The quest for the nature of unidentified INTEGRAL sources

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On behalf of (in sparse order)

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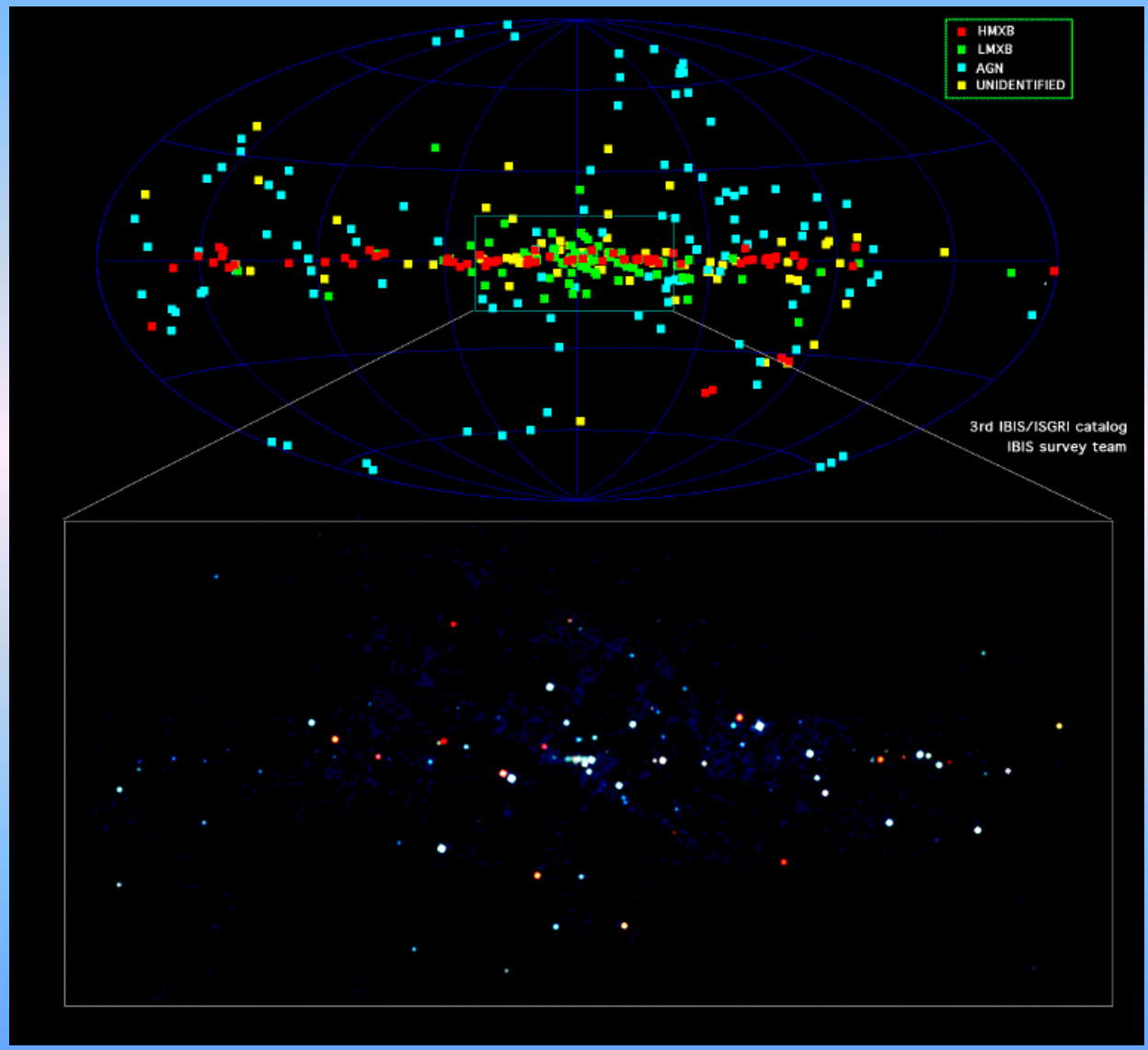
The INTEGRAL's 3rd IBIS survey

Collected between October 2002 and April 2006
~24000 pointings →
~40 Ms exposure
sensitivity: ~1 mCrab (20-100 keV)
positional accuracy: 1' to 5'



Bird et al. (2007)

3rd IBIS survey results

421 hard X-ray sources detected, of which:

- 118 Active Galactic Nuclei (AGNs)
- 79 Low Mass X-ray Binaries (LMXBs)
- 68 High Mass X-ray Binaries (HMXBs)
- 23 Cataclysmic Variables (CVs) and Symbiotic stars
- 12 Supernova products (isolated PSRs, PWNe, SNRs, AXPs)
- 2 galaxy clusters
- 2 Soft Gamma Repeater (SGR)
- 1 Gamma-Ray Burst (GRB)
- 1 RS CVn (magnetic) star
- 115 unknown/unclassified sources (~27% of the sample)

Bird et al. (2007)

Our activities on the identification of IGR sources

Sample selection:

- **correlation with** soft X-ray and/or radio **catalogues**;
- **search for counterparts** on DSS-II-Red and 2MASS surveys;
- **selection of** cases with few (<3) **relatively bright** optical/NIR **candidates** in soft X-ray and/or radio error boxes;
- optical **spectroscopy**.

We started our campaign at the OA-Bologna 1.5m telescope in Loiano (Italy).

Three objects were selected:

- IGR J17303-0601 (**IP CV**)
- IGR J18027-1455 (**Sy1 AGN**)
- IGR J21247+5058 (**Sy1 AGN**)

Our identifications aisle of plenty

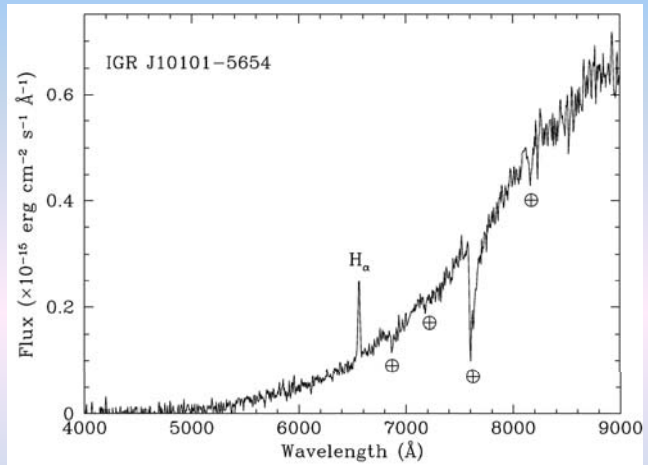
This is the breakdown of our 43 spectroscopic identifications at various telescopes up to 2006:

23 **AGNs** (11 Sy 1s, 11 Sy 2s, 1 BL Lac) with **0.013 < z < 0.084**

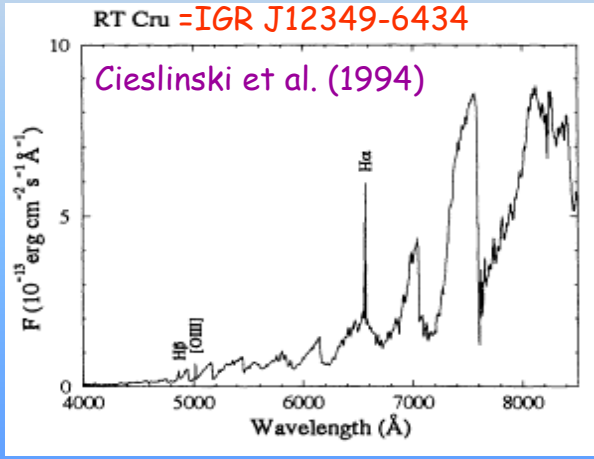
11 **HMXBs** (one in the LMC)

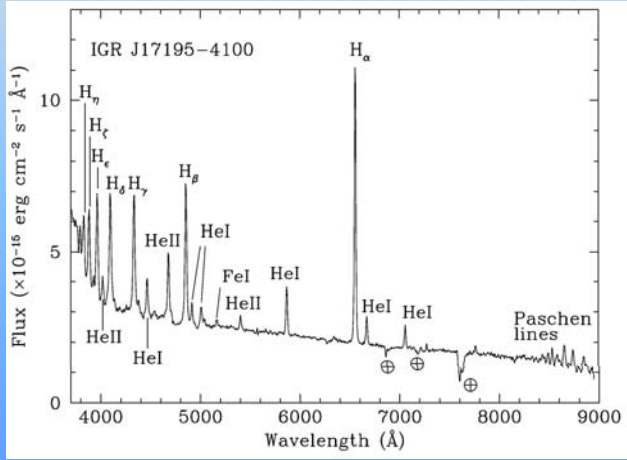
7 Intermediate Polar (magnetic) **CVs**

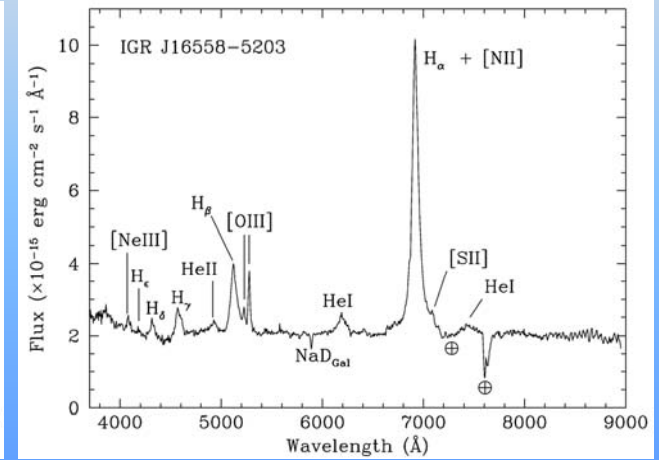
2 **Symbiotic stars**



Masetti et al. (2004, 2005, 2006a,b,c,d,e)







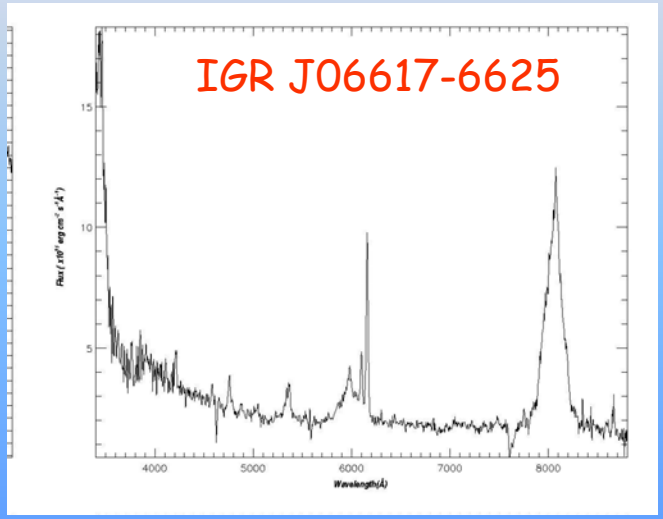
The 2007 multiobservatory campaign

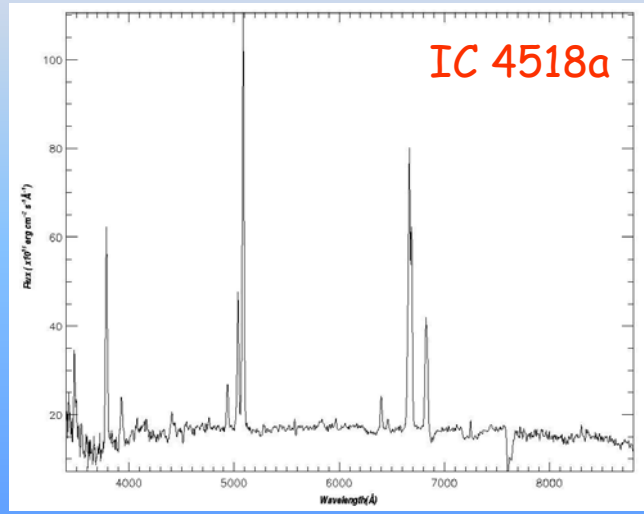
In order to continue to pursue this identification program, we asked for (and obtained) time at Loiano, Asiago, CTIO, ESO, SAAO telescopes, and extracted archival objects from the 6dF and SDSS surveys.

Preliminary data allowed us to identify:

13 AGNs (4 Sy 1s, 9 Sy 2s) with $0.006 < z < 0.230$

2 LMXBs (or CVs)

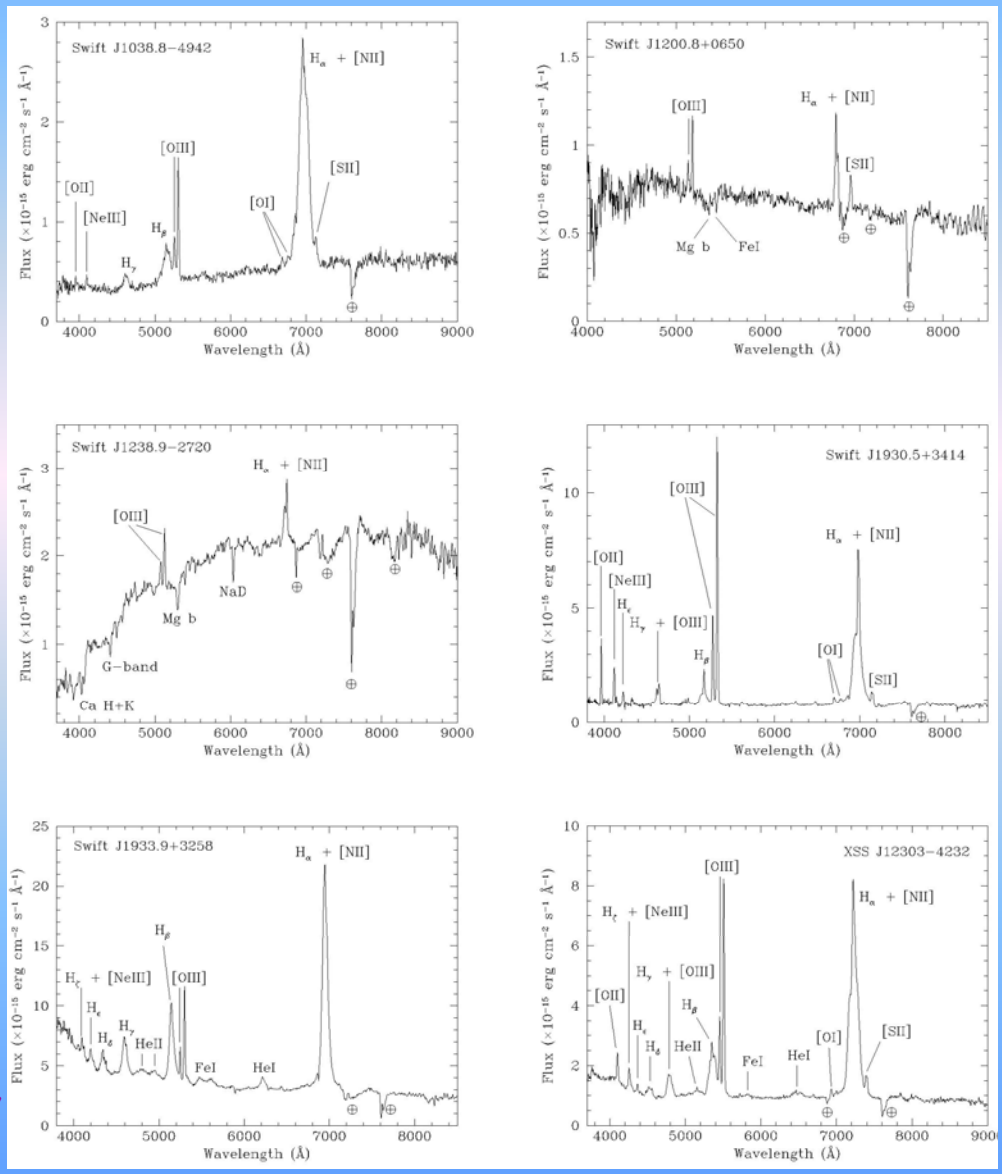




Masetti et al. (in prep.)

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

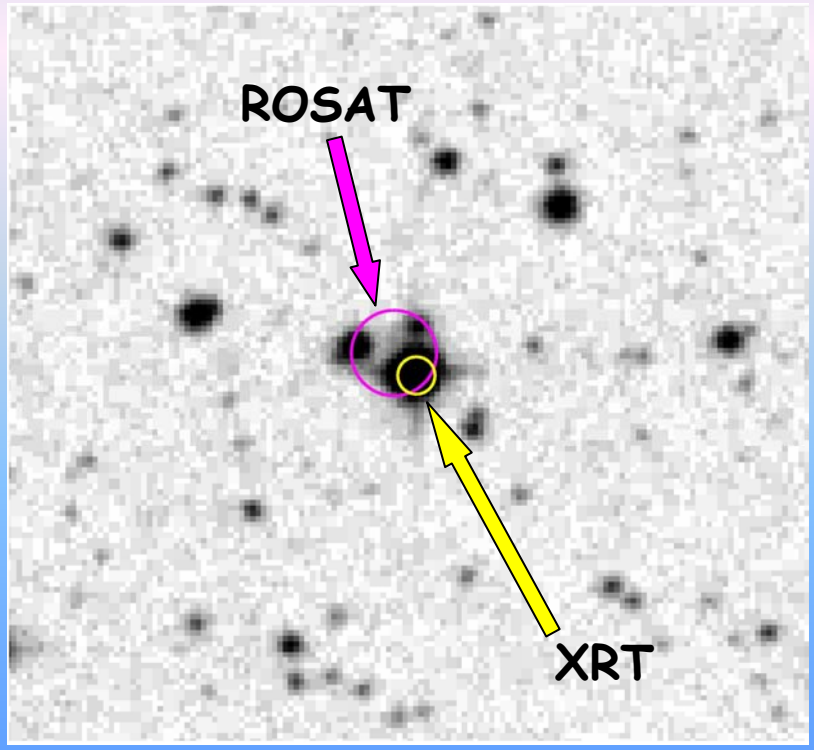
- Several unidentified or unclassified objects have been detected at hard X-rays by INTEGRAL/IBIS and Swift/BAT.
- XRT observations within our follow-up program allowed us to pinpoint their soft X-ray (and, in turn, their optical) counterparts.
- Optical follow-up spectroscopy eventually allowed us to 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.

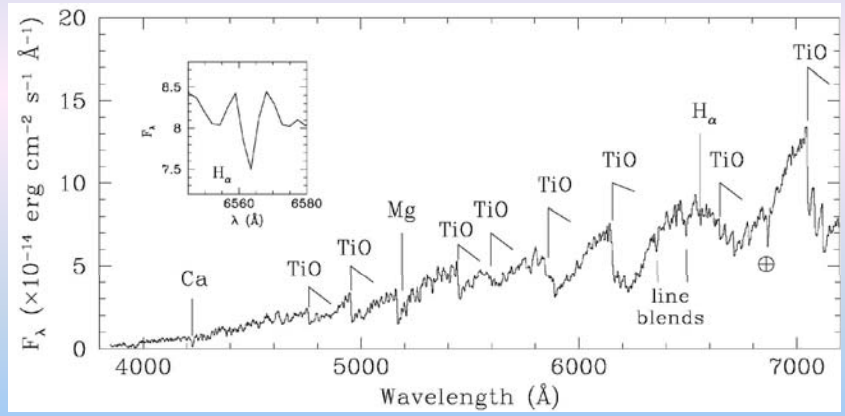


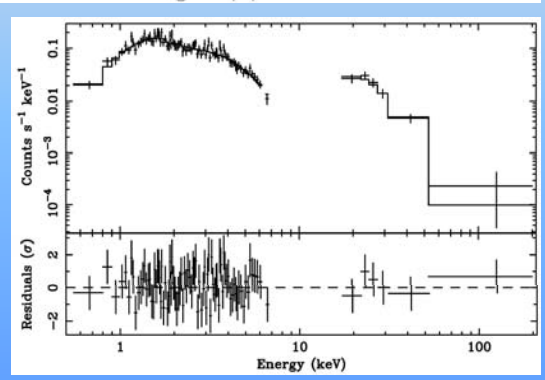
Masetti et al. (2006), Landi et al. (2007),

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 "normal" 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).







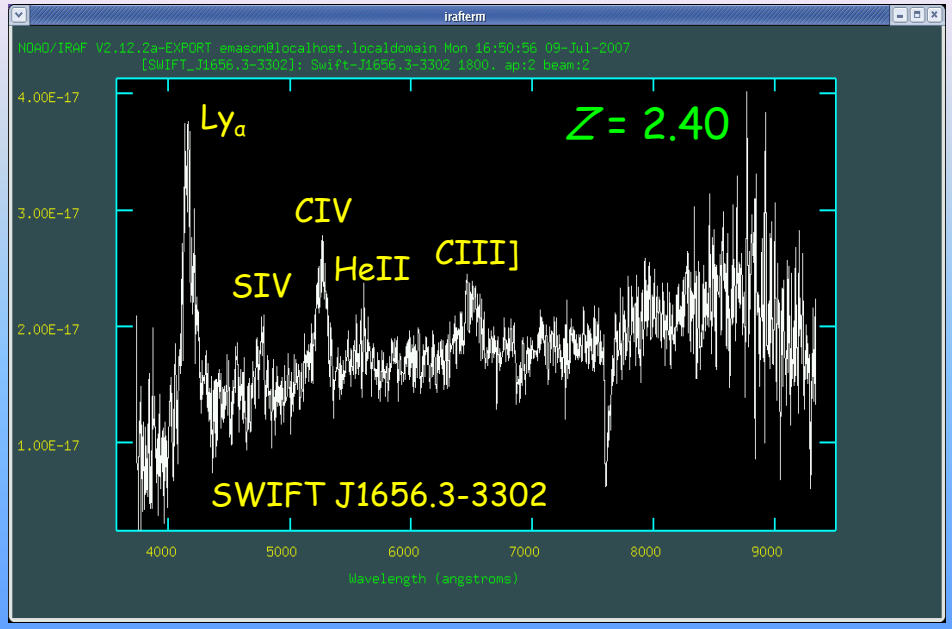
Masetti et al. (2007)

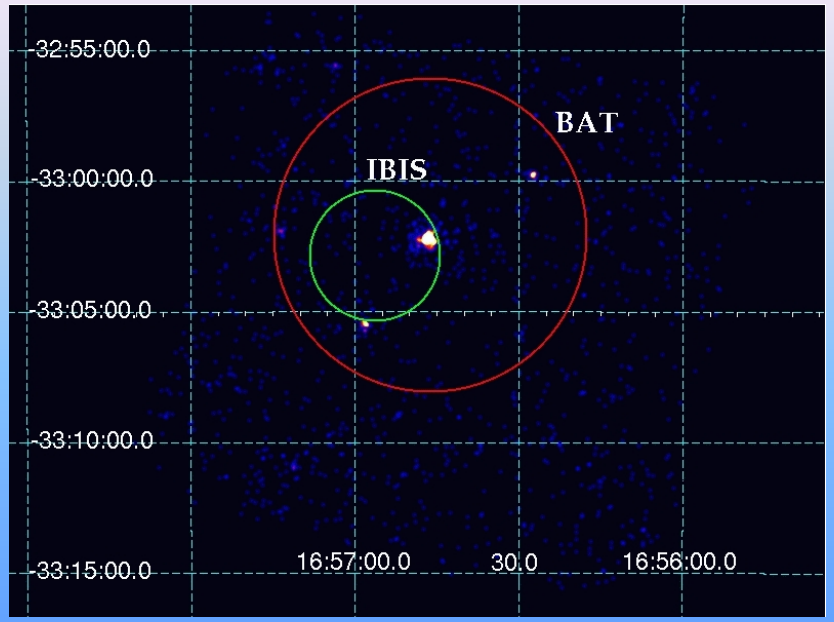
The distant blazar Swift J1656.3-3302

Data analysis of spectroscopy collected with the ESO-3.6m telescope plus EFOSC2 on June 2007 allowed us to identify the hard X-ray source Swift J1656.3-3302 as a powerful gamma-ray loud blazar at **z = 2.40**.

This is, up to now, the farthest optically-identified object of any INTEGRAL survey, and the fourth farthest of all objects detected with INTEGRAL.

Masetti et al. (submitted)





Summary

Up to now (October 2007) the inventory of the optically identified nature of INTEGRAL sources is the following:

- 4 LMXB;
- 17 Be/X HMXBs (with main-sequence or giant companion);
- 6 fast-transient HMXBs with supergiant companion;
- 39 nearby (z ~ 0.006 – 0.230) AGNs;
- 2 high-z blazars
- 1 BL Lac
- 1 XBONG hiding a Sy2 AGN;
- 1 (strange) radiogalaxy at z = 0.02, possibly a Sy1 AGN;
- 7 magnetic CVs
- 2 Symbiotic stars

So, 75 sources of the three IBIS surveys and 5 other sources detected with INTEGRAL were optically identified.

Some more statistics…

3rd IBIS/INTEGRAL survey
(306 known objects):

- 147 X-ray Binaries (48%);
- of these, 54% are LMXBs and 46% are HMXBs;
- 118 AGNs (38%);
- 23 CVs (8%);
- 20 others (6%).

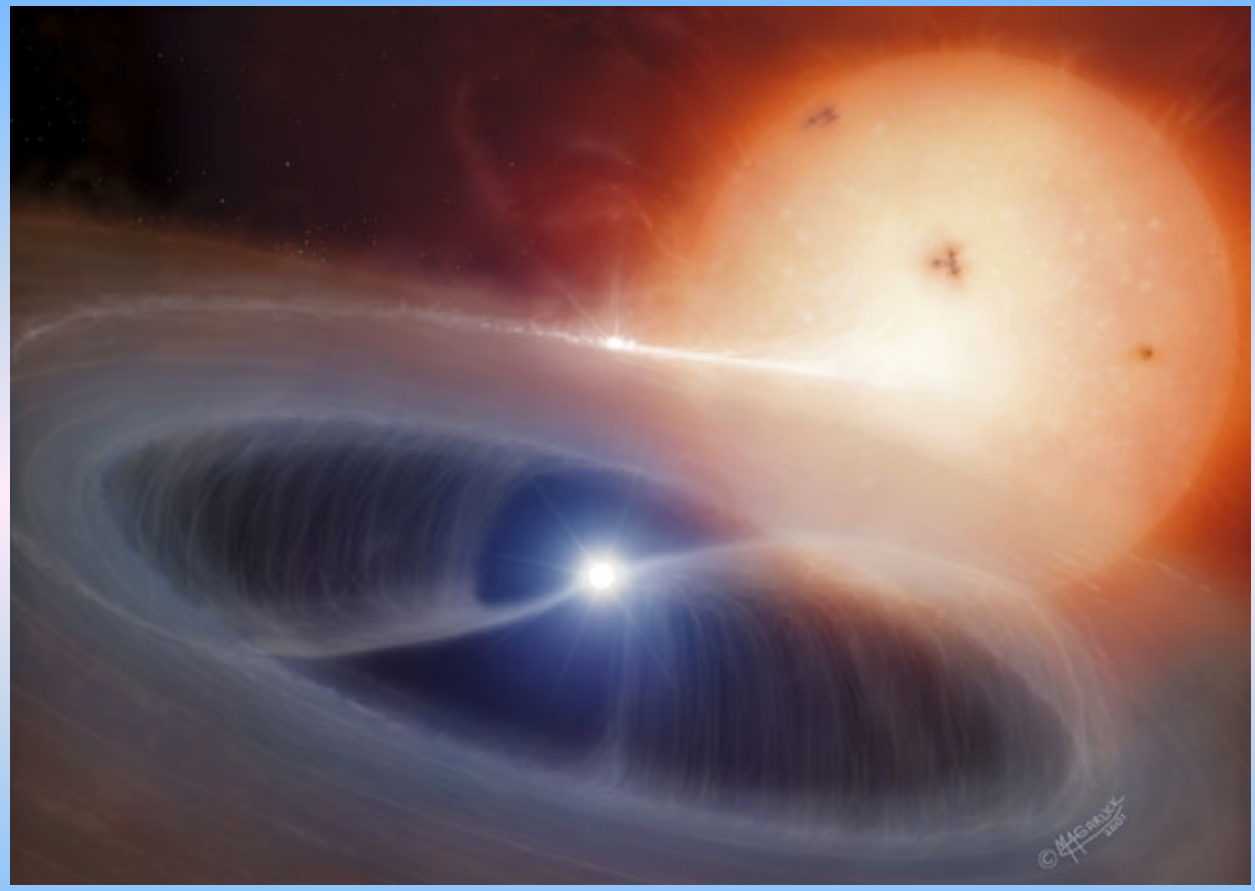
Optically identified IGR sources
(80 objects):

- 27 X-ray Binaries (34%);
- of these, 15% are LMXBs and 85% are HMXBs;
- 44 AGNs (55%);
- 9 CVs (11%).

This suggests that:

1) INTEGRAL is contributing to the **discovery of a (possibly new) class** of absorbed HMXBs in the Galactic Plane;
2) INTEGRAL is giving **fundamental insights to detect AGNs** in the Zone of Avoidance along the Galactic Plane;
3) INTEGRAL is able to detect a **substantial fraction of (magnetic) CVs**.

Free thoughts on CVs: hot food for the brain



It is impressive how many (mostly magnetic) CVs are detected by INTEGRAL (see also talk by **R. Landi**):

- **23** (out of ~300 objects, i.e. ~8%) in the 3rd IBIS survey;
- **~11%** of optical identifications (9 out of 80 cases).

Catalogue of optically identified IGR sources:

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