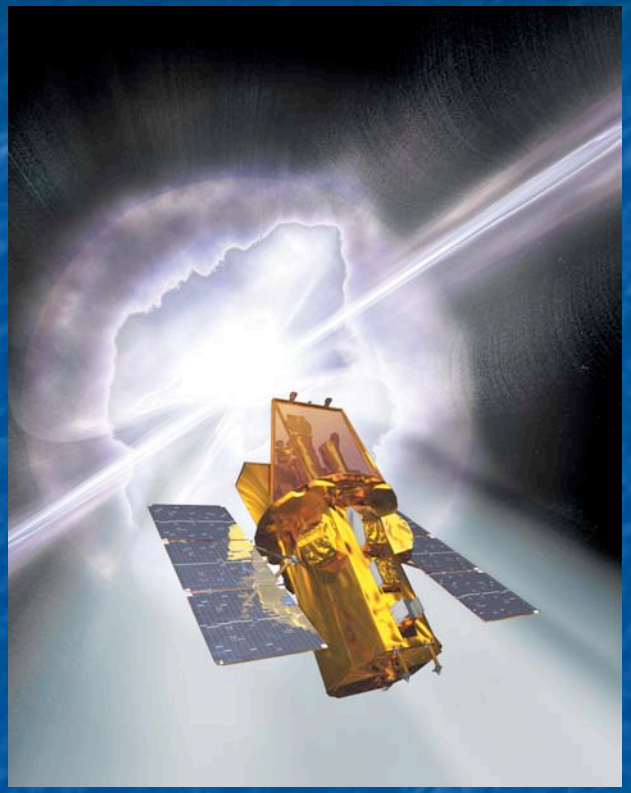
INTEGRAL/IBIS- Swift studies



Pietro Ubertini, IASF -Roma

Swift Workshop May 1-2, 2007

Istituto di Astrofisica Spaziale e Fisica Cosmica - Roma

Identification & Classification Process of INTEGRAL Sources

GREAT HELP FROM SWIFT/XRT

1. **Cross-Correlation Swift/XRT :**
   a) 58 objects are in the in Swift database
   b) 38 objects requested and granted (still 4 to be done)

2. **XRT provides arcsec positioning of likely counterpart(s)**

   Transients or false sources typically not detected

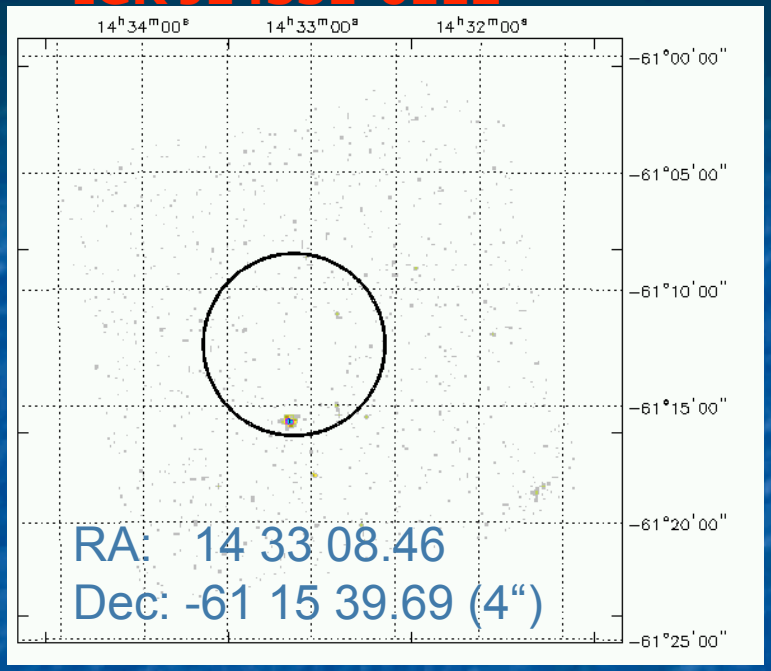
   Persistent sources always detected

3. **Optical Ground Telescopes: Loiano & Asiago in Italy, South Africa, CTIO-Chile, La Silla Chile, CASLEO Argentina**

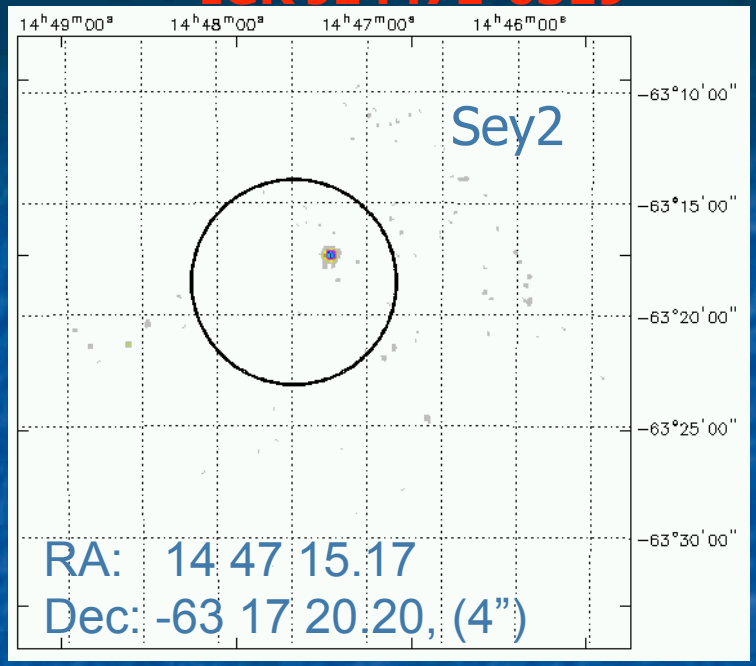
   Pursuing Infrared observations for sources too weak in optical

A FEW EXAMPLES

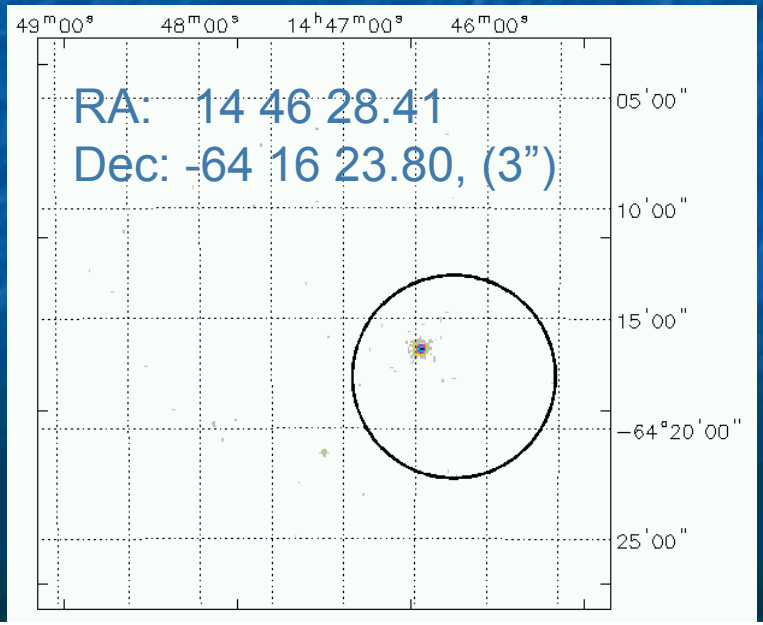
IGR J14331-6112



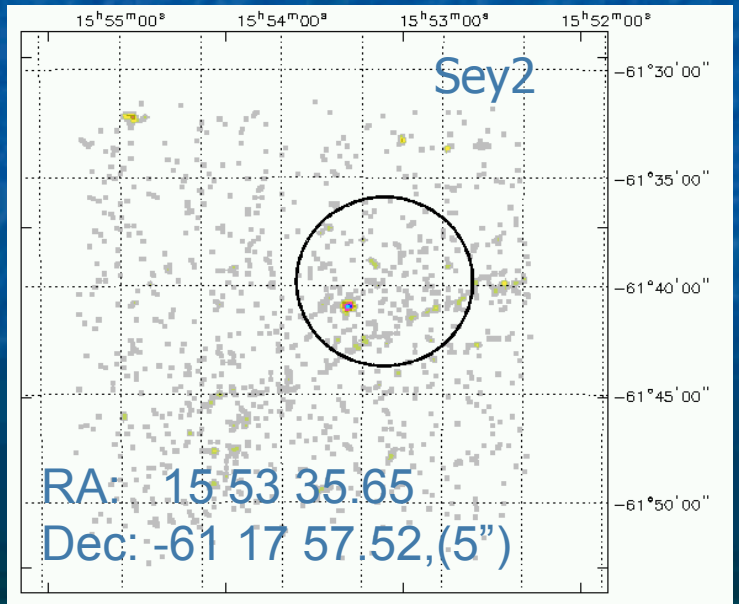
IGR J14471-6319



IGR J14471-6414

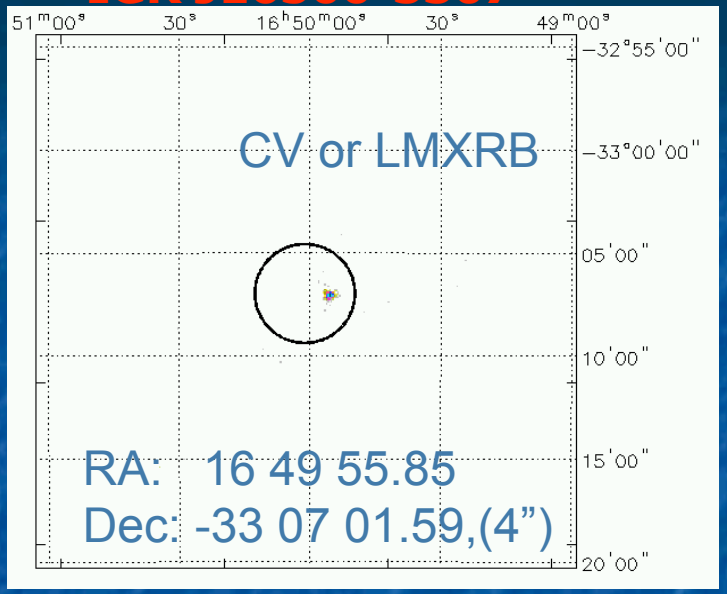


IGR J15539-6142

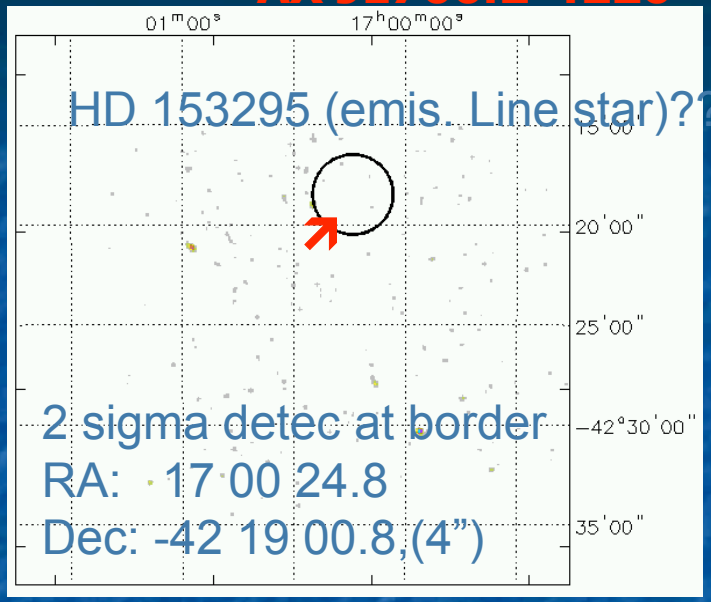


A FEW EXAMPLES

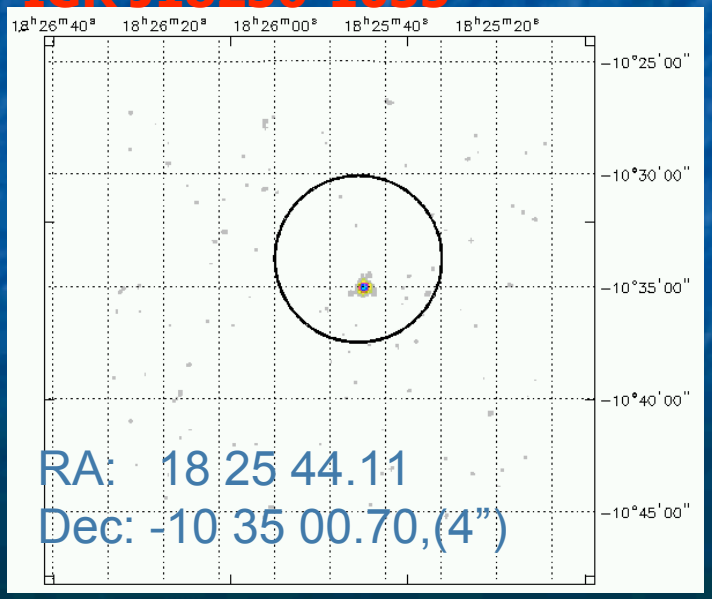
IGR J16500-3307



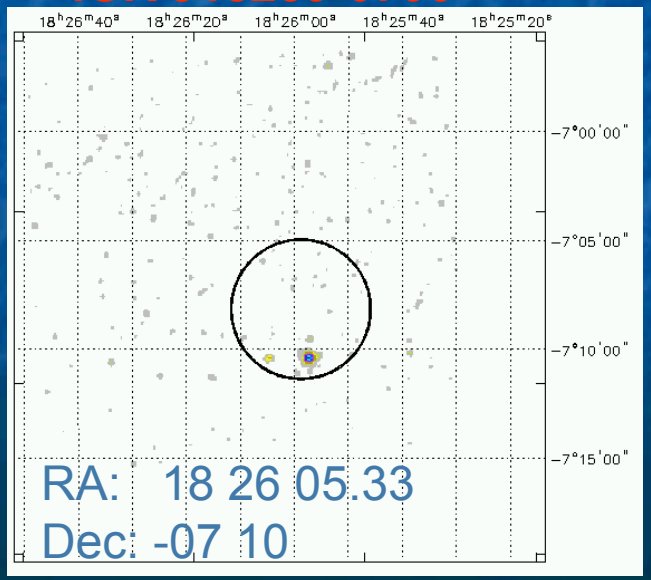
AX J1700.2-4220



IGR J18256-1035



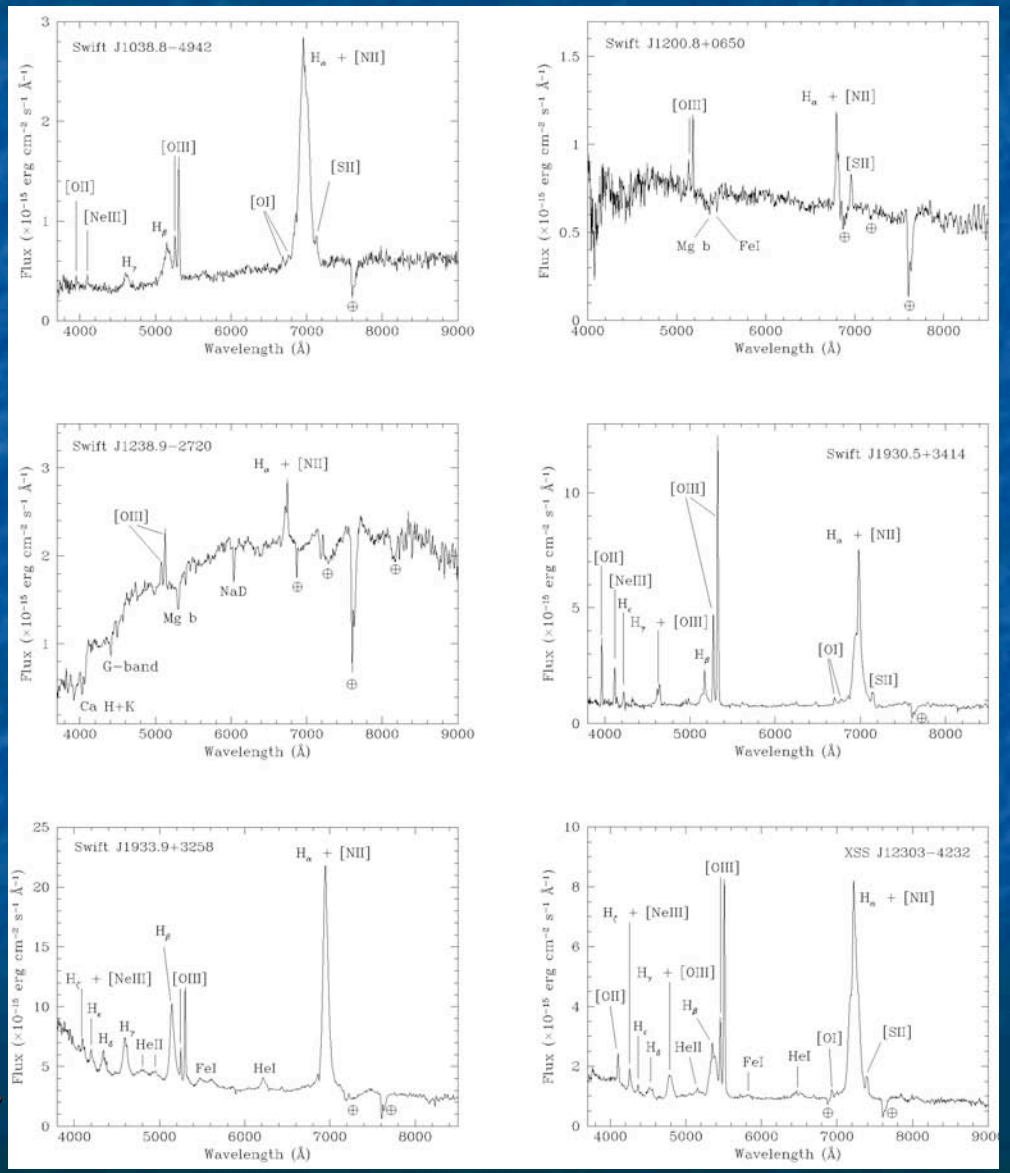
IGR J18259-0706



Identification and followup of INTEGRAL and Swift hard X-ray sources

- Several unidentified or unclassified objects have been detected at hard X-rays by INTEGRAL/IBIS and Swift/BAT.
- XRT observations within our follow-up program allowed us to pinpoint their soft X-ray (and, in turn, their optical) counterparts.
- Optical follow-up spectroscopy eventually allowed us to identify the actual nature of these sources.
- Most of them are AGNs, followed by X-ray binaries; a remarkable percentage is however composed of magnetic Cataclysmic Variables.

Masetti et al. (2006),
Landi et al. (2007),



Characterization of X-ray/gamma-ray spectra

X-ray Observations: SWIFT-XRT (0.5-10 keV)

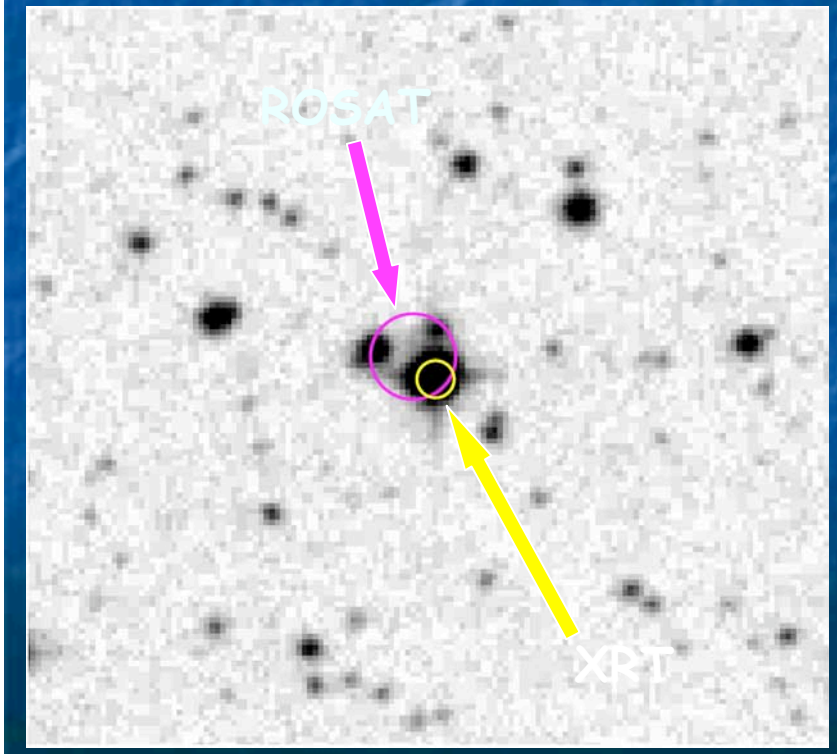
Gamma-ray Observations : INTEGRAL (IBIS) (17-500 keV)

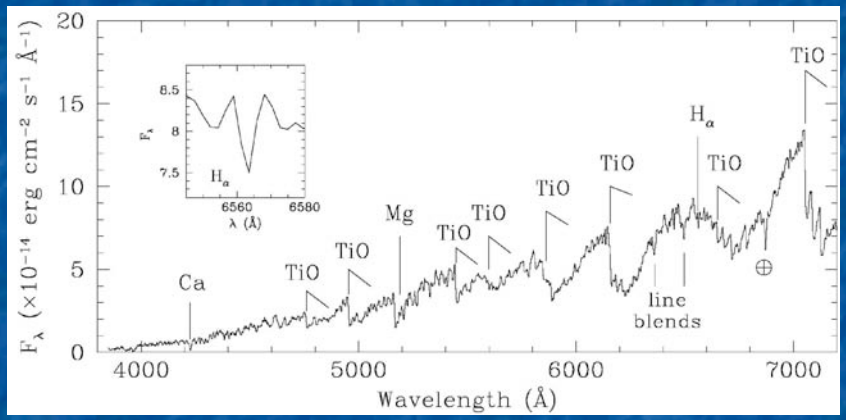
Primary Objectives

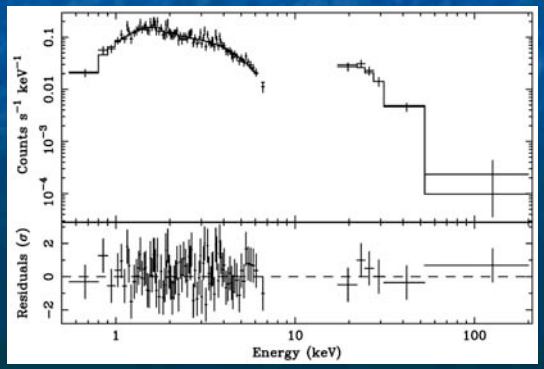
- ESTIMATE OF THE COLUMN DENSITY
- DEFINITION OF PRIMARY CONTINUUM(Γ and Cut-off energy)
- TO STUDY OTHER SOURCE FEATURES AND SPECTRAL DETAILS

IGR J16194-2810: a rare jewel

- XRT observations allowed us to spot the soft X-ray counterpart of this source and to see that it behaves as an X-ray binary.
- Optical spectroscopy revealed that the optical counterpart is a red giant of spectral type M2 III.
- The joint multiwavelength study shows that this source is a Symbiotic X-ray Binary (SyXB).
- SyXBs are very rare Low-Mass X-ray Binaries (only 5 of them are known to date).





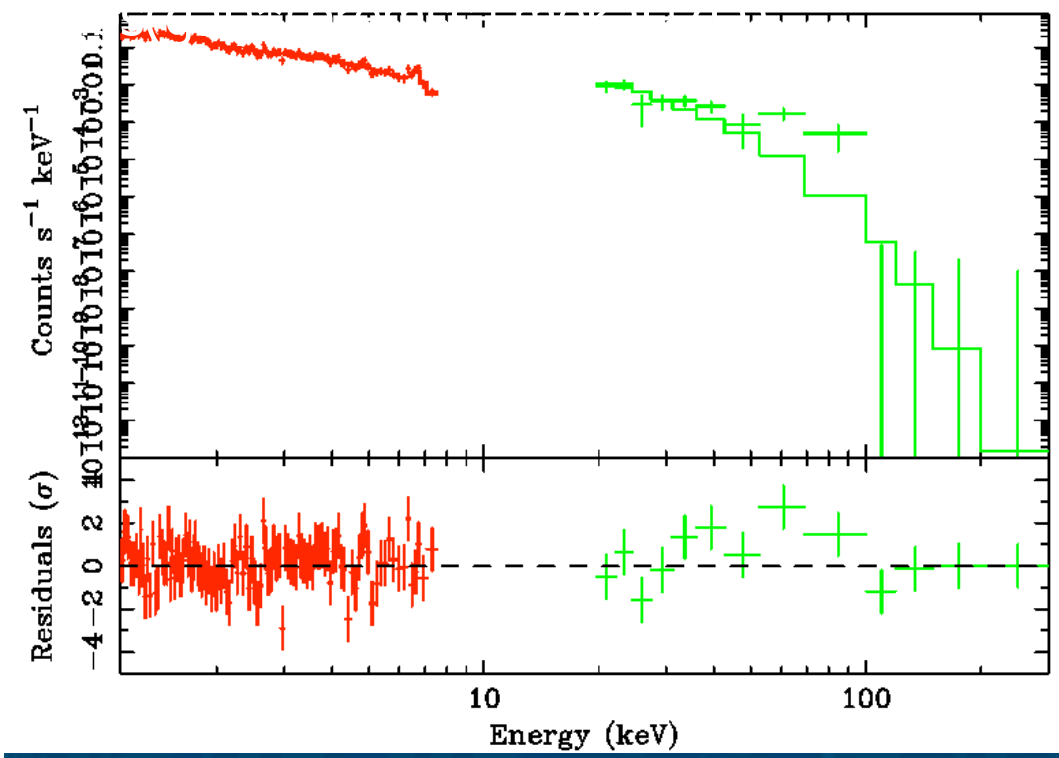


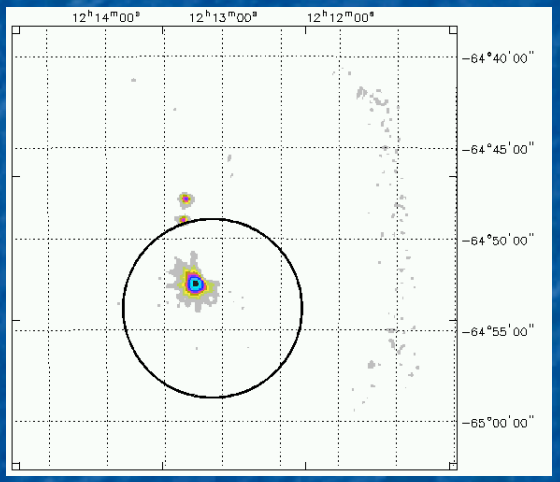
Masetti et al. (2007)

1ES 1210-646

Only detection of iron line in XRT spectra so far: object still unclassified as two optical counterparts to XRT source; brightest only a normal star still to observe the other

Model =

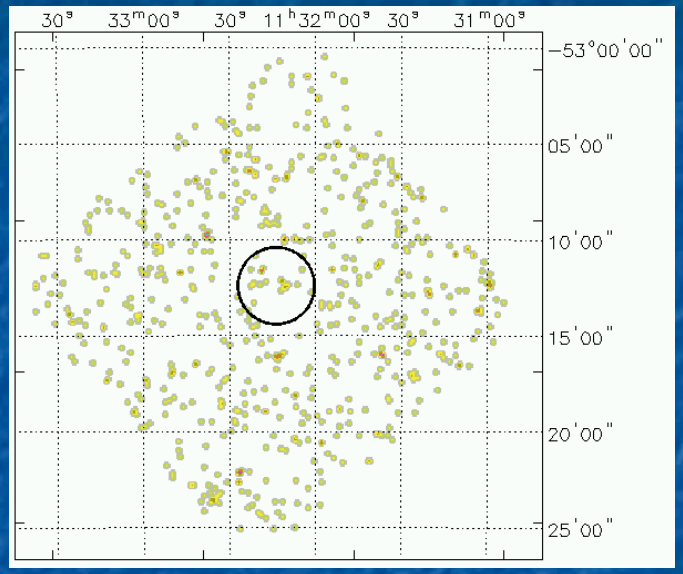




χ2/dof = 119.7/115
N_H(gal) = 9.75 x 10^{21} cm^{-2}
kT_{bremss} = 11.1 [8.75 – 12.2] keV
kT_{mekal} = 0.77 [0.65 – 0.96] keV
E = 6.67 [6.56 – 6.73] keV
σ = 0.13 [< 0.27] keV
Const = 0.87 [0.61 – 1.51]

F(2-10) = 4.2 x 10^{-11} erg cm^{-2} s^{-1}
F(20-100) = 7.9 x 10^{-12} erg cm^{-2} s^{-1}

- **The high energy transient IGR J11321-5311**



No X-ray counterpart from Swift/XRT!

..nature of this object still unknown

- **Broad Band Spectra of Cataclismic Variables:**

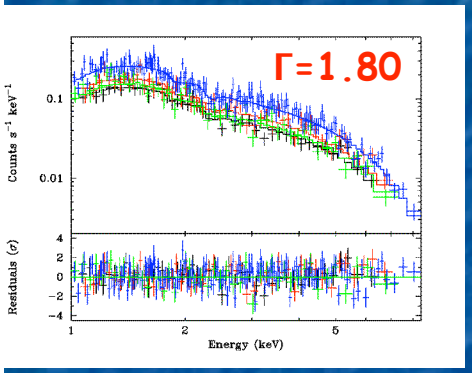
Extreme Spectral complexity and variability,

Sources detected up to high energies (100-200 keV)

…. work in Progress….

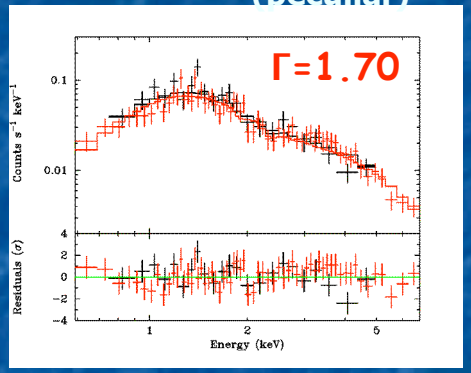
EXAMPLES OF SWIFT-XRT OBSERVATIONS of AGN

IGR J07597-3842



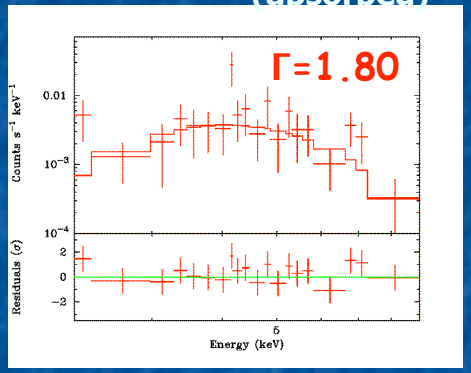
Sey 1.2

IGR J12415-5750 (peculiar)



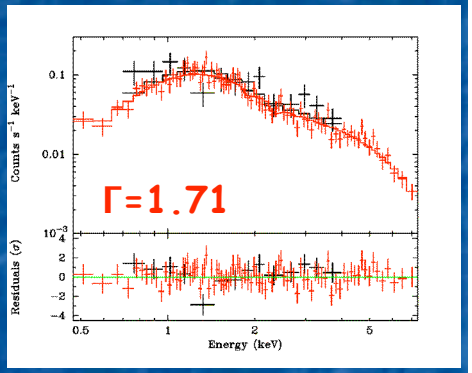
Sey 2

IGR J144925535 (absorbed)



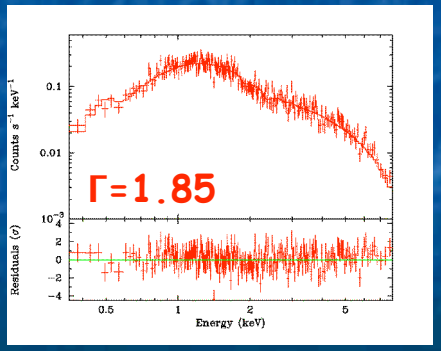
unclassified

IGR J16482-3036



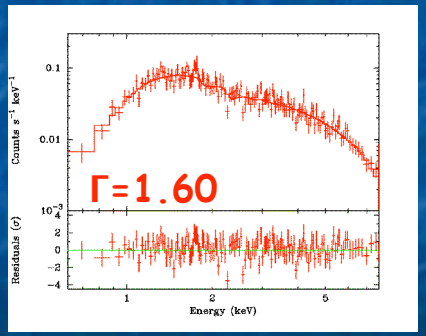
Sey 1

IGR J16558-5203



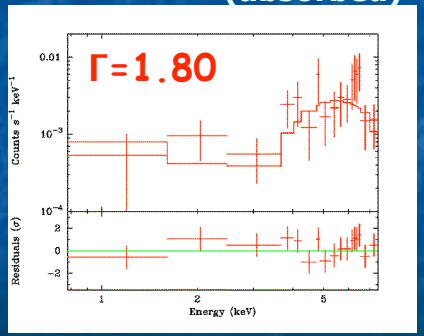
Sey 1.2

IGR J17488-3256



Sey1 (?)

IGR J20286+2544 (absorbed)

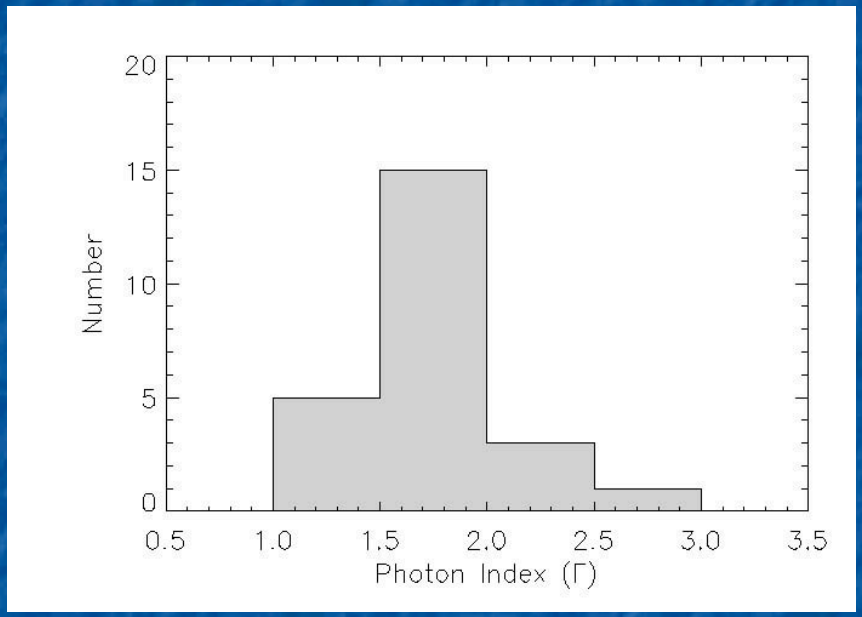


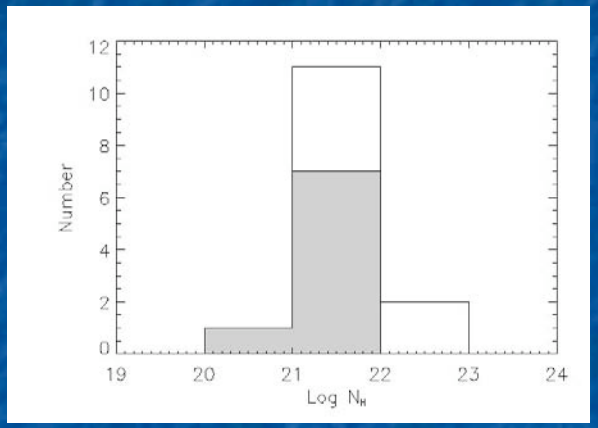
Starburst/Sey2

Typical AGN spectrum, excess column density in 3 objects out of 8.

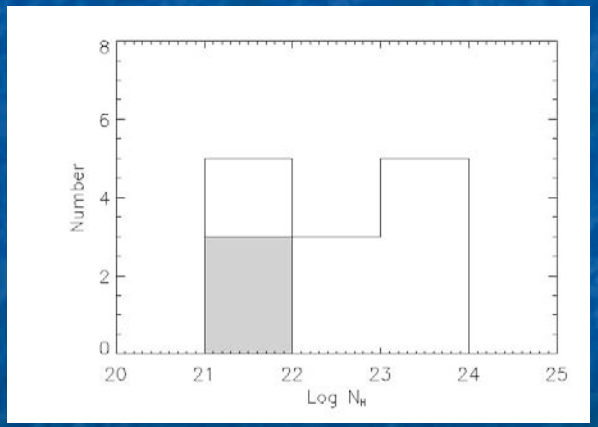
Nh and Γ distribution in a sample of 34 AGN

(Malizia et al. 2007)





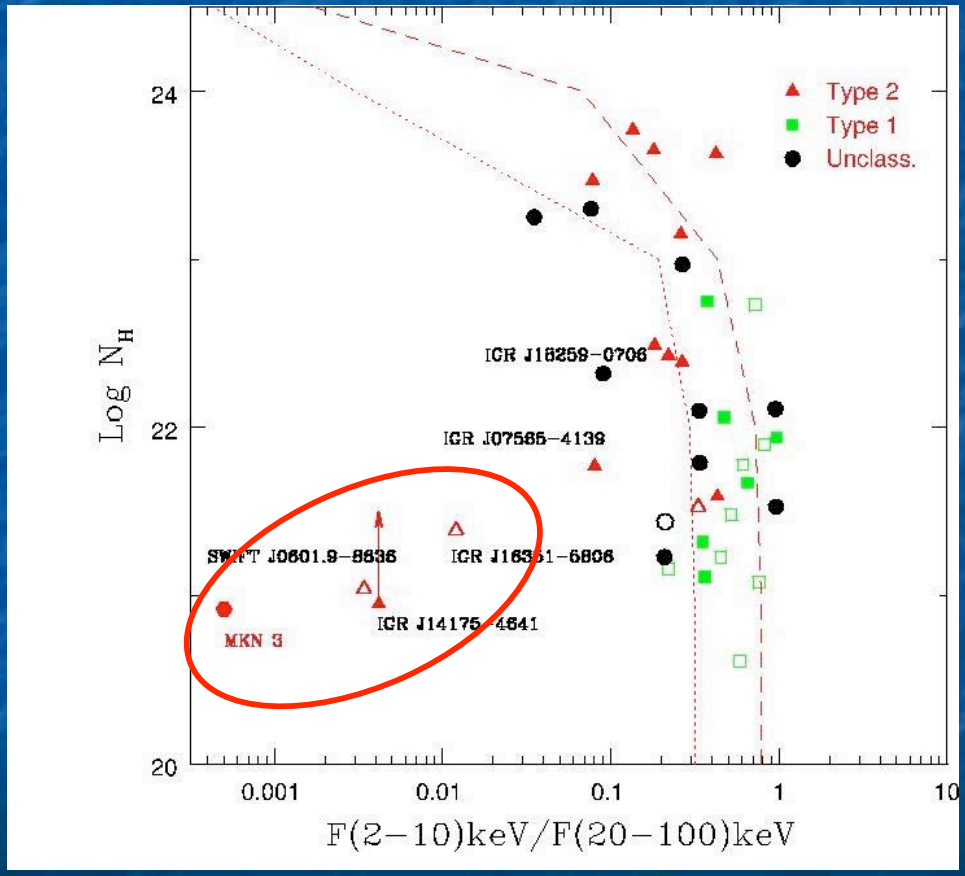
Sey 1



Sey 2

If Nh >10^{22} at/cm^2 is dividing line between absorbed & unabsorbed AGN then ~50% of our sample is absorbed.

SWIFT/XRT OBSERVATIONS DIAGNOSTIC DIAGRAM



Lines=Locii of F2-10/F20-100 keV vs Nh for an absorbed power law with Γ=1.5 (red), 1.9 (black)

Peculiar objects are easily recognized:

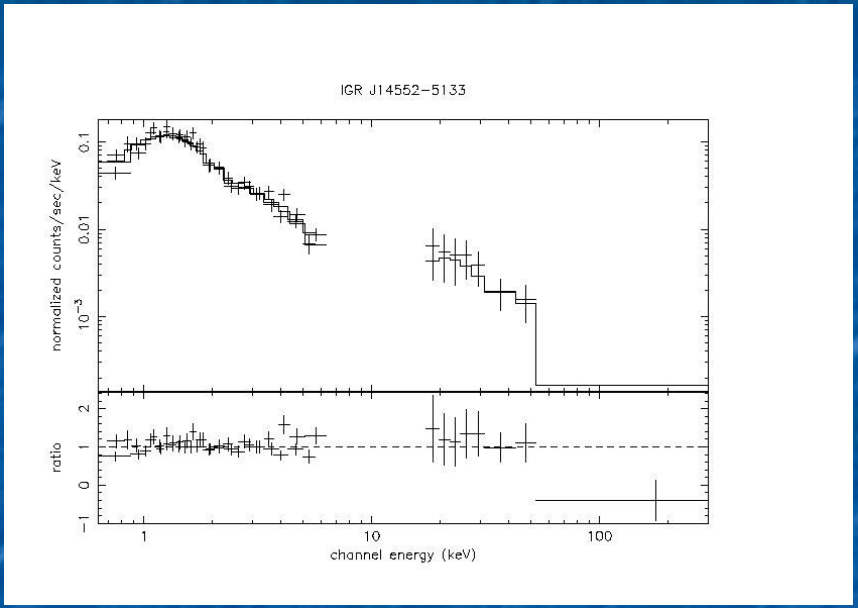
1) Compton thick AGNs (see MKN3 a known Compton AGN as a test)

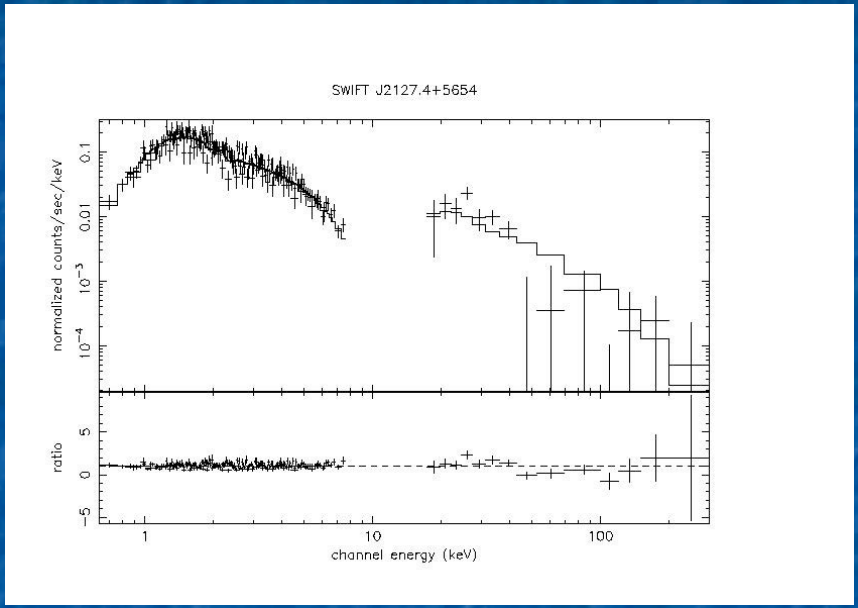
2) Absorbed type1 AGNs

3) Unabsorbed type 2 AGNs

Malizia et al. (2007)

Broad band spectra of Narrow Line Sey1





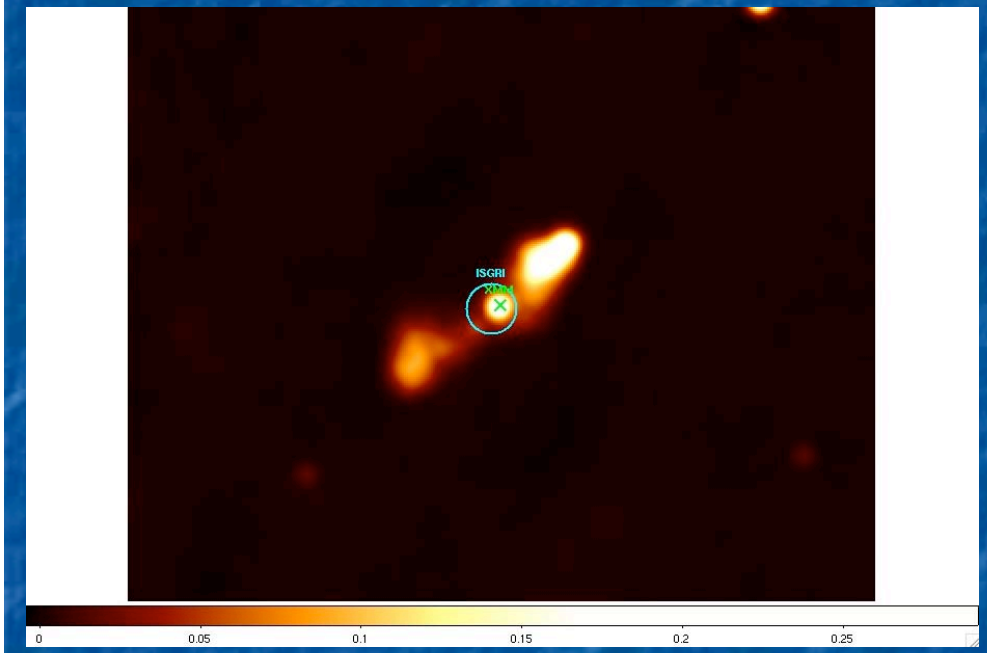
IGR J14552+513
Gamma=1.97+/-0.5
Factor XRT/ISGRI =0.63-1.42
Flux $_{2\text{-}10\ keV}$ =0.9 10^{-11} erg/cm2 sec
Flux $_{20\text{-}100\ keV}$ =1.2$10^{-11}$ erg/cm2 sec

SWIFT J2127.4+5654
Gamma=1.90+/-0.1
Factor XRT/ISGRI =0.65-1.17
Flux $_{2\text{-}10\ keV}$=2.2 10^{-11} erg/cm2 sec
Flux $_{20\text{-}100\ keV}$ =2.7 10^{-11} erg/cm2 sec

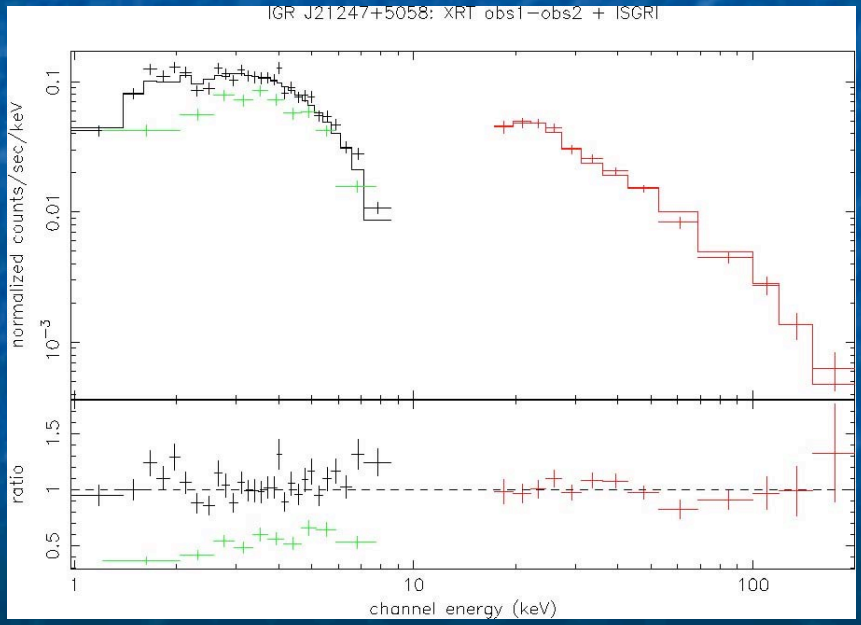
Spectral complexity expected (partial covering & reflection) but not seen as for typical AGN (Malizia et al. in preparation)

BROAD BAND SPECTRA of IGCR J21247+5058

IGR J21247+5058 Radio galaxy



Obs1: partial covering+power law
Obs2: much flatter shape
in X-rays similar to an XMM obs

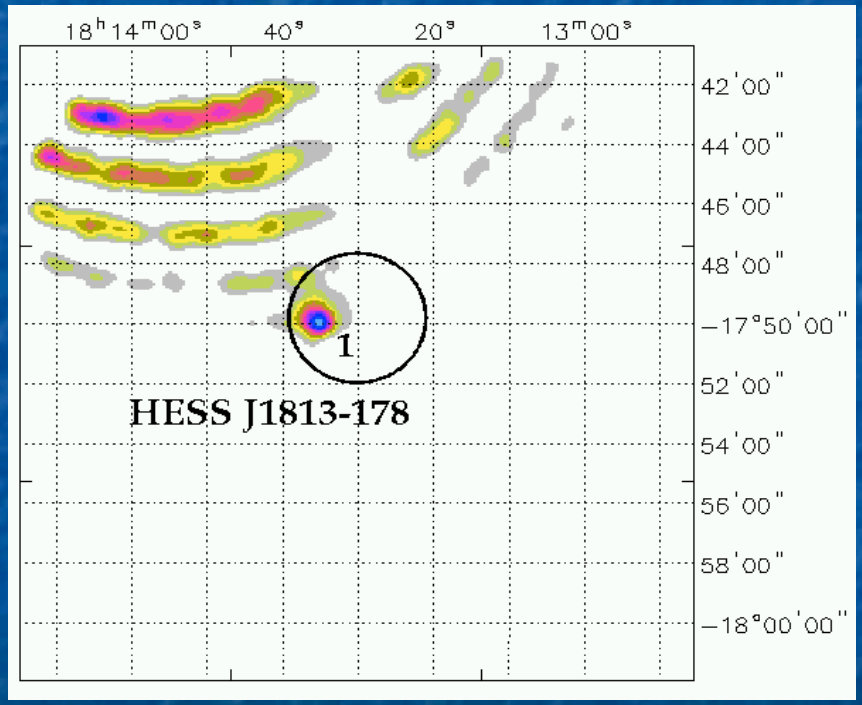


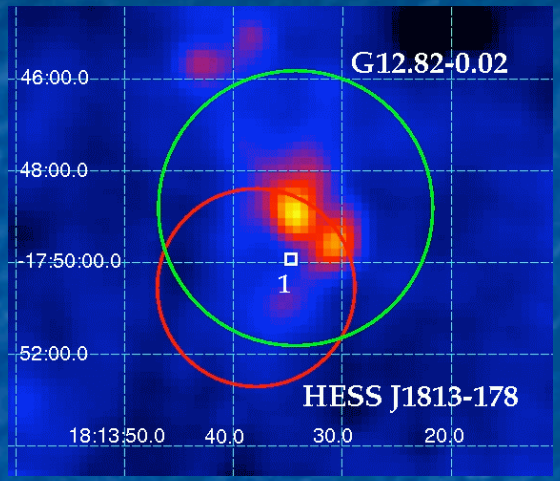
Two XRT observations which indicate variability both in flux and shape:

Molina et al. in preparation

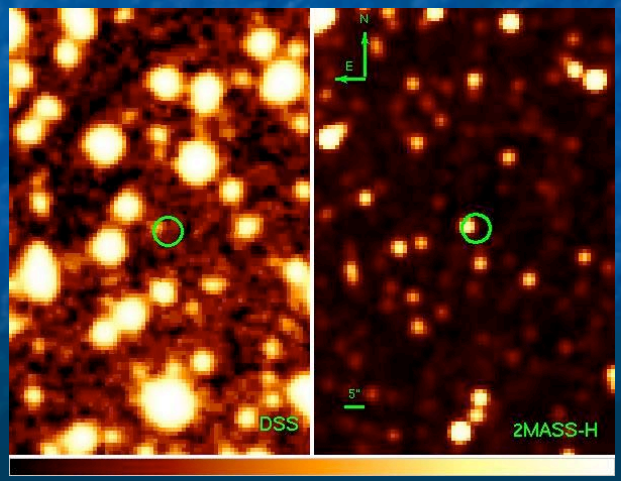
HESS J1813-178

XRT localizes the X-ray source with arcsec accuracy (C.P. ~ 0.01)





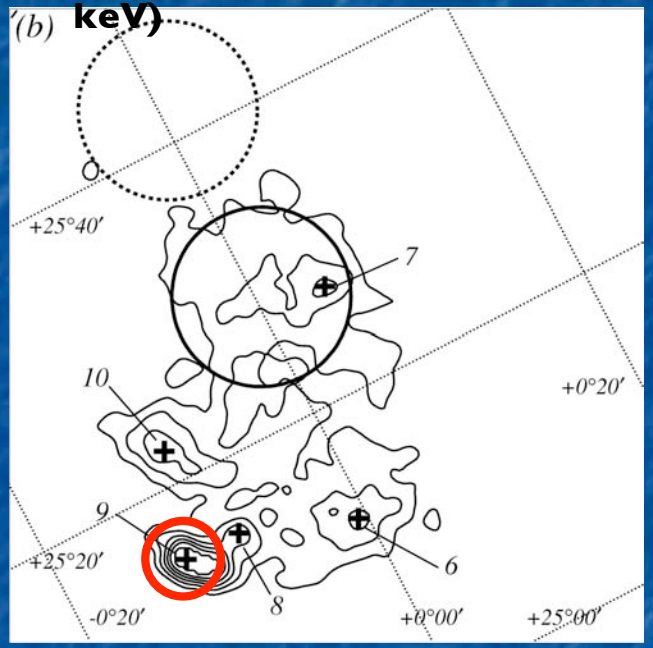
X-ray source inside the SNR

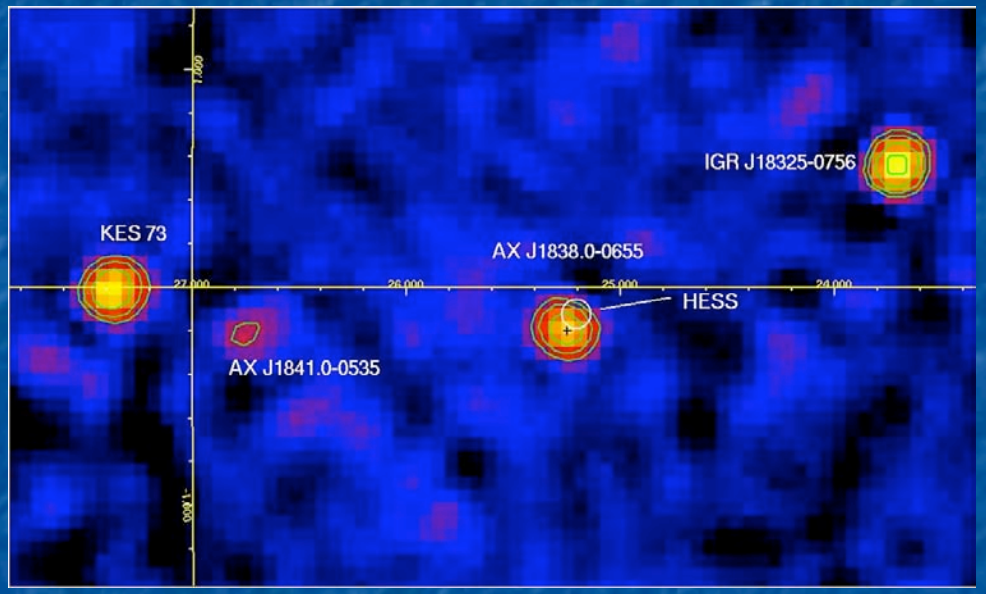


Counterpart: 2MASS/DENIS source K=11.8, I=16.7

HESS J1837-069

ASCA image (0.7-7.0 keV)



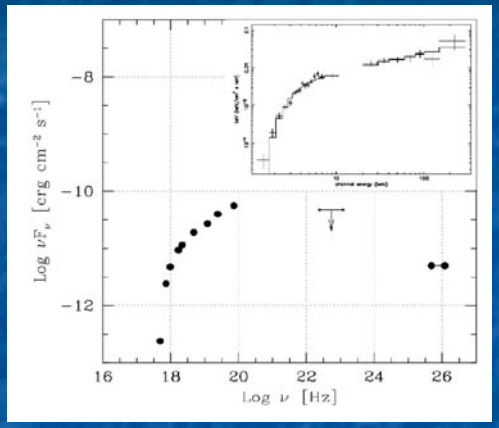


INTEGRAL/ISGRI map (20-100 keV)

Soon associated with the SNR G25.5+0.0 complex detected by ASCA

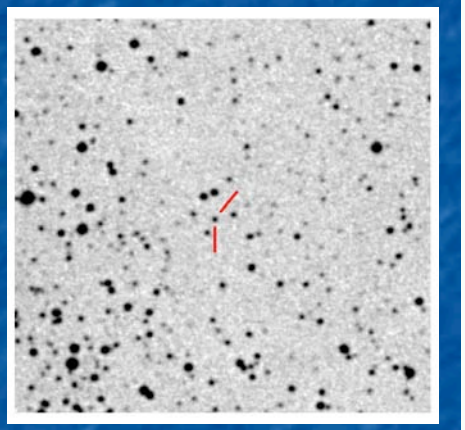
Brightest feature in ASCA (#9) =AX J1838.0-0655 also seen by INTEGRAL/ISGRI and BeppoSAX/PDS

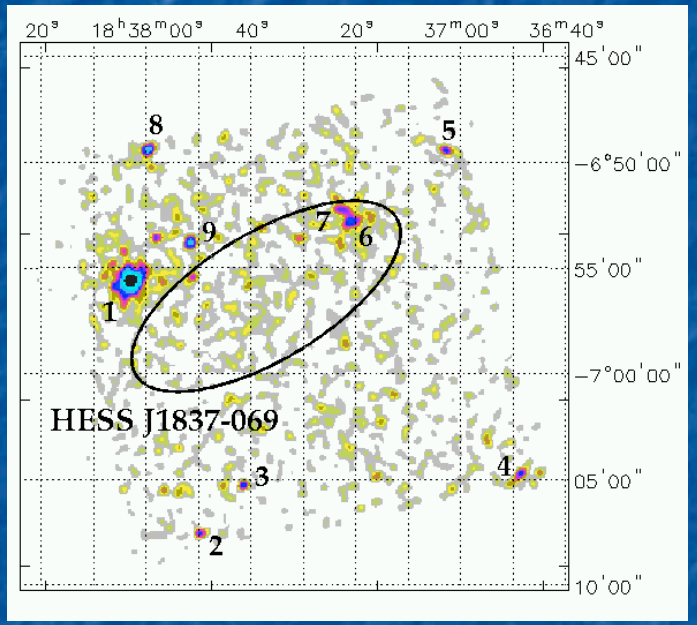
HESS J1837-069



AXJ 1838-0655=Swift/XRT #1

SWIFT/XRT localizes the X-ray source with arcsec accuracy





Γ= 1.5 (1.3-1.7)

NH= 6.7 (5.4-8.0) x 10 22 cm-2

Cross Cal. Const. = 1.1 (0.7-1.7)

Possible optical counterpart:

USNO B1/2MASS source R-K=6.7

Only SWIFT/XRT sources inside H.E.S.S.extention:

#6 (F2-10 keV =4 x10^{-13} erg cm^{-2} s^{-1}) No counterpart

#7 (F2-10 keV =2 x10^{-13} erg cm^{-2} s^{-1}) 2 MASS object with K=13.2

Need optical follow up of #1 & #7

Swift/XRT is playing a key role studying the newly discovered class of: SupergiantFXTs: to date 8 firm members

(1) Swift/XRT ToO observations of SFXTs in outburst provide crucial informations such as:

. refined arcsec positions which allow to pinpoint a univocal optical counterpart.

. spectra and light curves in the soft X-ray band 0.3-10 keV (i.e. constrain of the absorption).

(2) Targeted observations of SFXTs, not in outburst, furnish important informations on their quiescent emission thanks to the very good sensitivity of Swift/XRT.

Firm SFXTs studied with Swift/XRT:

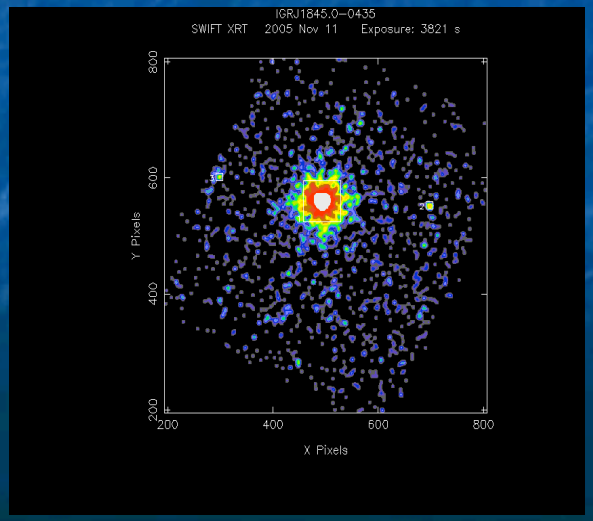
AX J1845.0-0433

IGR J11215-5952

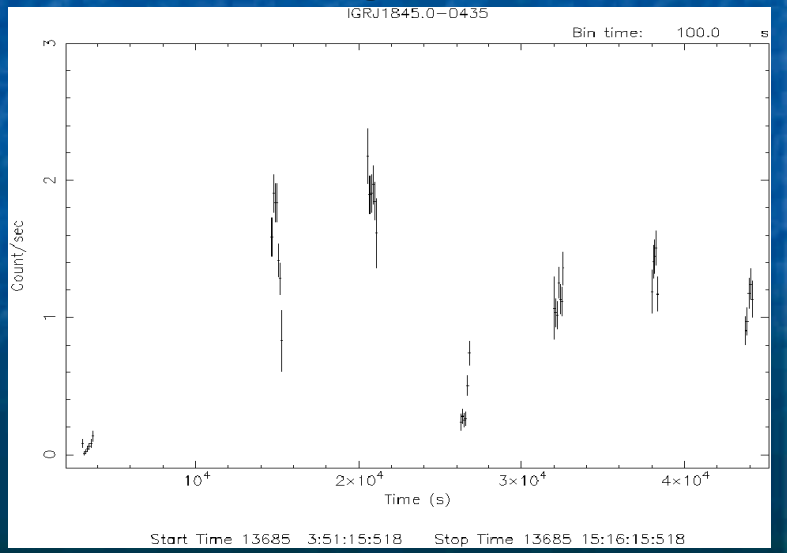
IGR J08408-4503

Swift/XRT observation of AX J18450-0433 (0.2-10 keV) on 11 Nov 2005 (4.6 ks) Sguera et al. 2007

…Image ….



and light curve



Candidate SFXTs studied with Swift/XRT:

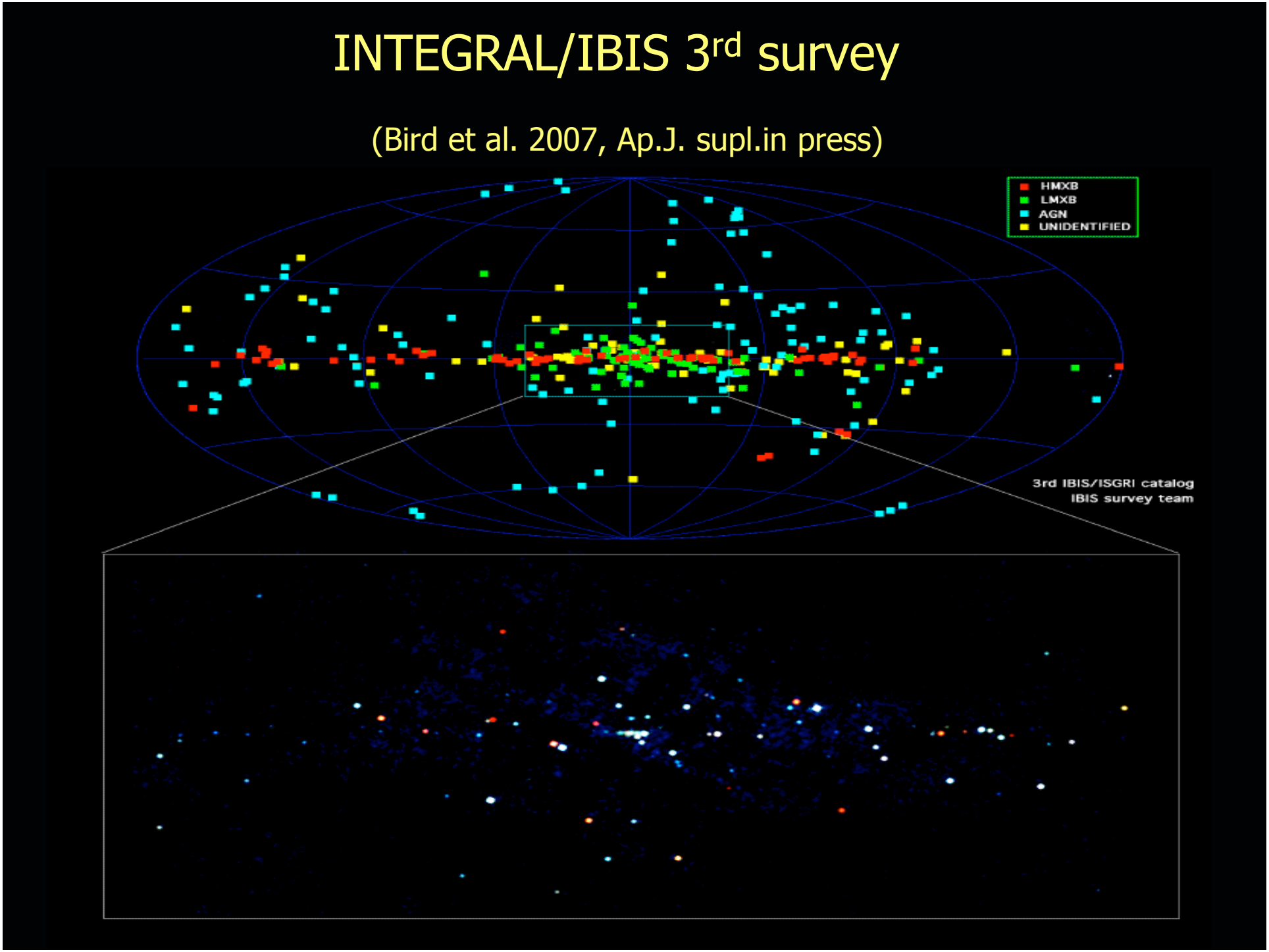
IGR J16479-4514

AX J1749.1-2733

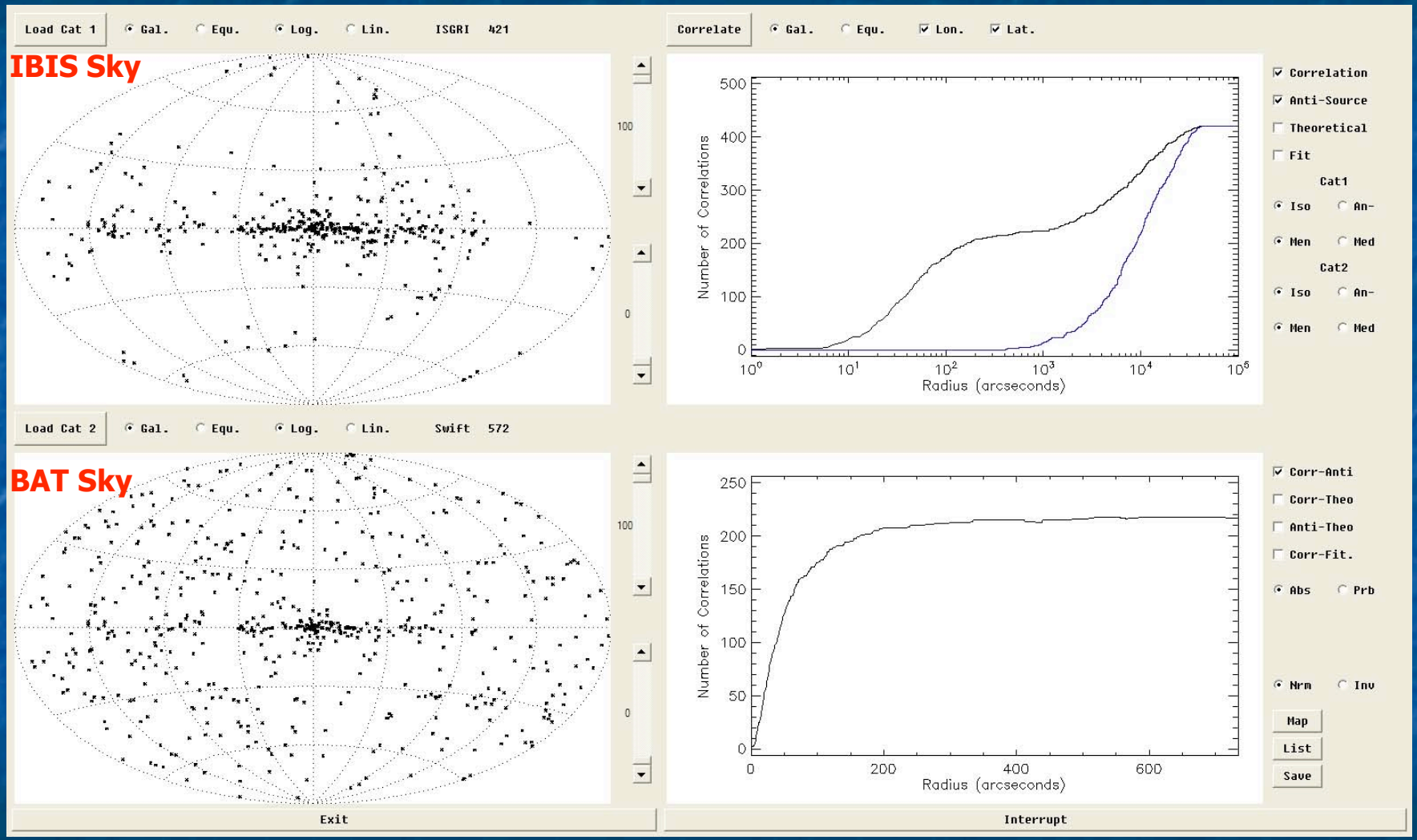
IGR J18483-0311

INTEGRAL/IBIS 3rd survey

(Bird et al. 2007, Ap.J. supl.in press)



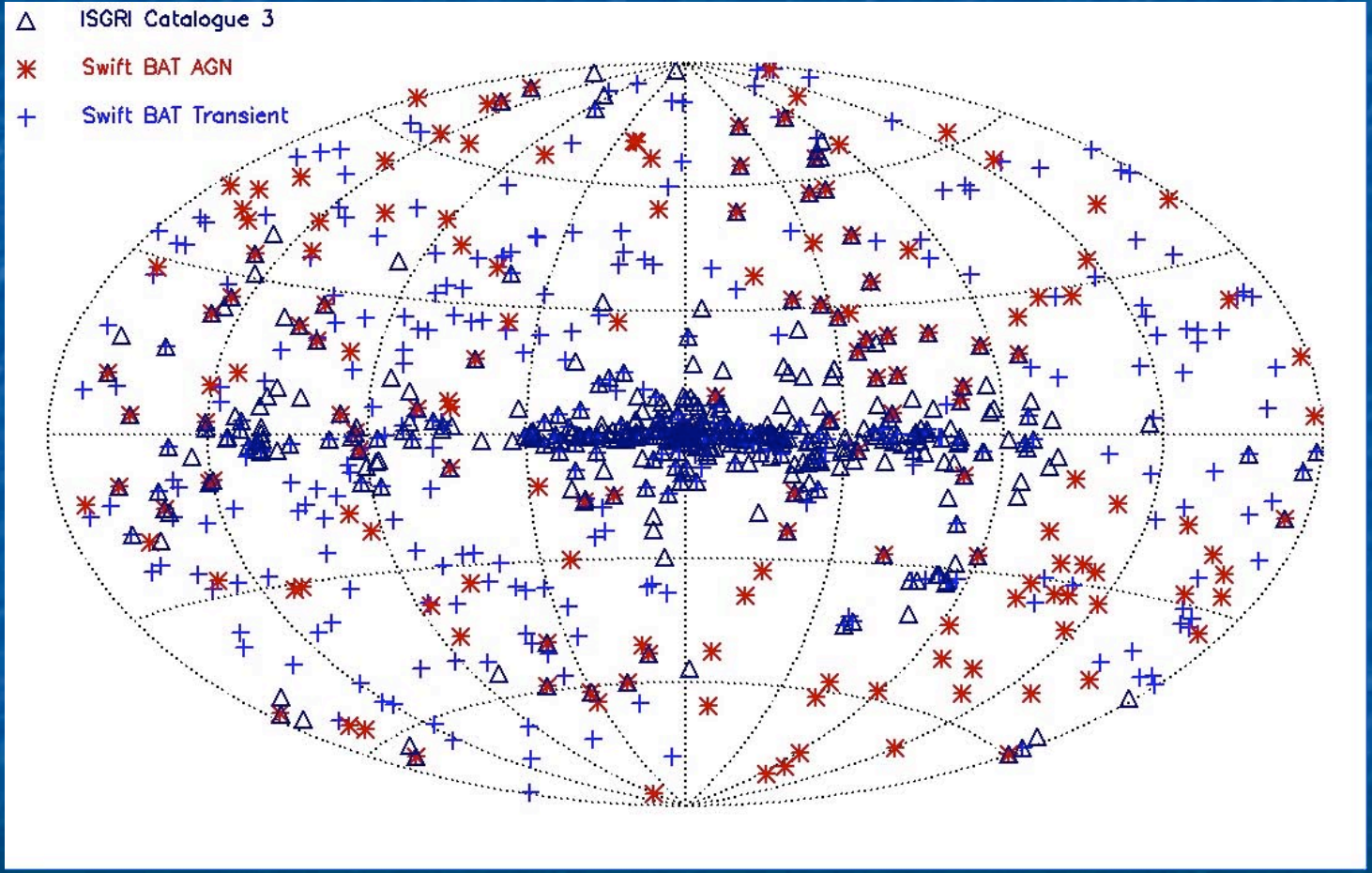
INTEGRAL/IBIS- SWIFT/BAT cross correlation analysis



Swift/BAT: Transient +AGN catalogue on the web (take out duplications)

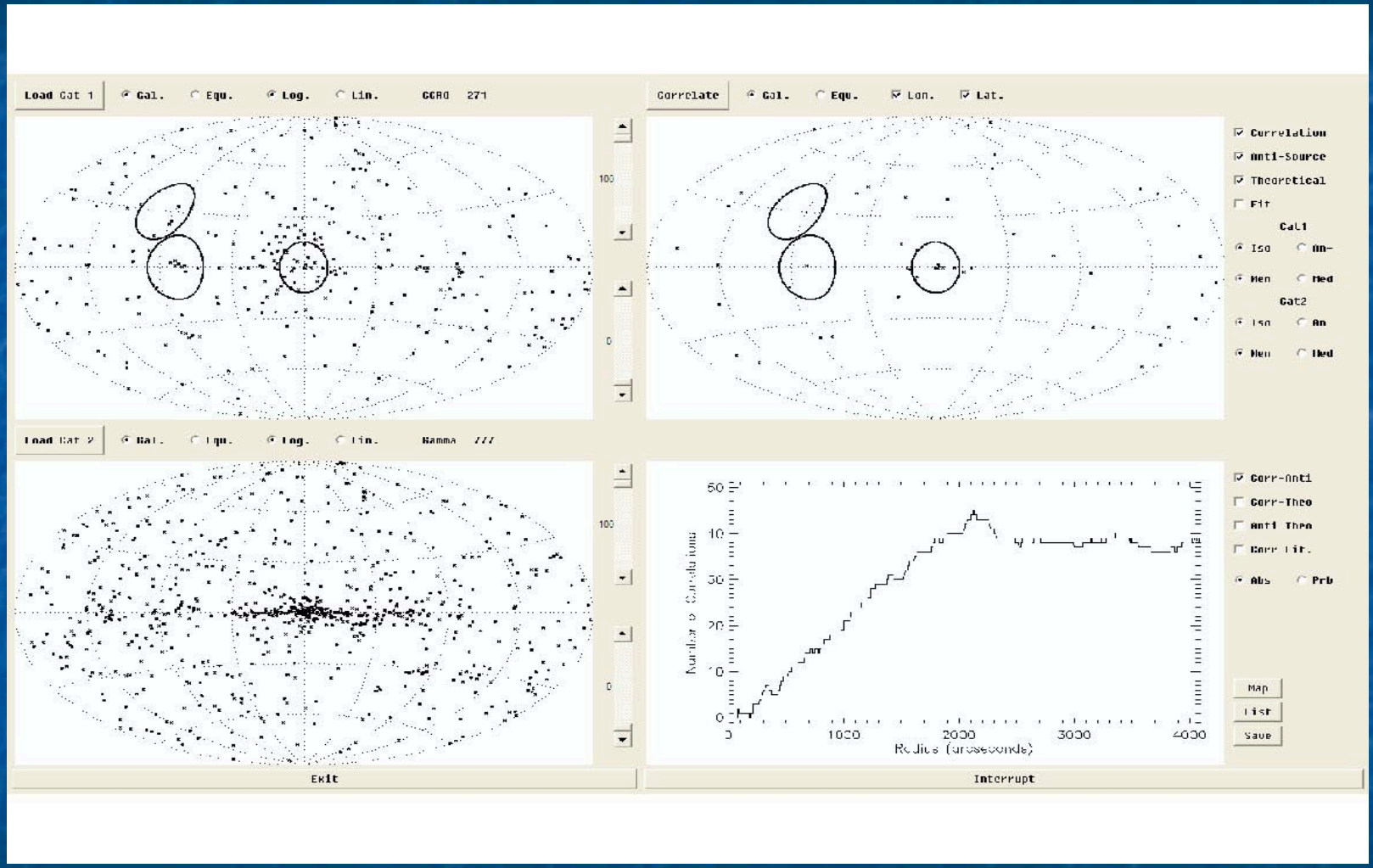
INTEGRAL/IBIS : 3rd Survey catalogue → **~200 objects in common**

INTEGRAL/IBIS-SWIFT/BAT cross correlation analysis



High Energy Sky Master Catalogue (HEMC) : ~777 objects

Cross Correlation analysis: HEMC vs EGRET



48 associations up to a distance of 1 degree, with 8 expected by chance:
82% are Blazars, 13% pulsars, 5% microquasars

SWIFT and INTEGRAL prospects for GLAST

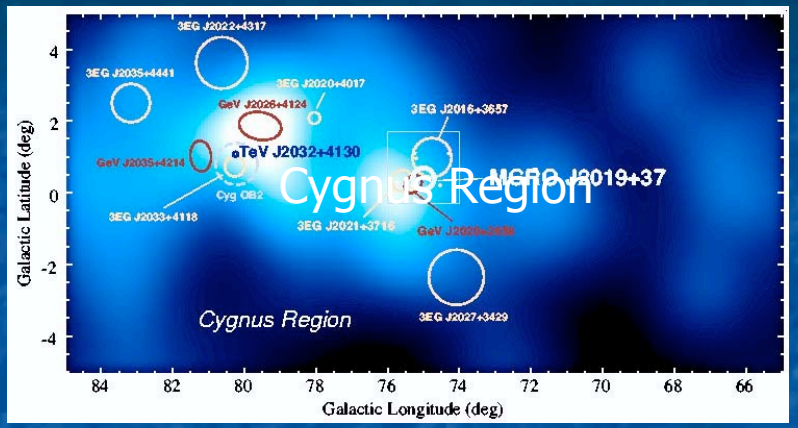
- Expected number of GLAST detections

  in INTEGRAL Key Projects ~400 (1/10 ONLY of the whole sky!)
- If percent of association as with EGRET (~14%)
- Then ~50 associations possible:

~ 40 Blazars,

~ 7 pulsars,

~ 2-3 microquasars



Conclusions: we expect a large number of Blazars associated with SWIFT detections with several INTEGRAL high quality spectra from deep fields

end