Searching for EGRET Unidentified Sources Counterparts with IBIS

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Methods: General

1. Search for X-rays Counterparts with IBIS

2. Multiwavelenght analysis to see if X-ray counterparts are likely to be the EGRET emitters.

... then define, if possible, the best candidate

Methods: X-ray Counterparts

1. Mosaic analysis

    1.1) used different energy ba|20-40 keV

    1.2) investigated all the "sour|40-60 keV

| 20-40 keV |
| 40-60 keV |
| 80-120 keV |
| 20-100 kev |

2. Time dependent analysis

  "signals" with s>4 were serached within EGRET error boxes (95% con. level) in each SCW investigated.
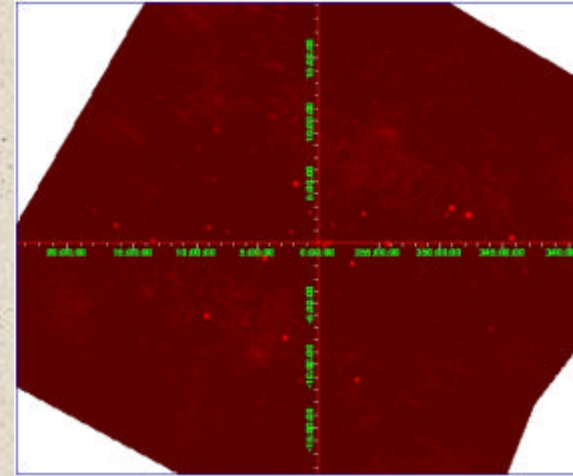
Methods: Investigated Regions

Mosaics/Deep Fields very similar to Surveys

Timing: time consuming -> defined most "interesting regions" (trade-off between available data and numer of Unid. EGRET sources in the fields):

1. Galactic Center
2. Norma Arm
3. Great Attractor Region

The Galactic Center (I)

- All SCW centerd within 6° from the GC have been used both for the mosaic (deep exposure) and for the timing analysis

- Data collected from rev. #26 to rev. #186 for the mosaic (20-40, 40-60, 80-120 and 20-100 keV energy bands)

- Data collected from rev #53 to 241for time dependant analysis (20-40, 40-60, 80-120 keV energy bands)

$(20\text{-}40 \text{ keV})$

The GC (2): the inner 3°×3°

(credits: Bazzano, Molina, Malizia, Stephen & Bassani)

SOURCE	l deg	b deg	T_95 deg	F_? ph cm^-2 s^-1	?	GeV	Variability
3EG J1746-2851	0.11	-0.04	0.13		1.3±0.07	yes	0.48(0.29-0.75)
3EG J1736-2908	358.79	+1.56			2.18±0.12	no	0.64(0.31-1.12)
3EG J1744-3011	358.85			3.9			0.30(0-0.61)

Labels in figure: 3EG J1736-2908, SLX 1737-282, GRS 1734-292, AX J1733.1-3020, 3EG J1746-2851, 1E1740.7-2942, 3EG J1744-3011

3 X-ray sources within the error box detected 3EG J1736-2908:
1) Seyfert 1: GRS 1734-292 (SNR=34.3)
2) LMXRB: SLX 1737-282 (SNR=26)
3) HMXRB: AX J0073 (SNR=5.4)
Both sources are classified LMXRB

3EG J1746-2851: region crowded ->difficult to
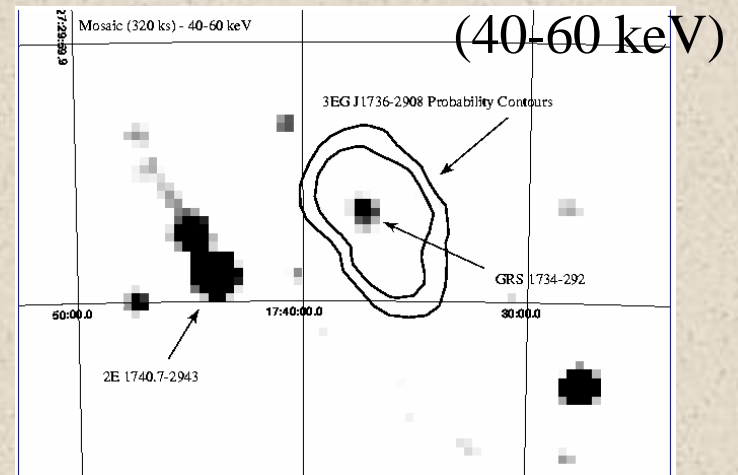disentangle contribution (SNR?) and X-ray emission
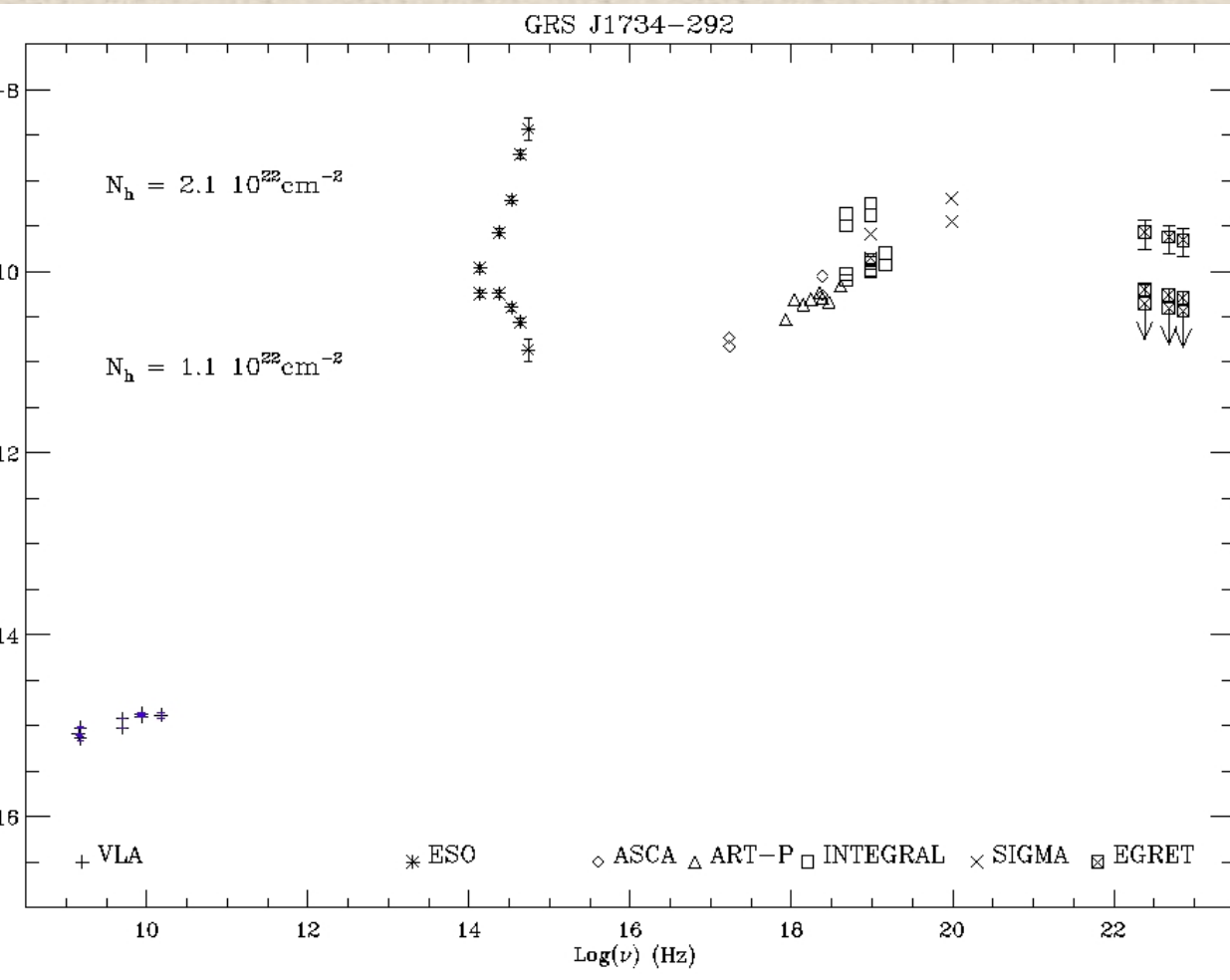
The GC (3): 3EG J1736-2908

(20-40 keV)

- INTEGRAL (ISGRI) found only 1 X-ray source inside the 99% EGRET error contours: GRS 1734-292 (Classified as Seyfert 1)
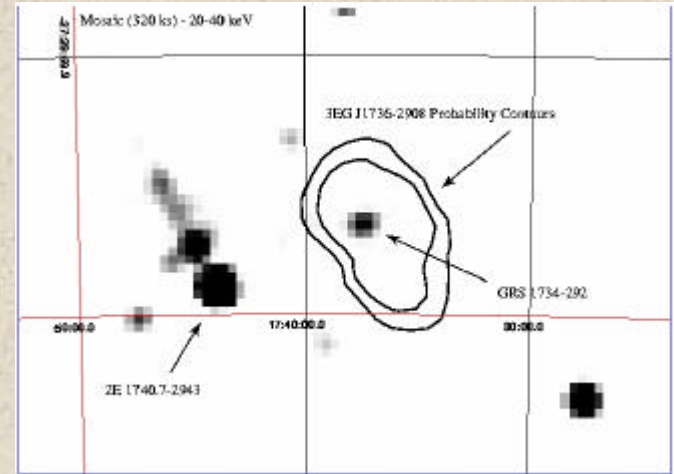
- No other suitable candidate revealed by multiwavelenght analysis of objects inside the EGRET error contours
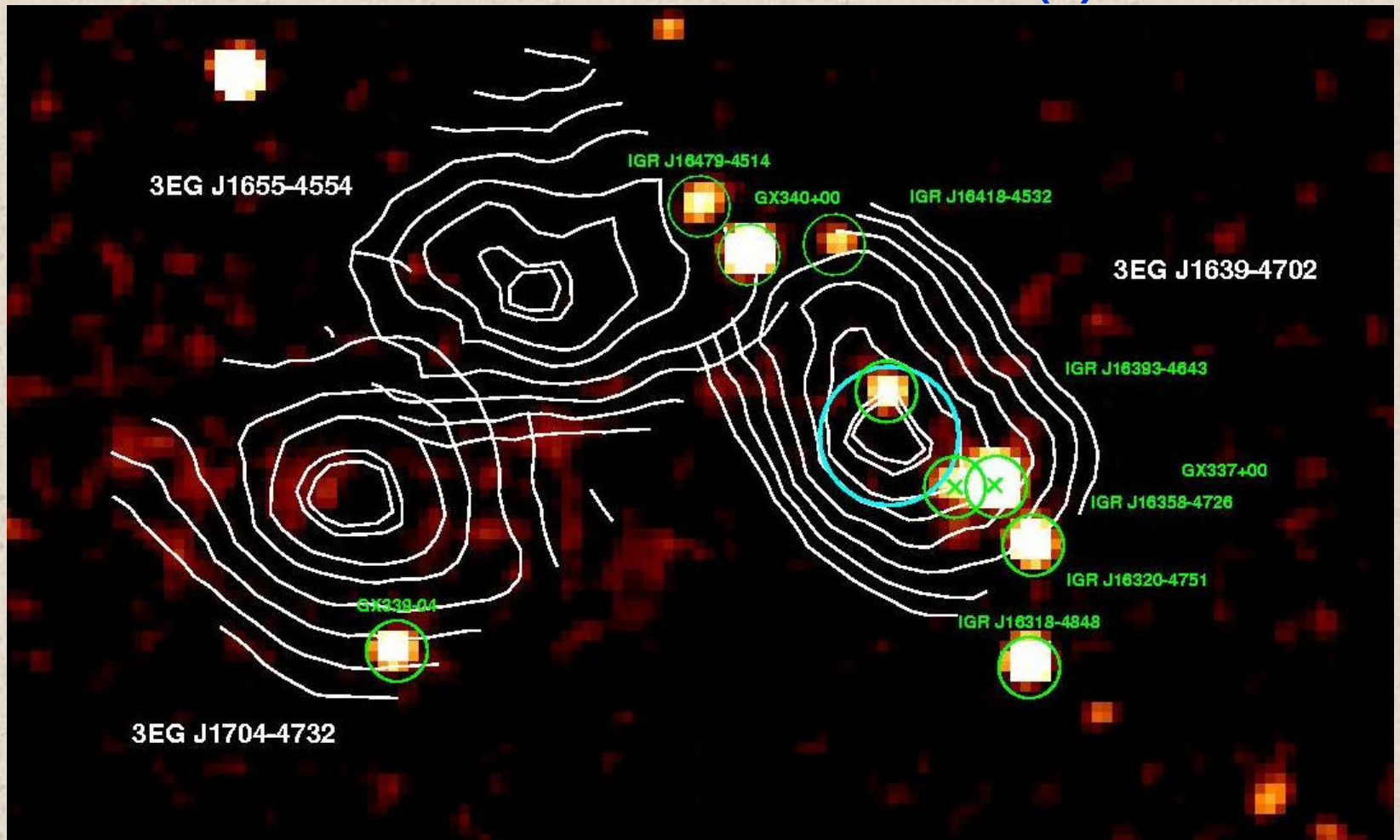

(40-60 keV)

Di Cocco et al. 2004

The GC (4): 3EG J1736-2908

GRS J1734−292

$N_h = 2.1 \ 10^{22} cm^{-2}$

$N_h = 1.1 \ 10^{22} cm^{-2}$

+ VLA   * ESO   ◇ ASCA △ ART−P □ INTEGRAL × SIGMA ⊠ EGRET

$Log(\nu)$ (Hz)

Radio loud?
Radio quiet?

Is GRS1734-292
able to generate
photons with
E>100 MeV?

The Norma Arm (I)
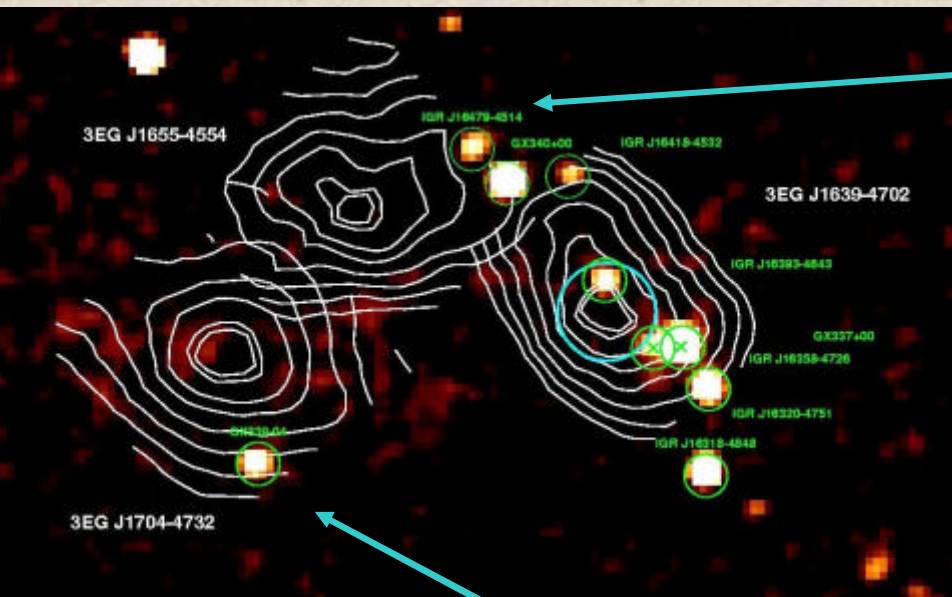

Exposure ~700 ks in the 20-100 keV Energy band

The Norma Arm (II)

Sources analyzed according to the 3EG Catalogue

SOURCE	l deg	b deg	T_{95} deg	$F_{?}$† ph cm^{-2} s^{-1}	?	Var. (Nolan)	Notes (Hartman)
3EG J1639-4702	337.75	-0.15	0.56	53.2±8.7	2.5±0.18	no	C,em
3EG J1655-4554	340.48	-1.61	0.66	38.5±7.7	2.19±0.24	yes	C,em
3EG J1704-4732	340.10	-3.79	0.66	<20.5	1.83±0.33	yes	C

(†) Mean Flux, EGRET P1234

The Norma Arm (III)

Sources in the 3EG J1655-4554 error box:

GX334+00 (LMXB) **?** Rosa bright source
at 1.4 arcminute from the
radio source PMN J1645-4537 (2.4 Jy at 4.8GHz)

IGRJ 16479-4514 (unid.)

Sources in the 3EG J1704-4732 error box:

GX339-04 (LMXB) microquasar
(Markoff et al. 2003)

The Norma Arm (IV)

Sources in the 3EG J1639-4702 error box:

1) **GX 337+00 (LMXB)**

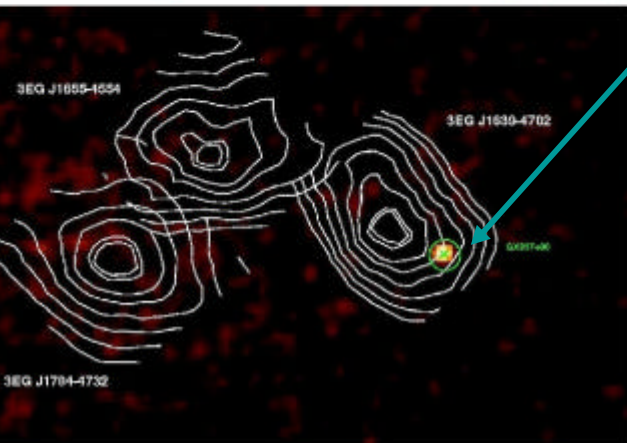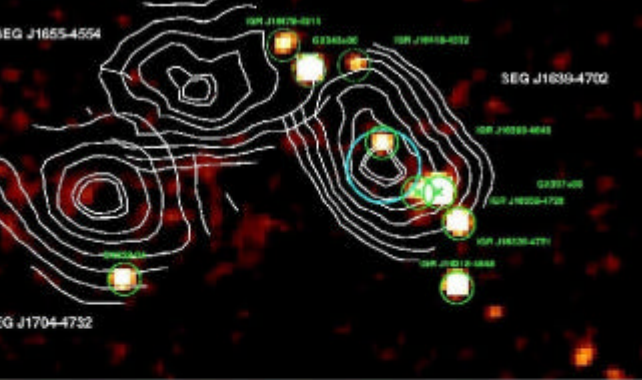2) IGR J16320-4751 (X-Ray Binary System)
3) IGR J16420-4530 (??)
4) GX 340+00 (also inside 3EG J1655-4554 error box)
5) IGR J16418-4532
6) AX J1639.0-4642 (X-ray source-ASCA)
7) IGR J16358-4726
8) IGR J16320-4751

700 ks obtained from Galactic Center Deep Exposure observations).
e images show the IBIS/ISGRI image in the 20-100 keV range (top) with EGRET contours
perimposed and the 100-250 keV image (bottom). In the case of 3EG J1639-4702 the possib
t-enshrouded source IGR J16393-4643 has been proposed as a counterpart (Malizia et al.
04, Atel 227; Combi et al. 2004, astro-ph/0401643). However, the high energy image shows
t only GX 337+00 (a black hole candidate) emits above 100 keV. GX 337+00 shows many
raracteristics of galactic microquasars (radio jets, QPO, and X-ray behaviour).

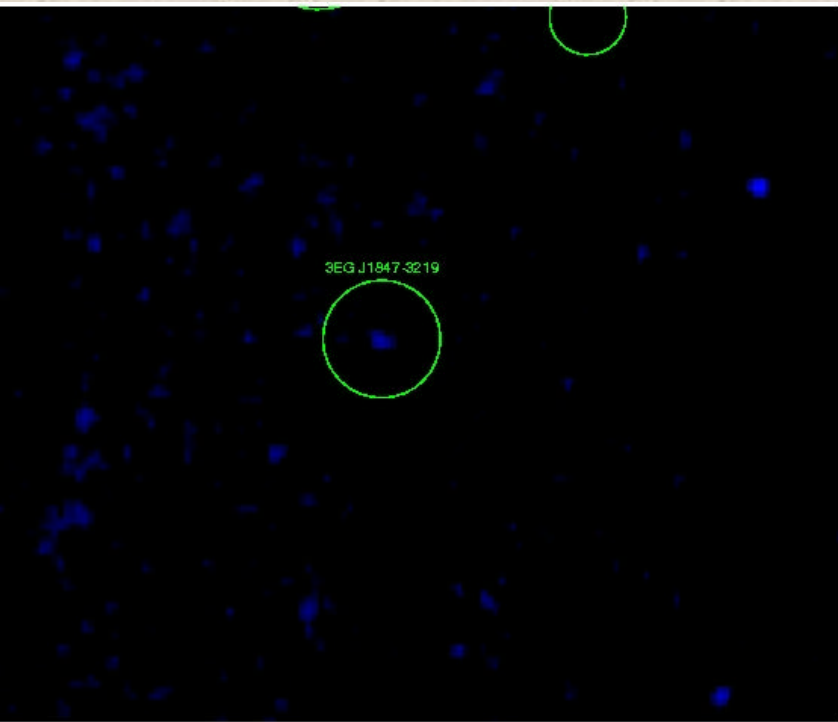# The Great Attractor Region
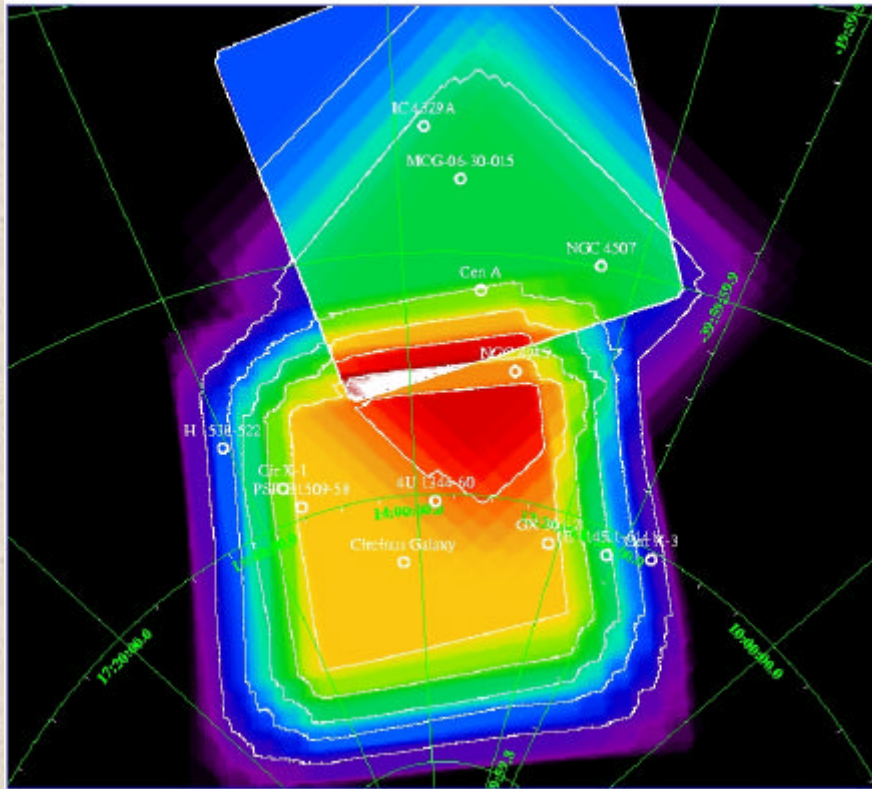
Exposure map (up to ~700 ks)
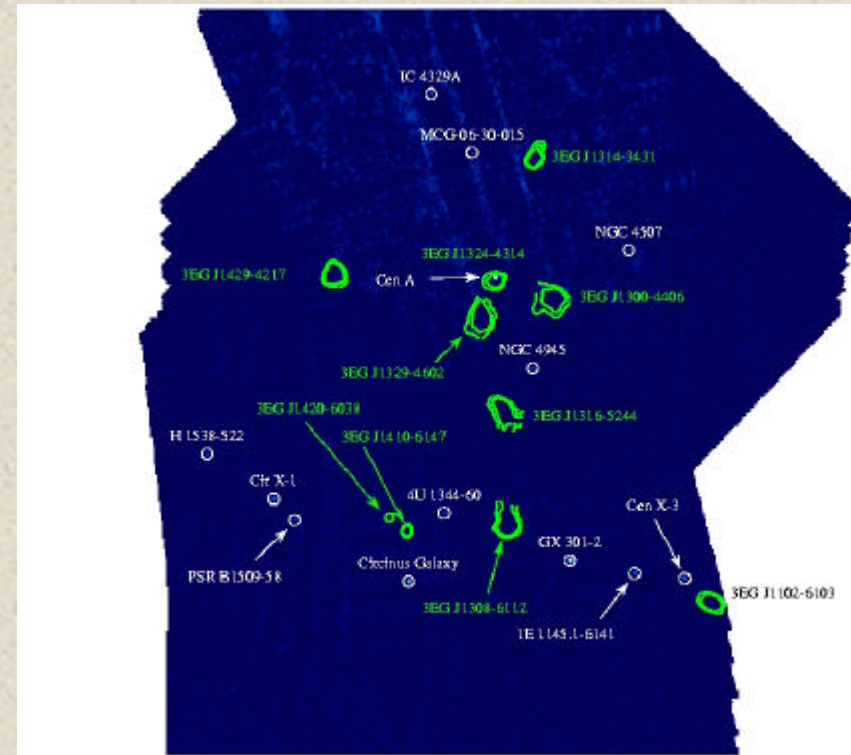
IBIS/ISGRI mosaic 20-40 keV

No X-ray counterparts found in EGRET error contours

Timing

Timing technique:

- Search for SNR>4 excesses in EGRET error contours

- 3 Energy Bands adopted (20-40, 40-60 and 80-120 keV)
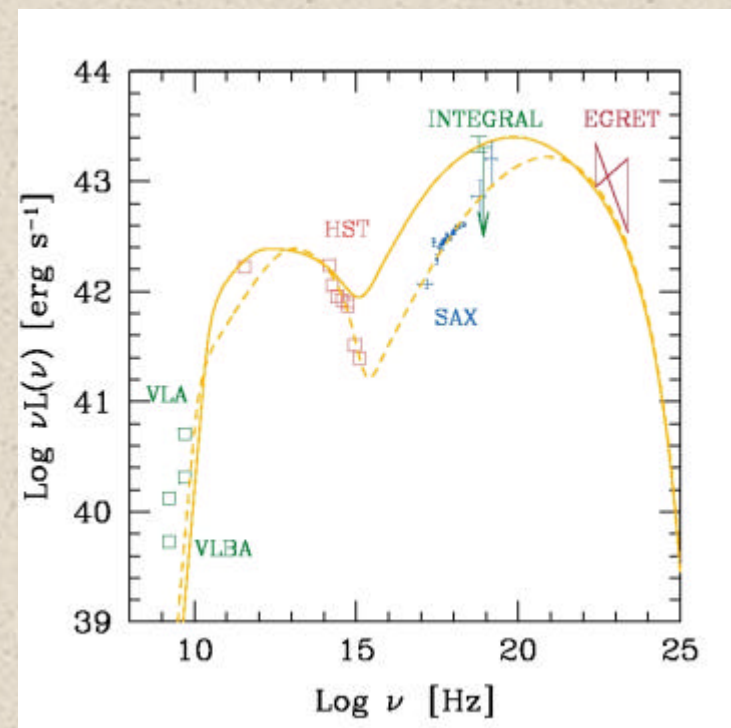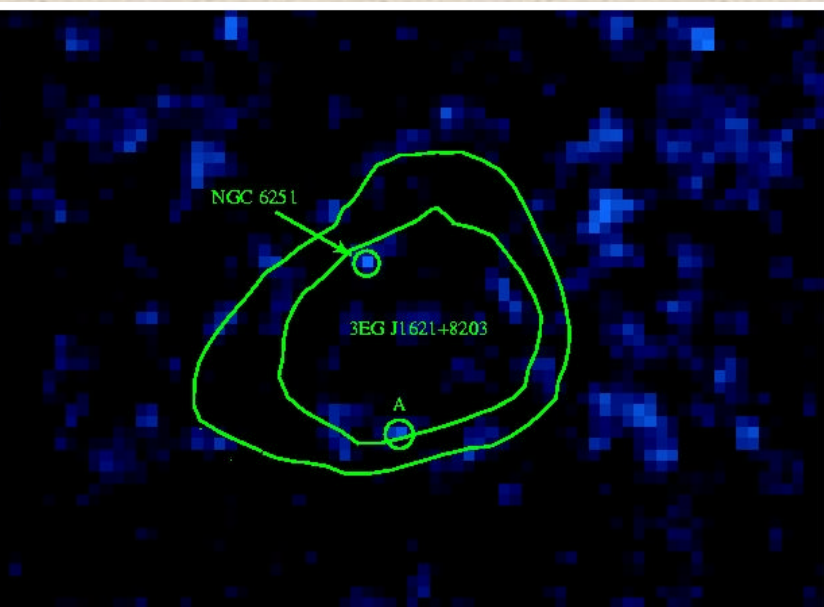
- Good SCW are used to mosaic the interesting source

Found one candidate: 3EG J1847-3219

Exposure~7 ks
$s = 5.75$

20-40 keV

INTEGRAL AO2 Observations:
EGRET sources and radiogalaxies connection (PI Foschini)

The Case of NGC 6251

**(Foschini et al., A&A, accepte...
astro-ph/0412285)**

Summary

- Found 12 associations between X-ray sources and EGRET error contours (5 more than presented today from the analysis of the entire Galactic plane)

- As expected, the EGRET error contours are often populated by more than one counterpart emitting in the hard (>20 keV) X-ray band... at least in the Galactic plane!

- The case of GX 337-00 (Norma Arm) highlights that is foundamental to go deep and at highest possible energy

- Multiwavelenght analysis is a foundamental tool to disentangle the puzzle (see the case of NGC 6251)

To be done....

Time dependent analysis to be applied on longer (~10000 s) time scales