SEARCH FOR X-RAY SOURCES IN THE COS-B GAMMA-RAY ERROR BOXES

Giovanni F. Bignami
Laboratorio di Fisica Cosmica e Tecnologie Relative del CNR
via Bassini 15/A, 20133 Milano, ITALY

The publication of the first (Hermsen et al, 1977) and preliminary second catalogue of the COS-B sources (Wills et al, 1980), has brought to the attention of the astronomical community the new reality of the high-energy Galactic Gamma-Ray Sources (GGRS). It is worth recalling here the definition of such objects, in the COS-B sense: "A GRS is a significant excess of photon counts, compatible with the instrument's angular resolution, or, more clearly, with the instrument's Point Spread Function". This definition of an unresolved (as it is the case for the vast majority of the GGRS) GRS is, to some extent, dependent on the shape of the source spectrum; however a general shape of the PSF for the case of the source associated with 3C273 can be found in Bignami et al, 1980. Naturally, the absolute flux (i.e. the total number of photons) from a source is also important in determining the positional error, especially when usage is made of the cross-correlation method (Hermsen, 1980). Typical photon numbers (100 Mev) for GGRS range from 50 to few hundreds. The COS-B catalogue error boxes are defined taking into account both the PSF and the photon statistics; it is then apparent that the search for candidate counterparts of the GGRS should be carried out inside such boxes, or in their immediate vicinity, and that, for examples, such loose positional coincidences as obtainable by increasing a quoted error radius by 50%, let alone doubling it, are totally unacceptable.
Systematic searches for counterparts at other wavelengths have not yet been carried out, except for a few cases of X-ray and radio observations, as for example in the case of CG 135+1 (the only COS-B GRS erbox compatible with a 4U erbox) which led to the discovery of a new X-ray QSO by Apparao et al, 1978.
A truly systematic approach for a search in the X-ray band has been rendered possible by the advent of the Einstein Observatory, with its Guest Observer Program. The size of the IPC instrument field of view is comparable with the COS-B error radius, so that with few (from three to five) mosaic-arranged pointings it is normally possible to cover a GRS erbox. An IPC coverage of the COS-B erboxes has been foreseen, and so far about 11 GGRS regions have been, or are being, mapped, as a result of a collaborative effort involving R.C. Lamb, (ISU), R. Hartman and D.Thompson (GSFC), T. Markert (MIT), P. Caraveo (LFCTR) and, for some cases, the

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whole COS-B Caravane Collaboration.
From a pre-Einstein X-ray astronomy point of view, these IPC pointings (a total of about 50) represent a small galactic survey, totally unbiased and quite random. It has, however, been limited to regions as far away from the center as possible: the sensitivity of exposure is that achievable with 1.5 - 2.0 x 10^3 secs of useful IPC time, yielding sources down to 5 x 10^{-13} erg/cm^{2}sec, or 3 x 10^{-2} UEFU (1 UEFU $\equiv$ 1 UFU in the Einstein 1 - 3 keV range).
The data are slowly coming in, showing preliminarly that the number of sources found is compatible to that obtained by extrapolating the Uhuru-Einstein LogN - LogS of Giacconi et al (1979), i.e. (7 ± 2.6) $S^{-1.5}$ sources/steradian, down to 3 x 10^{-2} UEFU, or $\lesssim$ 1 source/square degree ($\equiv$1 IPC field). Thus the survey will yield a number of new IPC sources which will be totally manageable from the point of view of individual follow-up observations, already under way with HRI and optical data. Last, but not least, the problem of what to look for in the new X-ray sources: obviously time variability and/or common properties between sources in different GRS erboxes could be powerful tools to single out potential candidate counterparts of the GGRS ; in general, it is clearly useful to explore the boxes down to an energy flux limit which is 10^{-2} of that associated to the gamma-ray emission, since even a negative result could be very important. In any case, new interesting results of galactic X-ray astronomy per se are being obtained, one for all the "case of the twin pulsars" (see Lamb et al, 1980).

References

Apparao, K. et al, 1978 Nature, 273 450.
Bignami, G.F., et al, 1980 Astron. and Astrophys., in press.
Giacconi, R. et al, 1979 Ap. J. 234, L1.
Hermsen, W., 1980, Thesis, Univ. of Leiden.
Hermsen, W. et al, 1977 Nature, 269, 494.
Lamb, R.C. et al, 1980 Ap. J., in press.
Wills, R.D. et al, 1980 Proc. XXII COSPAR Pergamon Press, pag. 43.