EGRET Observations Of Galactic Relativistic Jet Sources

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Abstract

Microquasars are promising candidates to account for unidentified, but variable EGRET sources at low galactic latitude. Support for this hypothesis is given by already claimed associations between unidentified gamma-ray sources and known or recently discovered galactic relativistic jet sources. In contrast to spatial-statistical methods we have analyzed archival data throughout the EGRET mission at positions of six microquasars using the likelihood source finding algorithm. Preliminary results will be given and compared with existing models which suggest detectable high-energy gamma-ray emission.

Microquasars as sources of high-energy gamma radiation

Galactic black hole candidates in X-ray binary systems with relativistic outflows, collectively refereed to as microquasars [12], have been suggested as either counterparts of persistent gamma-ray sources as exemplified in the associations of 3EG J0241+6103/LSI+61°303 [11,14,15] and 3EG J1824-1514/LS5039 [13], or more generally as potential explanation of unidentified, but variable high-energy gamma-ray sources in the Galactic Plane. A reason to expect high-energy emission can be seen in the existence of a non–thermal emission component extending into IR and even optical wavelength. The same synchrotron-radiating energetic particles will also Compton-scatter photons of the ambient or external medium [2,4]. This is by analogy to what is inferred from AGN, yielding to a 'microblazar' hypothesis if we see a microquasars jet directed towards us. It is also suggested that one expects significant contributions from upscattered stellar photons from the companion star/donor [10].

In several microquasars hard X-ray power law components have been detected [3], some indicating a spectral cutoff (GRO J0442+32), others extending well into MeV-energies without any indication of spectral changes (GRO J1655-40, GRS1915+105) [5,16]. Thermal or bulk-motion Comptonization as responsible emission mechanism is therefore ruled out. At high-energy gamma-rays, a systematic study of 16 LMXB and 4 HMXB found no evidence of periodic or persistent emission above 100 MeV [8], but here we concentrate on exceptional

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Table 1. Microquasars investigated using EGRET data from 1991 to 2000.

Microquasar	l	b	u.l. $[cm^{-2}\ s^{-1}]$ E > 100 MeV	significance
GRO J1655-40	344.98	2.46	$< 9.8\times10^{-8}$	
GRO J0422+32	165.97	-11.99	$< 4.2\times10^{-8}$	
GX339-4	338.94	-4.33		4.0 σ (1.28° from 3EGJ1704-4732)
GRS1915+105	45.37	0.22	$< 3.5\times10^{-7}$	
LS5039	16.88	-1.29		6.0 σ (0.52° from 3EGJ1824-1514)
LSI+61°303	135.68	1.09		5.7 σ (0.2° from 3EGJ0241+6103)

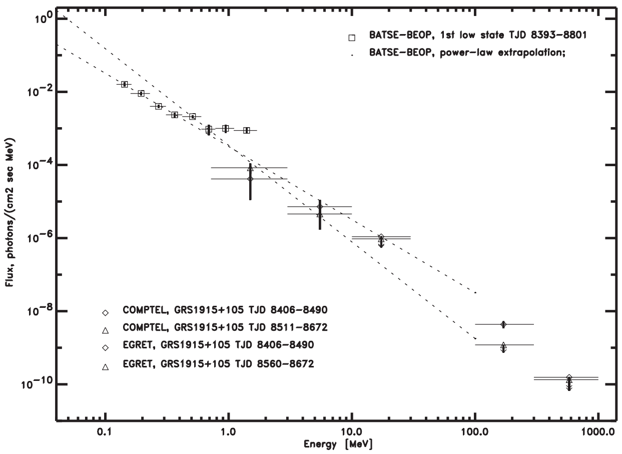

Fig. 1. GRS1915+105 as observed by BATSE, COMPTEL and EGRET during CGRO phase 1. Extrapolations of the BATSE low- and high state power law spectra [9] are sketched as dotted lines.

promising candidates (Tab.1). Data from EGRET between 1991 and 2000 have been used to investigate these sources throughout the entire CGRO mission. Although the statistical gain of source stacking is noticeable for persistent sources (3EG J0241+6103), other microquasars are more appropriately analyzed in strict accordance with source activity, monitored at other wavelengths.

We confirm earlier reported positional coincidences between at least two of the microquasars, but emphasize that these associations could only be convincingly investigated by carrying out simultaneous multifrequency observations as in case of GRS1915+105 [7]. Unfortunately, the unambiguous prove of a μQSO–unidentified EGRET source association have to be postponed for the next generation instrumentation, to say the GLAST-LAT, or perhaps IACTs [1].

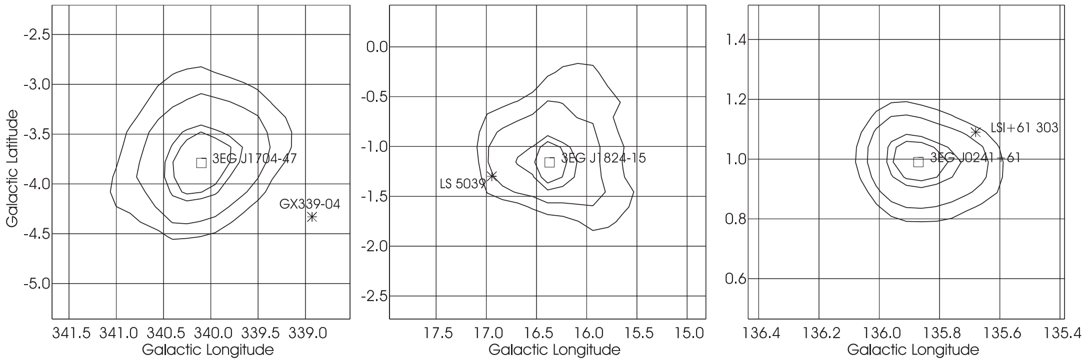

Fig. 2. EGRET source location maps as given in the 3EG catalog [6]. The respective microquasars have been noticed as potentially associated with high-energy gamma-ray emission. Contours represent the 50%, 68%, 95% and 99% statistical probability that a single source lies within the given contour, a cross denotes the position of the μQSO.

References

1. Aharonian F.A. et al. 1998, Nucl. Phys. B (Proc. Suppl.) 60B, 193
2. Atoyan A.M. and Aharonian F.A. 1999, MNRAS 302, 253
3. Fender R. 2000, AIP Conf. Proc. 558, 221
4. Georganopoulos M., Aharonian F.A. and Kirk J.G. 2002, A&A 388, L25
5. Grove J.E. et al. 1998, ApJ 500, 899
6. Hartman R.C. et al. 1999, ApJS 123, 79
7. Iyudin A.F. 2000, Nucl. Phys. B (Proc. Suppl.) 85, 263
8. Jones B.B. et al. 1997, AIP Conf. Proc. 410, 783
9. Ling J.C. et al. 2002, ApJS 127, 79
10. Kaufman-Bernado M.M. et al. 2002, A&A 385, L10
11. Kniffen D.A. et al. 1997, ApJ 486, 126
12. Mirabel I.F. and Rodriguez L.F. 1999, ARA&A 37, 400
13. Paredes J.M. et al. 2000, Nature 288, 2340
14. Strickman M.S. et al. 1998, ApJ 497, 419
15. Tavani M. et al. 1996, A&A Suppl. 120, 243
16. Ueda Y. et al. 2002, ApJ 571, 918

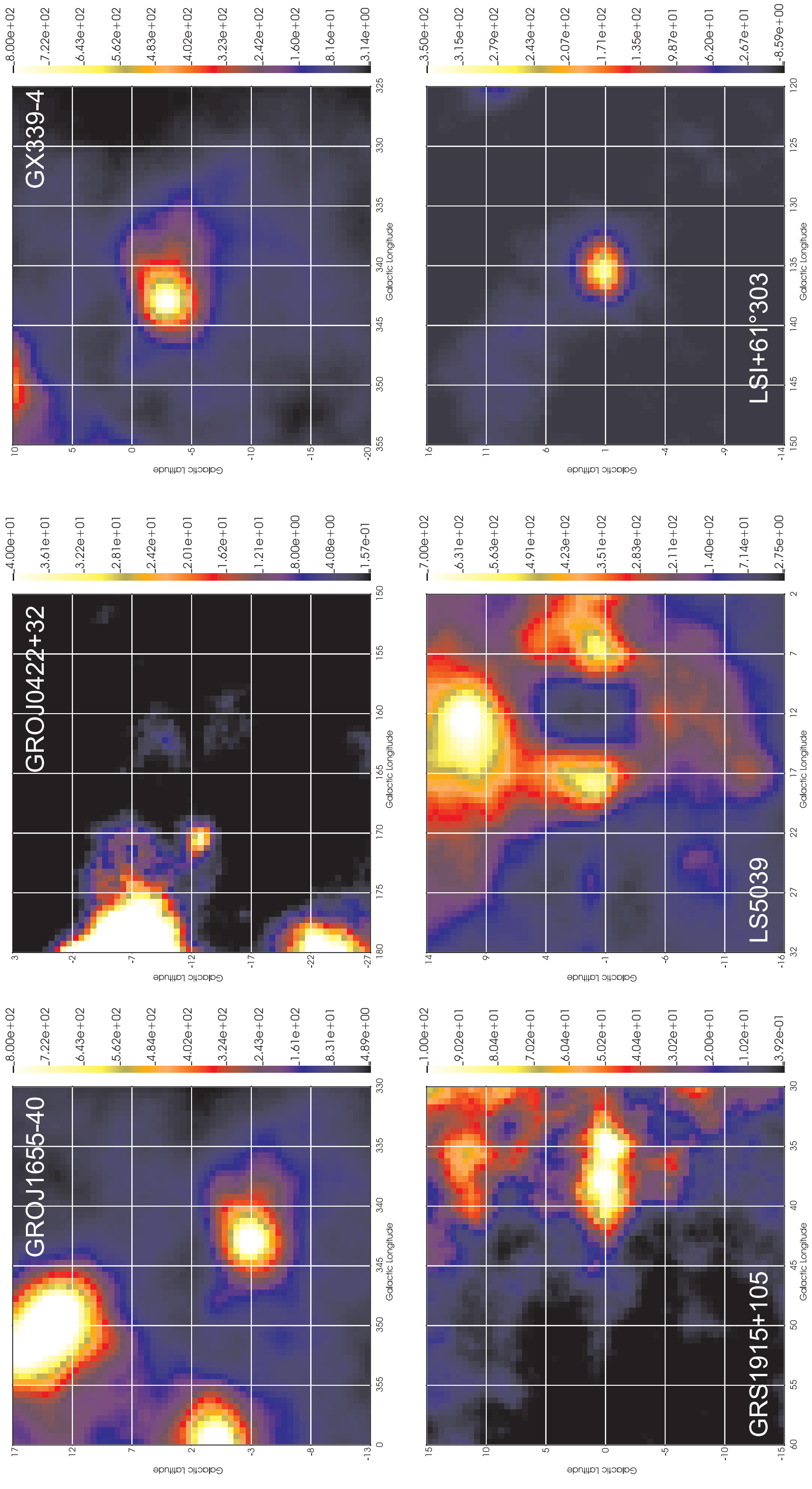

Fig. 3. Likelihood test statistics maps (corresponding to σ^2) of six microquasars through stacked EGRET observations between 1991 and 2000. The location of the microquasar is in close vicinity to the image center.