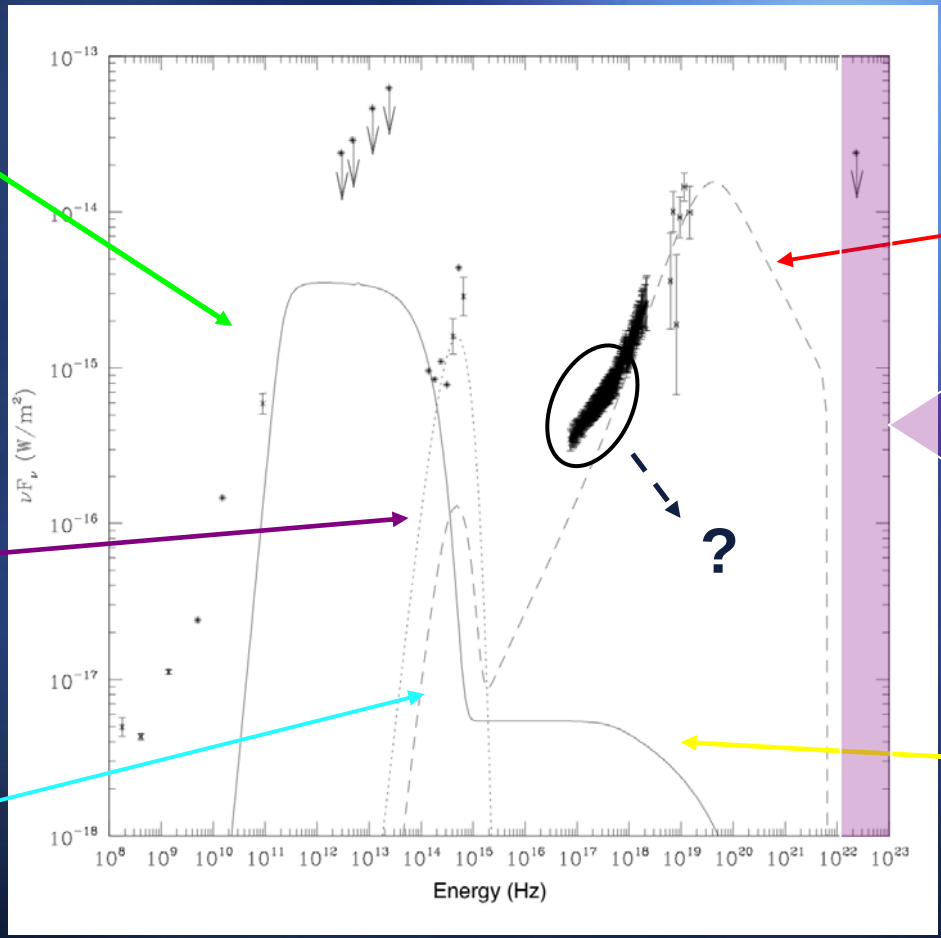
External Compton

GLAST AGILE

Disk emission

Self-Synchrotron Compton

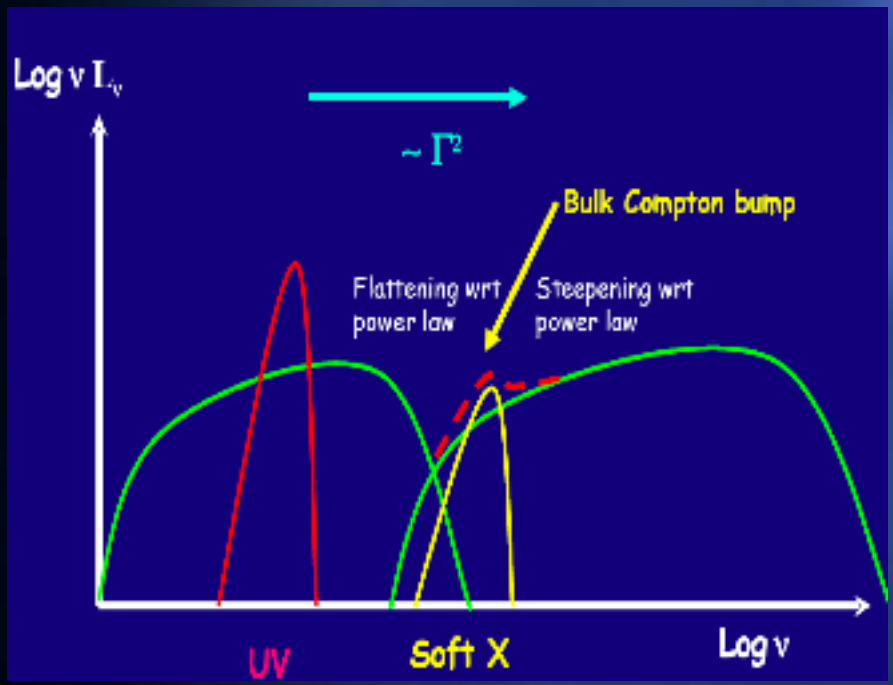
BLR emission



Bulk Compton

Celotti et al. 2007

Inverse Compton Scattering of cold electrons $\gamma \tilde{} 1$ on the external photons field: $\Delta E \propto \Gamma^2$.. UV-->soft X)



Energy Budget

$\nu_{BC} = \Gamma^2 \nu_{BLR}/(1+z) \tilde{} 1$ keV

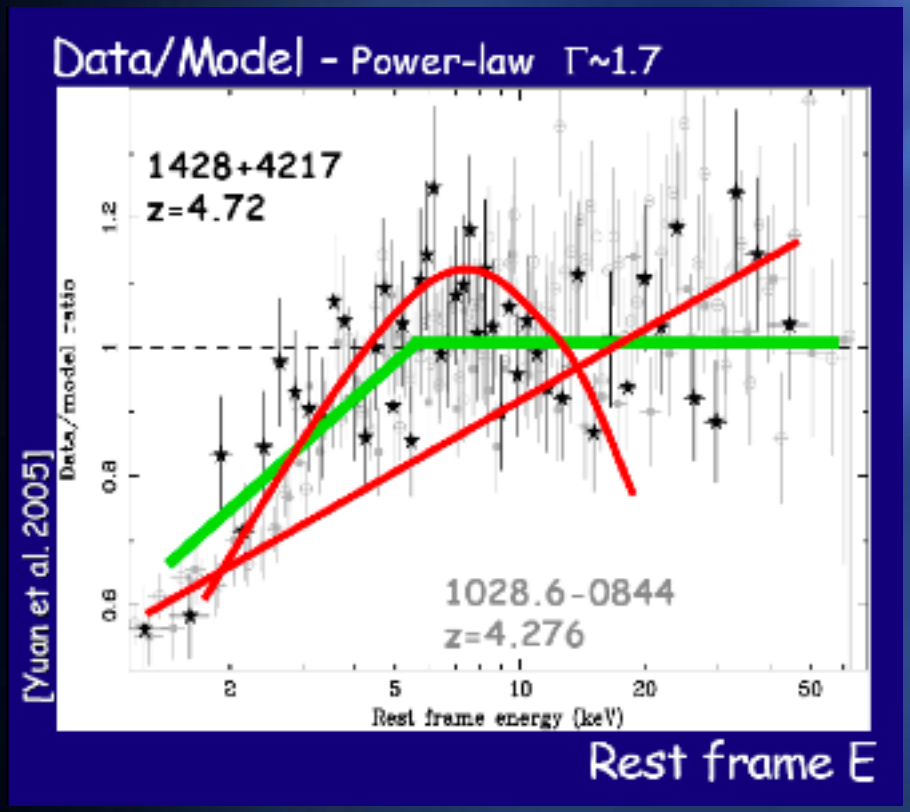
$L_{BC} = 4/3\sigma\, c\delta^4 U_{BLR} \Gamma^2 N_{cold}$

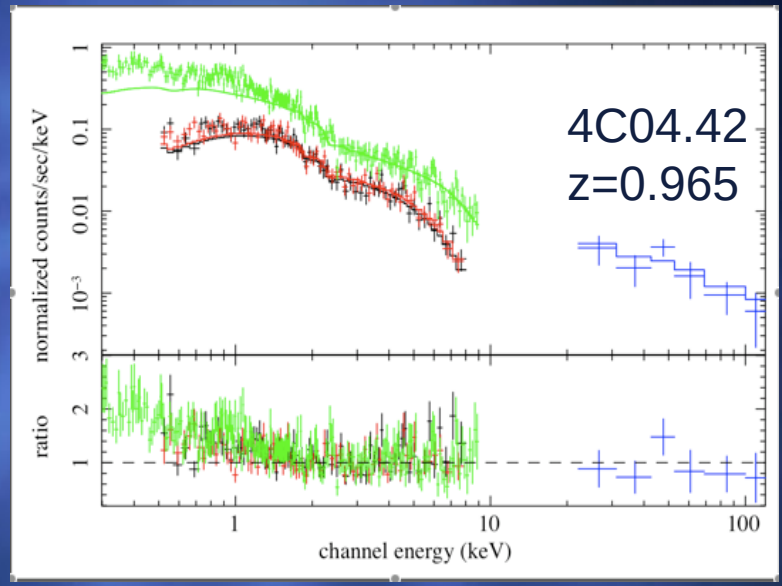
$\tilde{} 10^{46} N_{cold}/N_{rel}$,

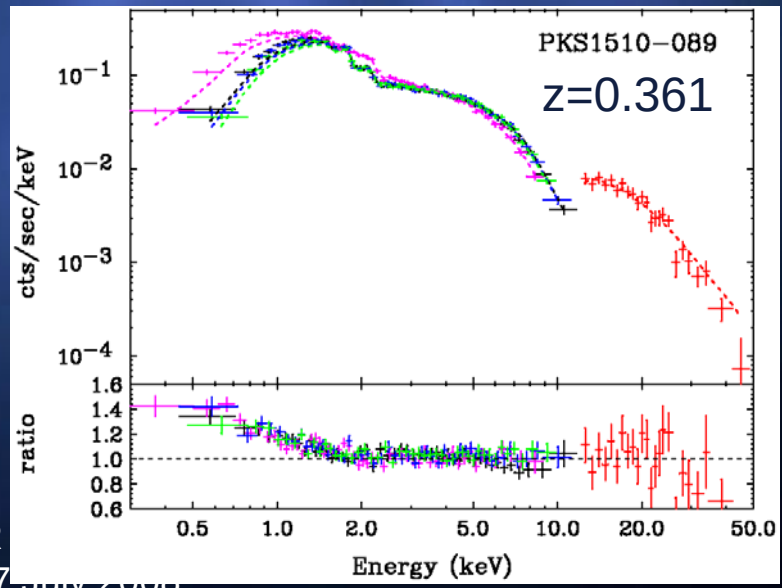
$L_{BC} \tilde{} 10^{45}$ erg/s

$\Rightarrow N_{cold}/N_{rel} \tilde{} 0.1$

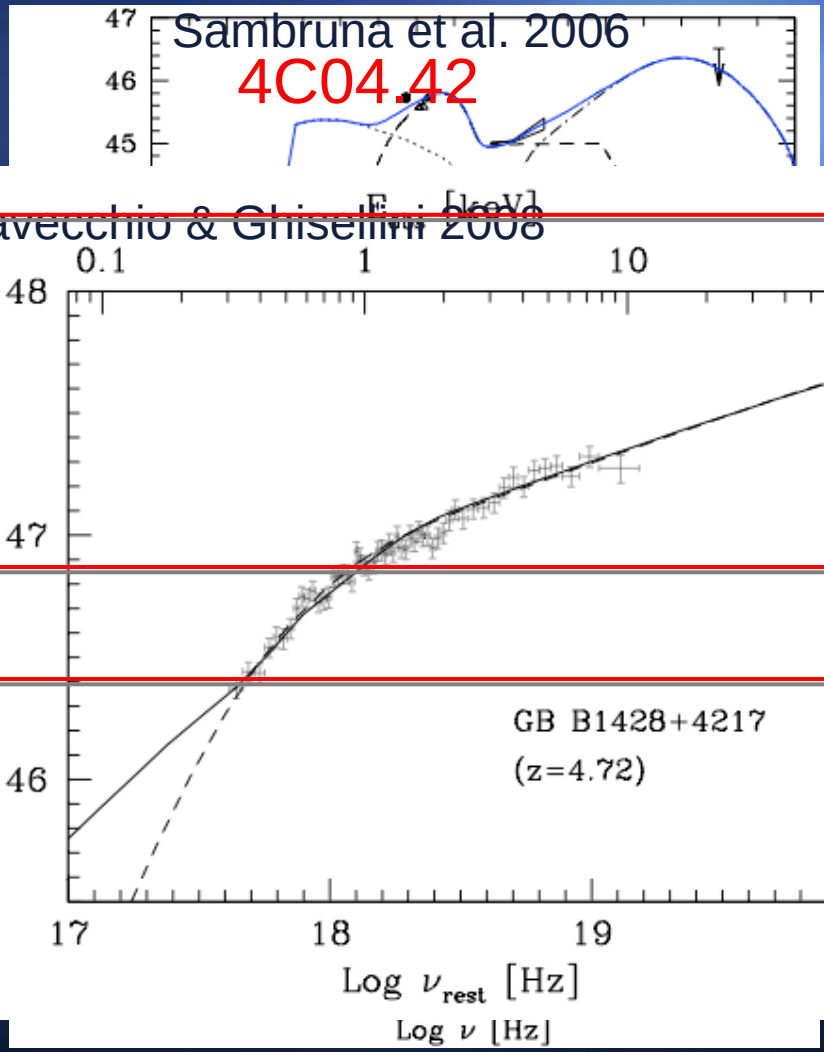
Evidence of BC?







Alternative models



- Increasi… …omponent in the X-ra…
- Accretio… …on like radio quiet AG…
- High en… …J22517)
- Disk em… …mponent (1136-1… …bruna et al. 2006)
- Realistic… …to compute the EC … …08)

The jet-disk connection

$P_{jet}=\pi R^2 \beta \Gamma^2 c U$, $U=U_B+U_e+U_p$

Source	z	R_{BLR} (10^{17} cm)	L_{disk} (10^{45} erg s^{-1})	$^{\star}P_{jet}$ (10^{45} erg s^{-1})
4C04.42	0.965	5	20	300
[1]0723+679	0.847	2	10	350
[1]1136-135	0.554	5.2	5	73
[1]1150-497	0.334	2.6	3	76
[2]1510-089	0.361	5	4	500

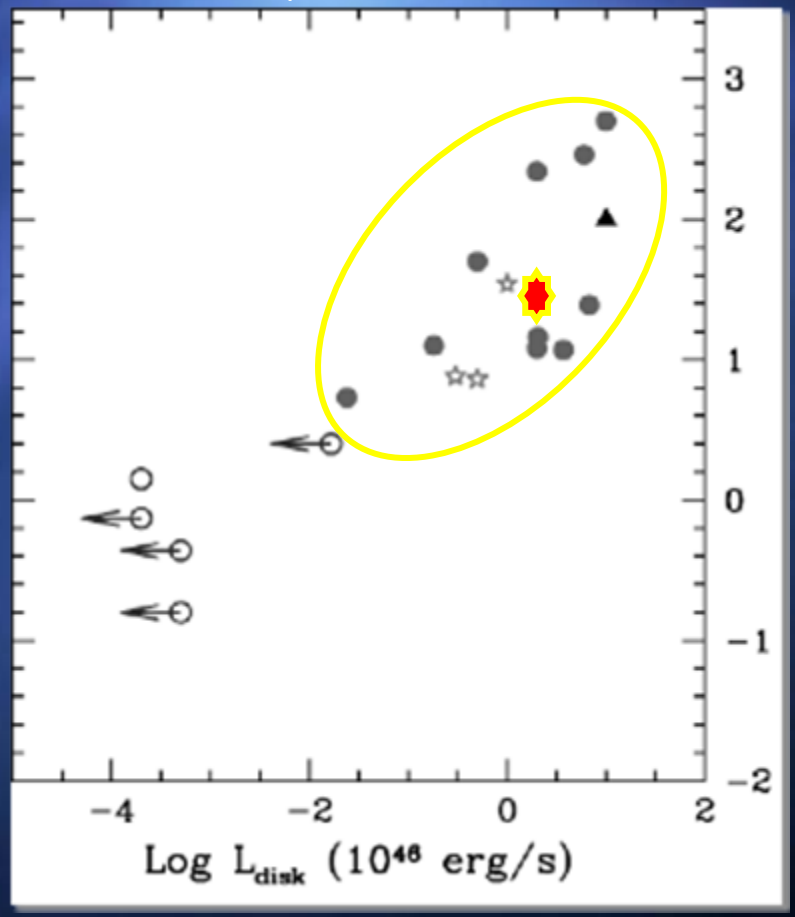
[1] Sambruna et al. (2006); [2] Maraschi & Tavecchio (2003); Kataoka et al. (2007). * calculated for $n_e=n_p$. See text for details.

The jet-disk connection

Sambruna et al 2006, Maraschi & Tavecchio 2003

$L_{disk}/P_{jet} \sim 0.1$

A large fraction of the accretion power is converted in bulk kinetic energy



High-z QSO & soft X-ray feature

- Evidence of flattening below 2 keV (rest frame) has been found in several high-z QSO up to z=4.4 (Yuan et al. 2006)
- Intrinsic curvature - absorption (cold/warm)
- Clear trend N_H *vs* z has been measured
- Excess of emission (4C04.42 like) has be found in very few cases (Sambruna et al. 2006, Kataoka et al. 2007, De Rosa et al. 2008)

INTEGRAL & "high-z" QSO

- Define a class of observed objects (~10 sur3, more coming from sur4)
- Broad-band spectral analysis: low energies break, evidence of BC
- Information of number density of cold electrons, Doppler/Lorentz factor
- Disk-jet connection

.. To be continued