

EGRET/INTEGRAL cross-correlation studies: a few possible associations (and prospects for GLAST ?)

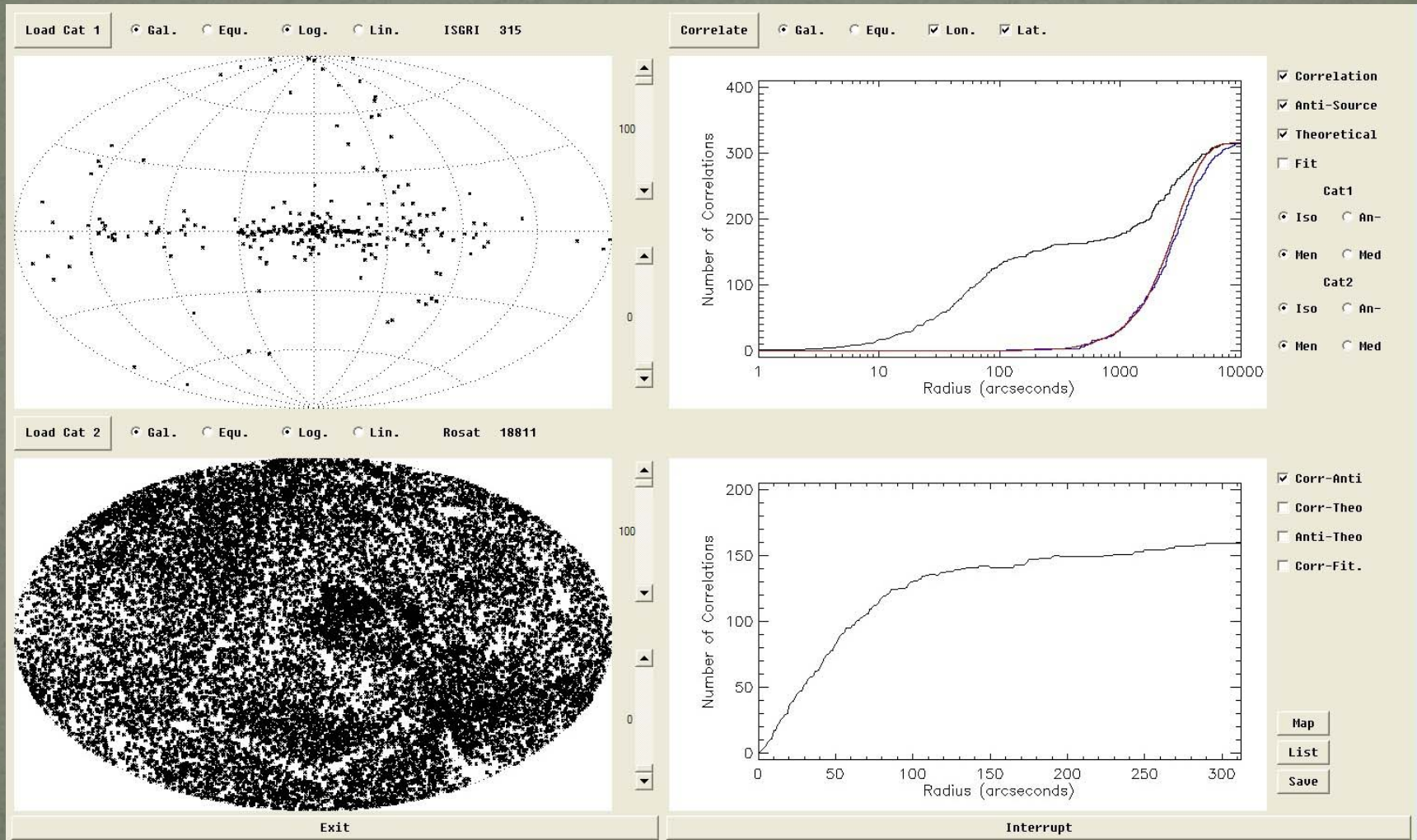
J. B. Stephen, INAF-IASF Bologna



Five Years of INTEGRAL: Chia Laguna, (Cagliari), October 17th -19th 2007

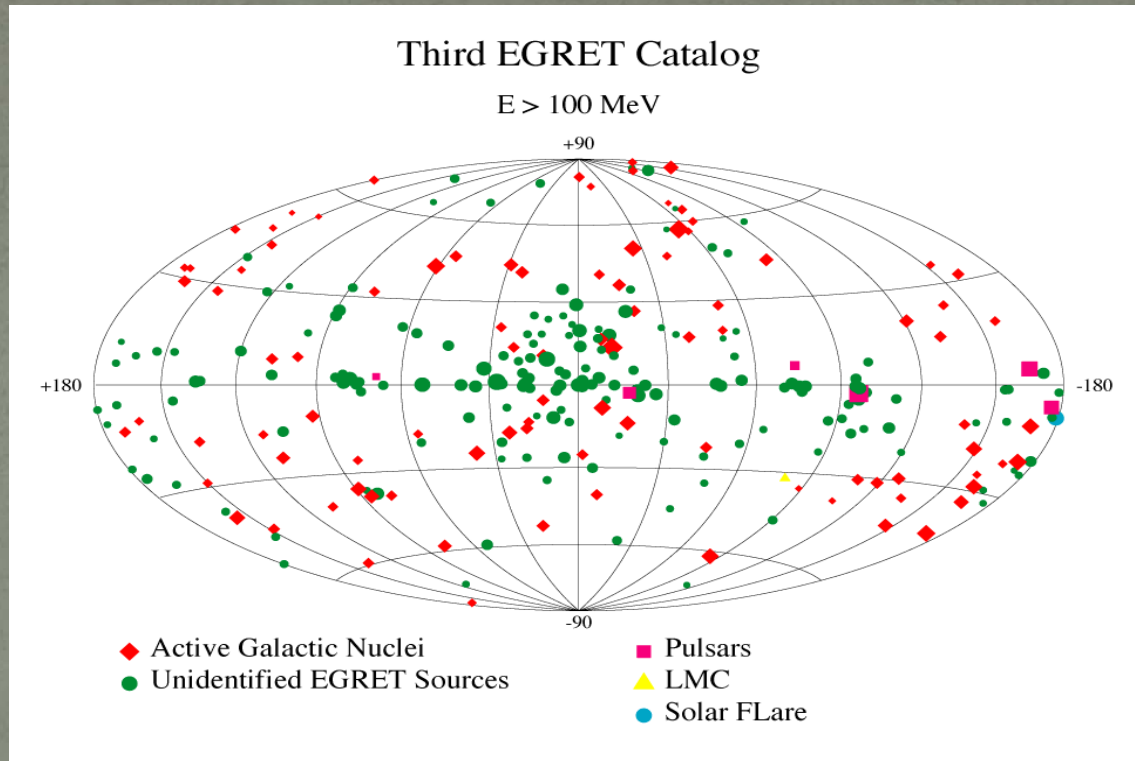
WHY EGRET/INTEGRAL-IBIS cross correlation?

- following on from ISGRI/ROSAT results:



Strong correlation has led to the identification of many sources

The 3rd EGRET catalogue



The 3rd EGRET catalogue comprises 271 sources.

101 were identified (mostly with Blazars, a few pulsars, LMC and a Solar Flare).

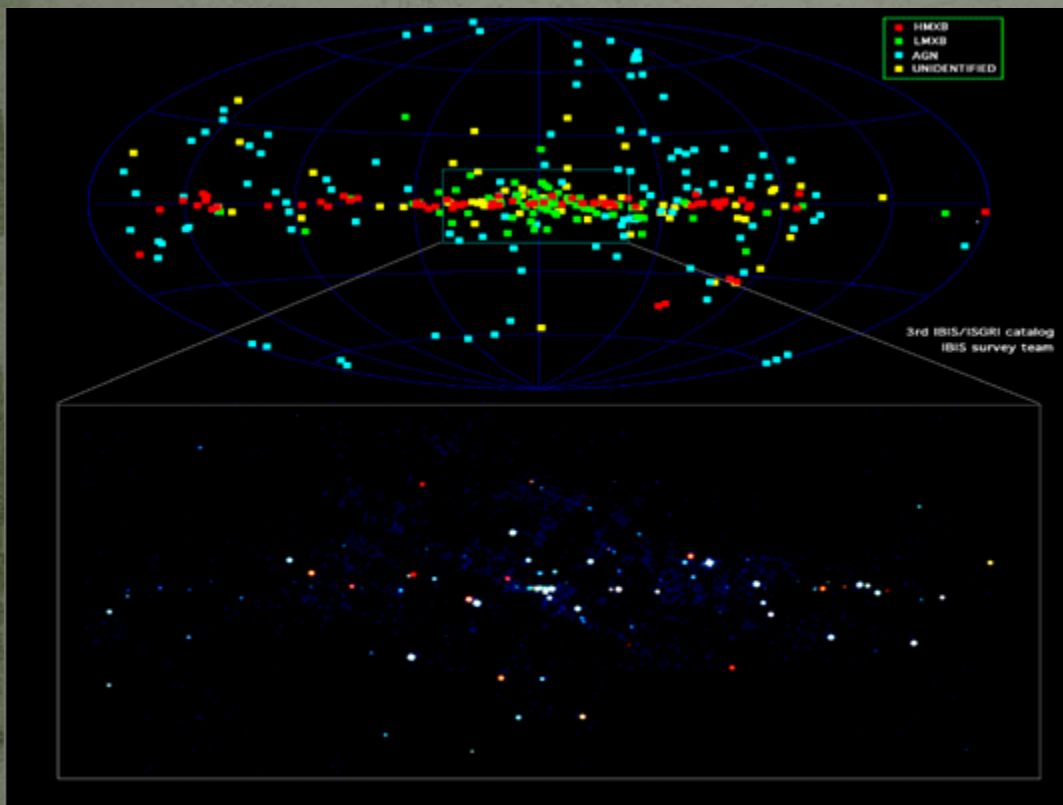
171 (> 60%) unidentified

Since the catalogue produced, > 40 more objects have been associated with a possible counterpart(s).

3rd INTEGRAL/IBIS survey

(Bird et al. 2007)

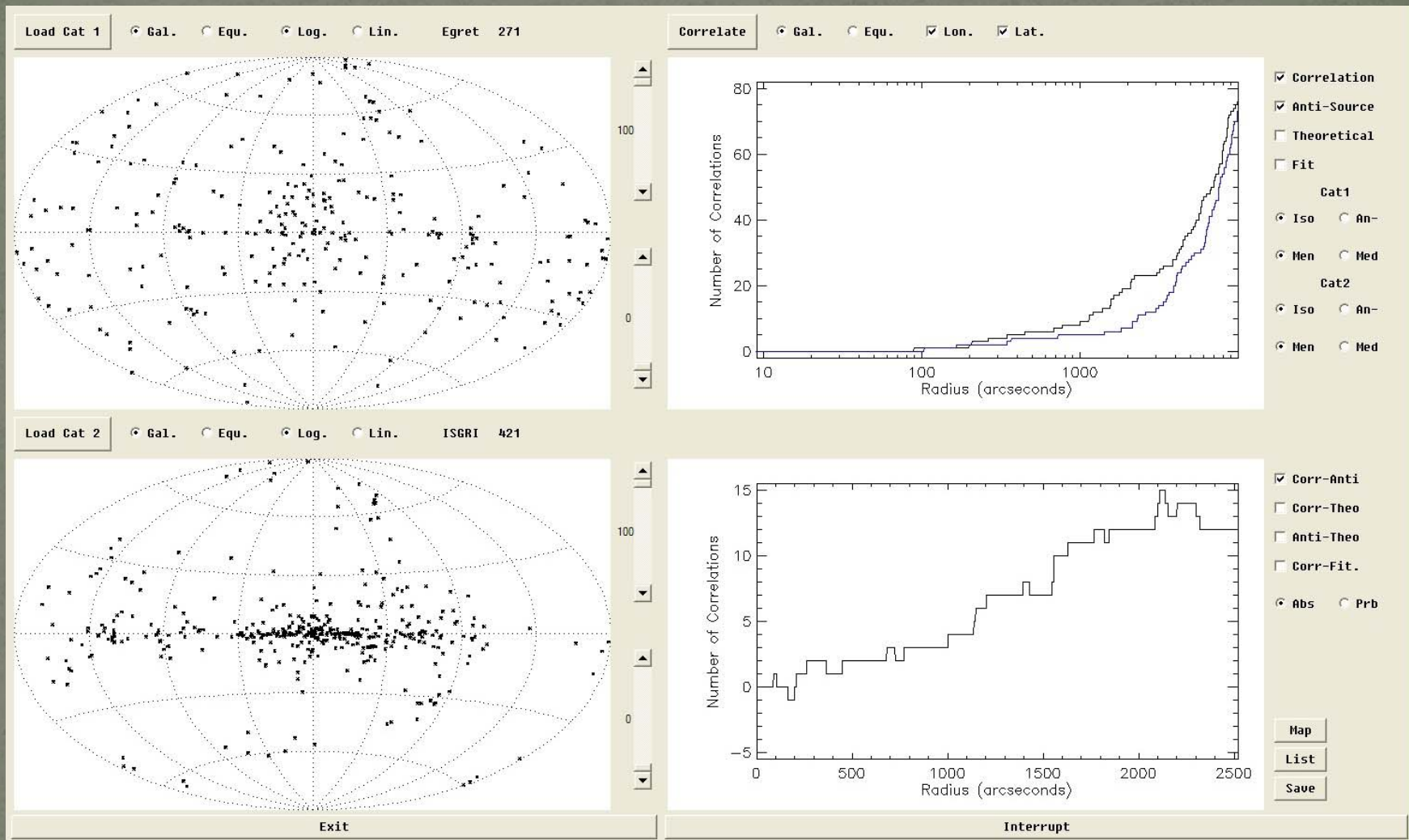
421 hard X-ray sources detected



- 118 AGNs (including blazars)
- 79 LMXBs
- 68 HMXBs
- 23 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)

Some associations with the EGRET catalogue likely

IBIS (3rd Cat) versus EGRET (3rd Cat)



Total Correlations ~ 22 (to 0.7°) of which ~ 8 expected by chance

IBIS (3rd Cat) versus EGRET (3rd Cat)

Distance (")	Egret Name	RA	Dec	INTEGRAL Name
80.	3EG J1746-2851	266.51	-28.86	IGR J17461-2853
193.	3EG J2202+4217	330.60	+42.29	BL Lac
211.	3EG J0534+2200	083.57	+22.01	Crab
269.	3EG J0834-4511	128.73	-45.20	Vela Pulsar
359.	3EG J1255-0549	193.98	-05.82	3C 279
445.	3EG J1229+0210	187.25	+02.17	3C 273
686.	3EG J1736-2908	264.16	-29.14	GRS 1734-292
803.	3EG J0241+6103	040.41	+61.07	GT 0236+610
997.	3EG J1324-4314	201.15	-43.25	Cen A
1145.	3EG J1714-3857	258.52	-38.96	XTE J1716-389
1157.	3EG J1832-2110	278.10	-21.18	PKS 1830-211
1206.	3EG J1639-4702	249.78	-47.04	AX J1639.0-4642
1385.	3EG J0845+7049	131.46	+70.83	QSO B0836+710
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1853.	3EG J1824-1514	276.20	-15.24	RX J1826.2-1450
2073.	3EG J0533-6916	083.42	-69.27	PSR B0540-69.3
2100.	3EG J1014-5705	153.54	-57.10	IGR J10101-5654
2127.	3EG J2020+4017	305.25	+40.30	IGR J20186+4043

22 Correlations of which ≈ 8 due to chance spatial coincidence

Confirmed INTEGRAL/EGRET associations

Egret Name	ISGRI Name	Egret-ISGRI Distance (°)	Egret Error Box (°)	Counterpart Type
3EG J2202+4217	BL Lac	0.055	1.05	Blazar
3EG J0534+2200	Crab	0.058	0.048	Pulsar/PWN
3EG J0834-4511	Vela Pulsar	0.064	0.021	Pulsar/PWN
3EG J1255-0549	3C 279	0.096	0.080	Blazar
3EG J1229+0210	3C 273	0.124	0.320	Blazar
3EG J0241+6103	GT 0236+610	0.214	0.180	HMXB, μ Quasar
3EG J1324-4314	Cen A	0.278	0.530	Radio Galaxy
3EG J1832-2110	PKS 1830-211	0.316	0.510	Blazar
3EG J0845+7049	QSO B0836+710	0.387	0.720	Blazar
3EG J1824-1514	RX J1826.2-1450	0.513	0.520	HMXB, μ Quasar

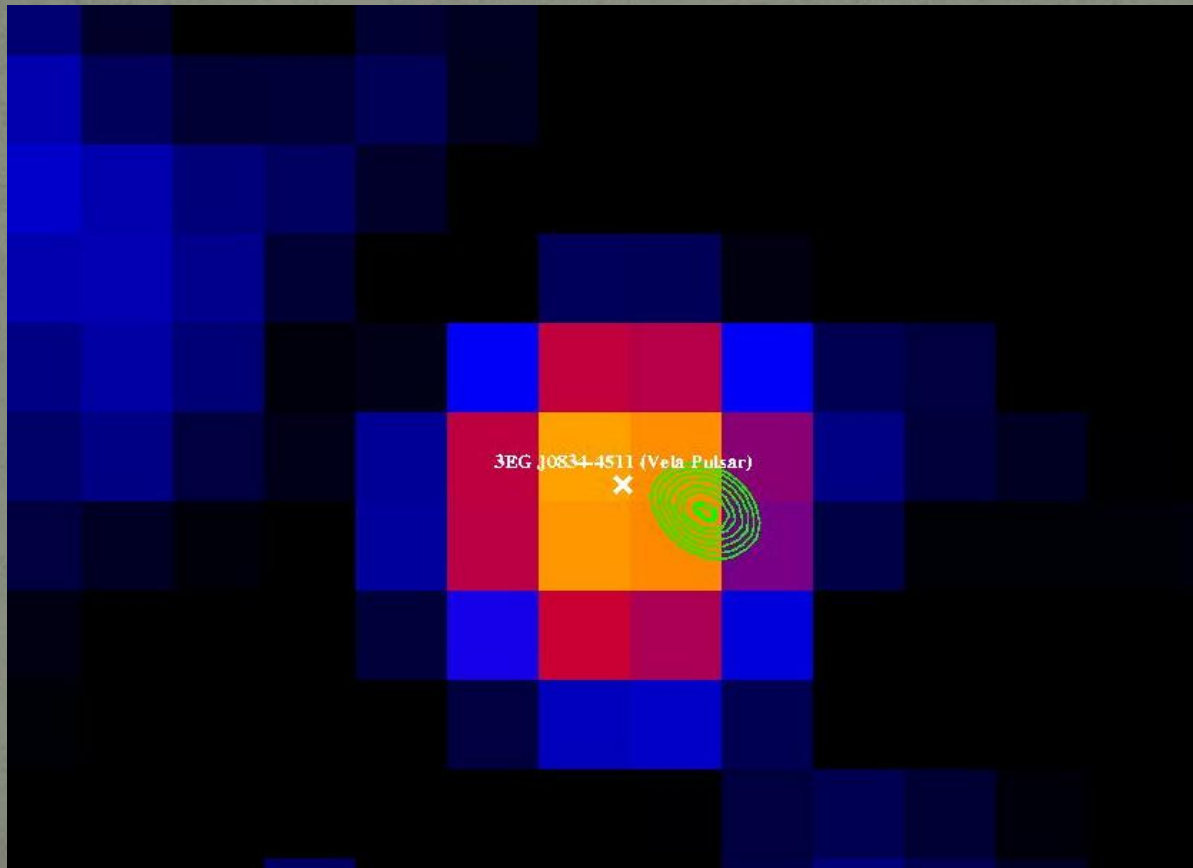
Likely associations come from

- **PWN,**
- **Microquasars**
- **Blazars**

Example type correlation - PWN

INTEGRAL has detected a number of pulsar/ PWN systems (Dean talk)

3EG J0834-4511 = Vela X



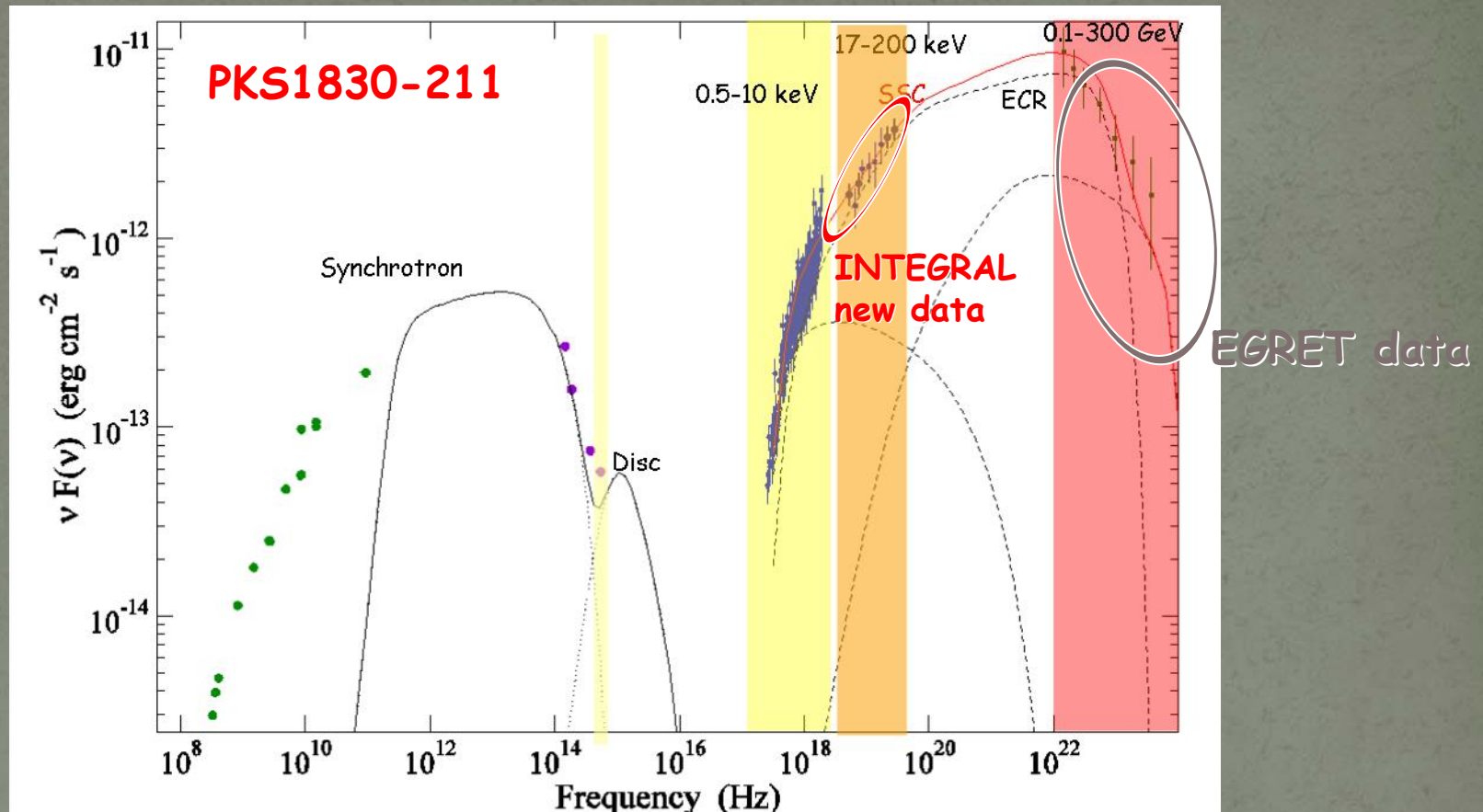
Secure INTEGRAL/EGRET associations

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Example type correlation - Blazar



The Spectral Energy Distributions of PKS1830-211 in the observers' frame derived from INTEGRAL and CHANDRA and other published data. Radio measurements are from Pramesh Rao & Subrahmanyan (1988), IR and optical data from Courbin et al. (2002) and gamma-ray data from the EGRET public data archive.

Confirmed INTEGRAL/EGRET associations

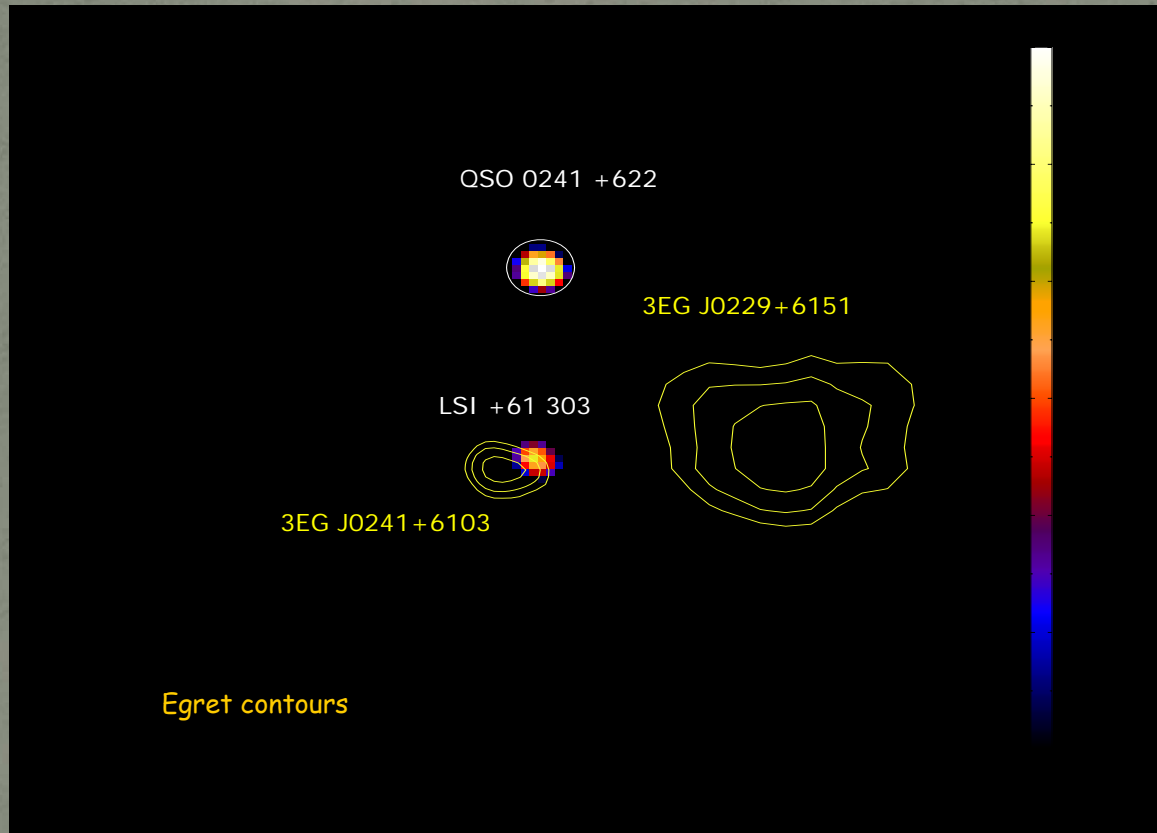
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Likely associations come from

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Example type correlation - HMXB/Microquasar

Recent example: the Microquasar and TeV/EGRET/
COS-B source LSI +61 303 seen by INTEGRAL

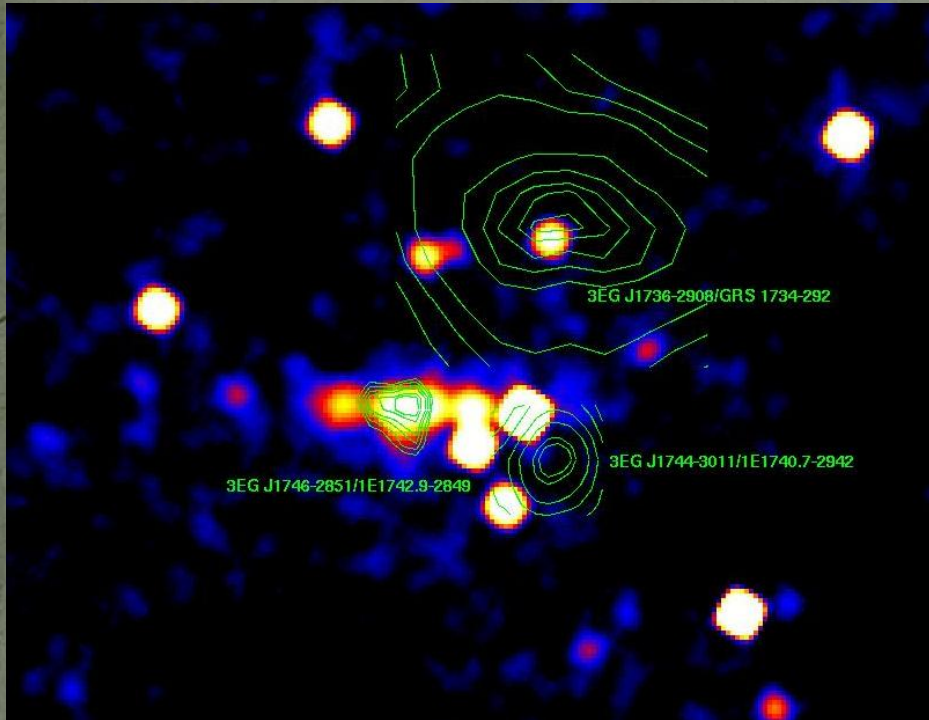


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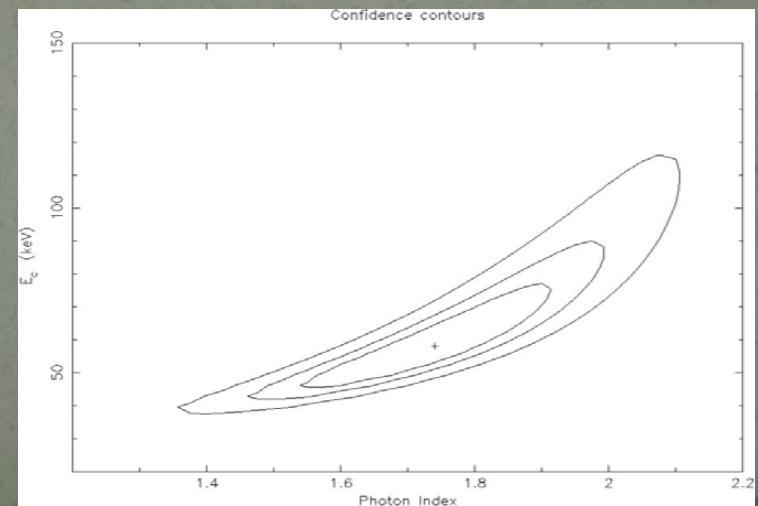
12 Correlations of which ≈ 8 due to chance spatial coincidence

The Galactic Centre - A highly complicated region to study:



In 2x2 square degrees there are
3 EGRET sources and many IBIS
objects:
Chance coincidence high.

3EG J1736-2908=GRS1734-292
(Di Cocco et al. 2004):
Seyfert 1, weak steep spectrum radio
source, X-power law 1.9 with high
energy cut-off below 100 keV



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3EG J1014-5705	IGR J10101-5654	0.583	0.67
3EG J2020+4017	IGR J20187+4041	0.586	0.16

But remember most (~8 out of these 9 + 3 GC) are likely to be false associations according to the cross correlation analysis ... so which are the true ones?

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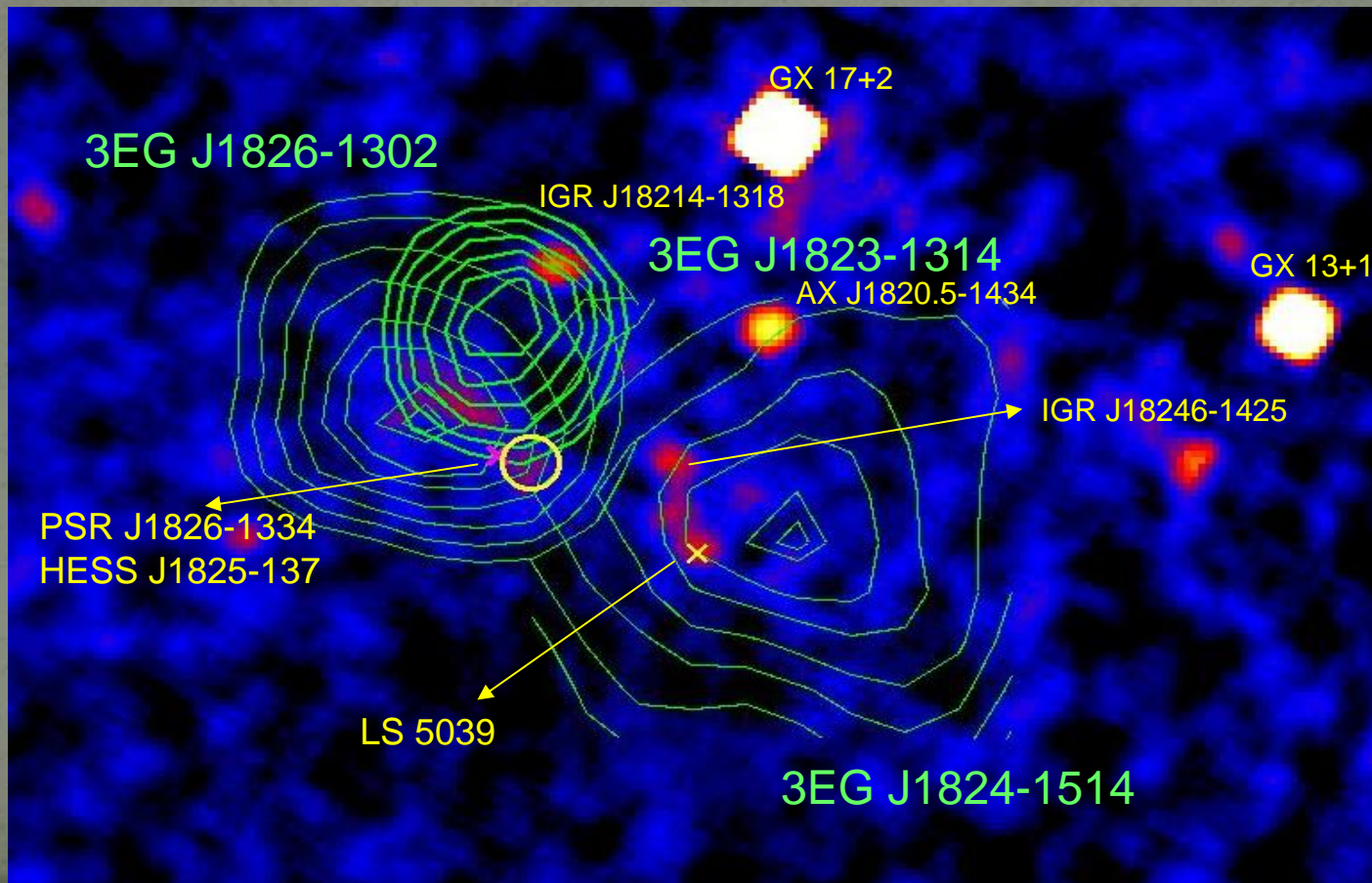
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A(nother) complicated case:

IGR J18214-1318 (IBIS unidentified) associated with 3EG J1823-1314

3EG J1824-1514=LS5039: the other only microquasar EGRET/IBIS

3EG J1826-1302=PWN G18.0-0.7/HESS J1825-137

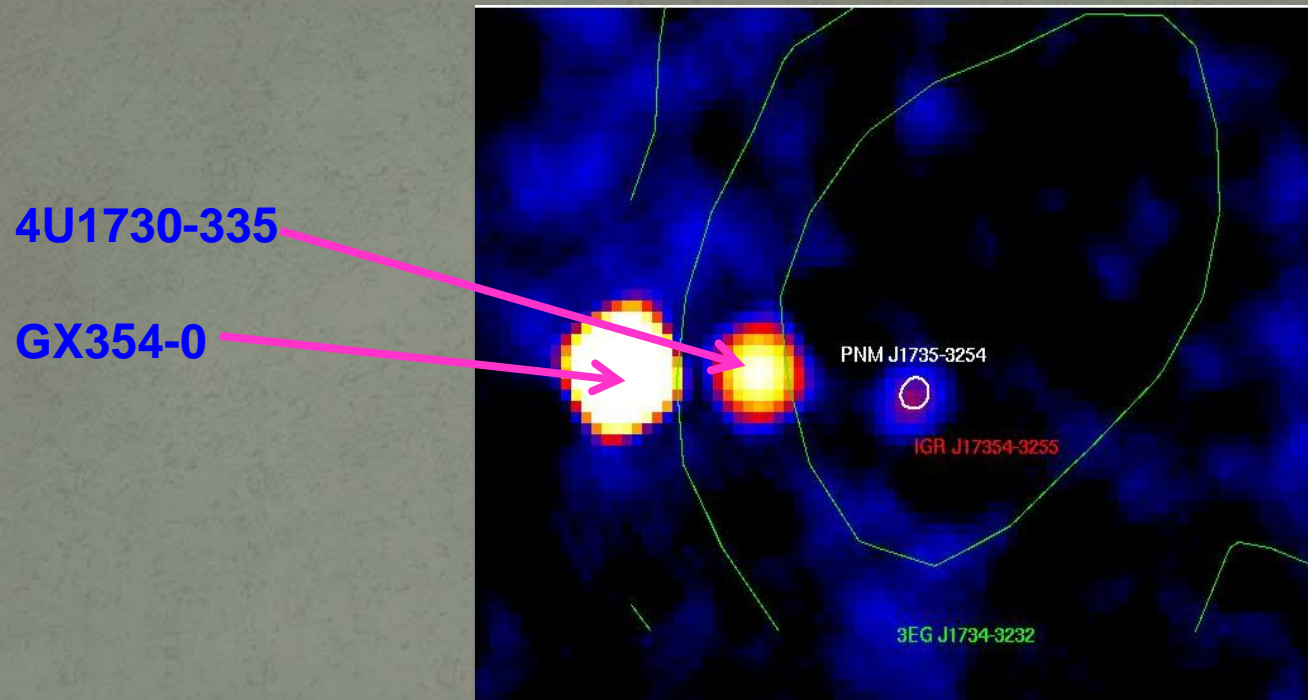


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Possible IBIS/EGRET ASSOCIATION - 2



3EG J1734-3232

IGR J17354-3255 (unidentified)

PMN1735-3254(extended radio source)

Variable as seen in survey and also Galactic Bulge Monitoring
but not EGRET variable

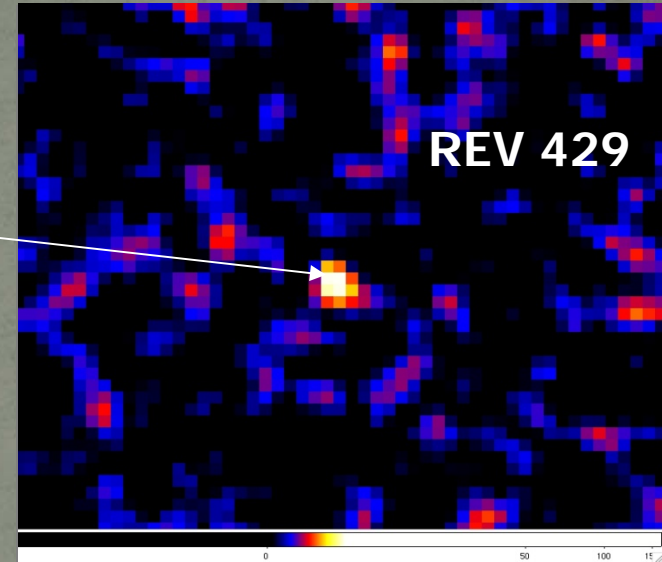
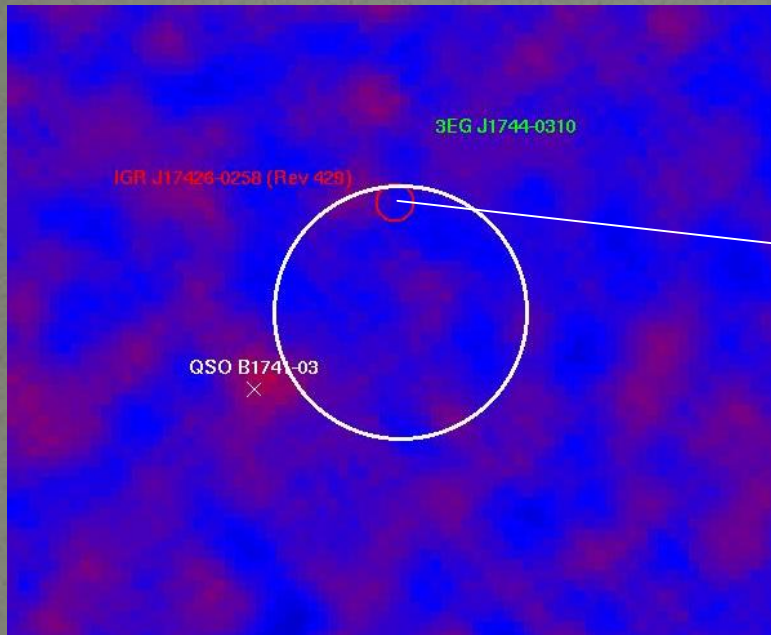
CHANCE OR REAL?

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Possible IBIS/EGRET ASSOCIATION - 3



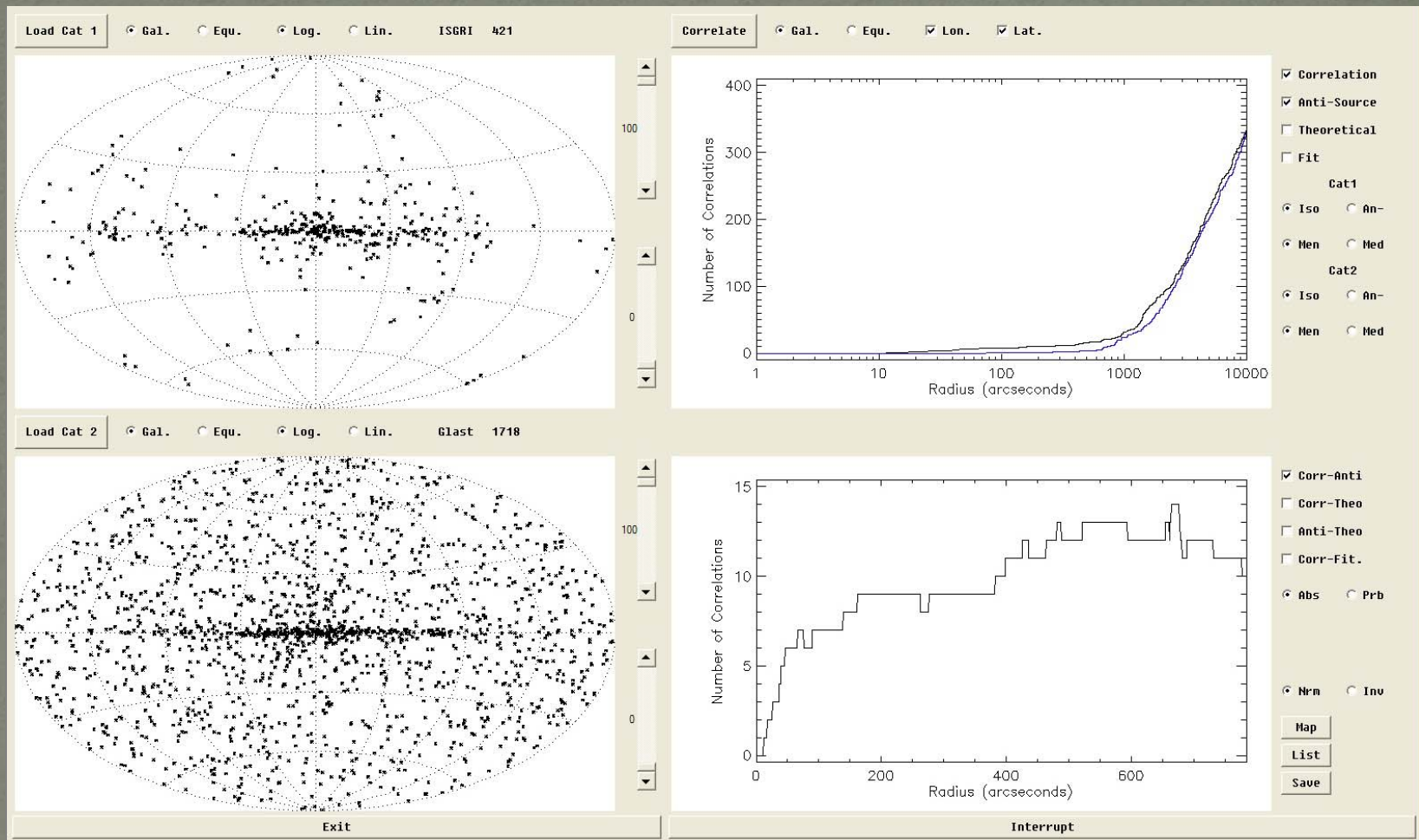
**3EG J1744-0310 has been identified with the $z=1.05$ QSO B1741-03
but...variable new IBIS source in EGRET' error box
IGR J17426-0258 (still unidentified source detected in Rev 429)**

Which is the counterpart to this EGRET'?

Summary

- IBIS v Egret shows only weak correlation
 - 22 total associations
 - 8 chance superpositions
- 10 are almost certainly correct
 - Blazars
 - Pulsars
 - microquasars
- Chance probability of association very high
 - Only 4 out of 12 are probably correlated
 - Confirmation must rely on alternative information
- Large fraction of ISGRI sources are XB & Sey AGN
 - Unlikely to be counterparts
 - most blazars seen by ISGRI have possible associations
- Deeper INTEGRAL observations will lead to more constraints/associations

IBIS (3rd Cat) versus GLAST DC2



Surprise! ONLY ~ 17 total correlations, of which 7 (8, if uncertain included) in common with the **EGRET** correlation map

IBIS (3rd Cat) versus EGRET (3rd Cat) vs GLAST DC2

Distance (")	IBIS-INTEGRAL Name	RA	Dec	GLAST DC2 Name
12	3C273	187.280	+02.049	J1229p0210
18	GRS1915+105	288.799	+10.944	Galactic_GRS19
26	NGC1275	049.953	+41.517	Cluster_Perseus
37	BL Lac	330.678	+42.288	J2202p4217
40	GT 0236+610	040.145	+61.242	Galactic_LSI61
46	Crab	083.629	+22.018	Plerion_Crab
66	QSO B0836+71	130.296	+70.897	J0845p7049
90	Coma Cluster	194.884	+27.939	Cluster_Coma
139	Cen A	201.365	-43.020	J1324m4314
162	IA 0535+262	084.732	+26.358	Galactic_AO053
277	GX 13+1	273.628	-17.158	DC2_J1814m1854
382	Kes 73	280.338	-04.948	PSR_J1841m0501
399	XTE J1716-389	258.915	-38.875	PSR_J1715m3903
426	IGR J18325-0756	278.117	-07.946	DC2_J1832m0956
464	4U 1746-37	267.550	-37.048	DC2_J1750m3704
481	PKS 1830-211	278.419	-21.073	J1832m2110
522	GX 340+0	251.448	-45.614	DC2_J1646m4617

indicates certain EGRET correlation

indicates uncertain EGRET correlation

7 extragalactic sources

9 Galactic sources