THE RESOLVING POWER AND MAPPING CAPABILITY OF IBIS IN IMAGING THE GALACTIC CENTRE REGION

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ABSTRACT

The capability of IBIS in mapping crowded regions of the hard X-ray sky is investigated with respect to observations of the Galactic Centre. ~ 100 known X-ray sources possibly emitting at medium and hard X-ray energies are within the 19 x 19 deg FWHM field of view of the instrument. Despite the high resolving power of IBIS (of the order of a few arcmin) this high number of objects may give rise to source confusion especially at lower energies.
In this paper we report on the performance of the instrument in spatially resolving and studying these sources. This is obtained by means of Monte Carlo simulations which include simple spectral modelling and a simple image reconstruction process, assuming a particular source scenario in which each individual source is assigned the lowest flux detected by previous instruments.

1. INTRODUCTION

The IBIS telescope on board INTEGRAL (Ubertini et al., 1996) will devote a significant part of its observing time to observations of the central region of the Galaxy. A total exposure time of about 2-3 x 10^6 s / year is foreseen to be dedicated to observations of the Galactic Centre Region. Due to its wide field of view, good sensitive area and efficiency IBIS features an unprecented combination of imaging capability and sensitivity at hard X-ray and low γ-ray energies.

About 25 hard X-sources have been seen to emit hard X-rays in a region of 20 x 20 degrees around the centre of the galaxy, with a distribution highly concentrated within about 100 square degrees. IBIS will allow a detailed study of this region that matches pretty well its 8 x 8 degrees fully coded field of view.

We have investigated the capability of IBIS in mapping this region of the sky by performing simulations of an observation in the hard X-ray range from 20 to 300 keV. In this energy band the high point-source location accuracy provided by the CdTe detector array (up to 30" for strong sources) will allow in particular the localization of source transient and burst events occurring in the field of view, as well as the discovery of other sources. However due to the high concentration of sources within a very few degrees from the centre (see Fig.1) IBIS could have some problem in resolving emission from these sources separated by only a few arcminutes.

2. SIMULATION OF A GALACTIC CENTRE OBSERVATION

Based on the current knowledge of the hard X-ray source distribution we have produced a simulated observation of the Galactic Centre region by means of a Monte Carlo code which takes into account the main characteristics of the instrument (sensitive area, efficiency, background and coded mask properties). No interaction physics is implemented but only the transmission of source photons through the mask and the shielding of the telescope are evaluated.

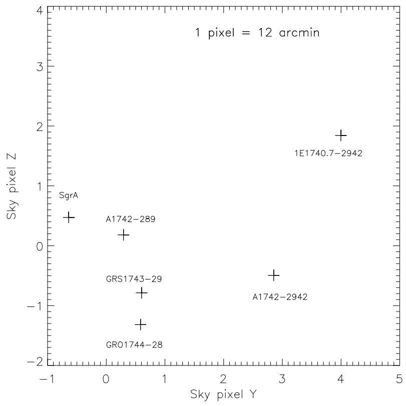

Fig. 1 The positions of 6 known hard X-ray sources are shown within a region of 1 square degree close to SgrA. Note that one unit corresponds to the IBIS angular resolution (12 arcmin).

A coarse image of the IBIS fully coded field of view (Fig. 2) has been obtained in the 20-300 keV band by simulating an observation of 10^5 s. To model the celestial flux distribution, we have assigned to each simulated source a flux value which is the lowest observed by previous instruments. This can be regarded as a "worst case" scenario in which the complete available set of hard X-ray sources is visible at the same time with the lowest flux values. In particular we have used a selection of high energy sources from a compilation of X-ray source fluxes provided by Bazzano et al. (1996). A count rate of ~10^3 c/s is observed, and the sources account for 20% of the total. The image shown has been obtained by simple cross-correlation, and contains a high noise level due to the presence of strong off-axis sources in the FOV. Nevertheless, at least 7-8 sources are positively detected.

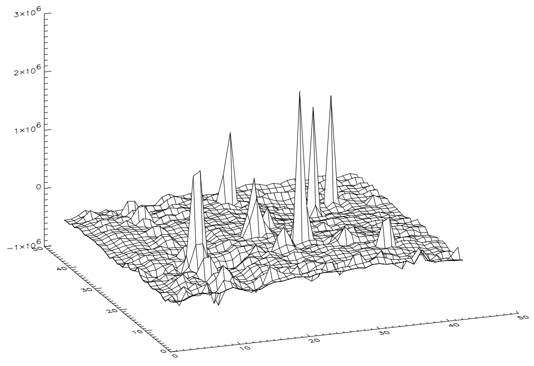

Fig. 2 Cross-correlated image of the IBIS fully coded field of view, for a simulated exposure of 10^5 s centered at $b_{II}=0$, $l_{II}=0$. The image is sampled at the resolution of 12'. The systematic noise is mostly due to the presence of strong partially coded sources.

A detail of the ~ 12 square degrees central region is shown in Fig. 3 and Fig.4 in two energy bands: 20-100 keV and 100-300 keV respectively. The detector images have been cross-correlated in steps of 4', and the systematic noise is still not removed. It is quite evident that for this particular scenario, even for energies above 100 keV, the IBIS angular resolution of 12' may be not sufficient to separate sources unambiguously.

In Tab.1 we list for each source the significance of detection based on the poissonian error distribution (i.e., systematic noise totally removed). The lack of a tail of weakly detected sources (low significance values) can be ascribed to the limiting flux threshold in the input source list compiled by previous instruments (mainly taken by GRANAT/SIGMA and CGRO/BATSE). If we take this into account we may expect that up to ~ 100 keV source confusion may occur for a few sources when observing this field region, due to the possible presence of these weak sources. On the other hand the total number and spatial distribution of detected objects is rather unpredictable: for example, most of the sources listed in Tab.1 can be found in a very low emission state (below the instrument minimum detectable flux).

We expect that in order to have a good imaging performance when observing such a crowded field the nominal angular resolution should be around 3'. This is not possible to achieve by IBIS since the instrument is optimised to work above ~ 100 keV, and the nominal angular resolution is constrained by the design of the imaging system. Nevertheless at lower energies, when source confusion is present, useful information about the spectral state of the sources provided by the X-ray monitor can be used e.g. to rule out high energy emission by candidate objects.

SOURCE NAME	**FLUX (mCrab, 20-300 keV)**	**DET. LEVEL (n.of sigma)**
GX 354-0	20	42
GRS 1747-34	5	10
GRS 1724-308	10	10
H 1743-322	50	104
H 1755-338	4	8
SLX 1732-304	60	122
H 1705-25	30	52
GRS 1736-297	4	8
GRS 1734-292	4	8
1E 1740.7-2942	10	21
A 1742-2942	20	42
A 1742-289	8	17
GRS 1743-29	9	18
SLX 1737-282	4	8
Sgr A	6	63
GRO 1719-24	100	199
SLX 1735-269	10	21
KS 1731-26	25	52
GX 1+4	10	21
GRS 1758-258	10	21
H 1700-377	200	228
GRS 1730-312	50	104
GRO 1744-28	50	104
GRS 1739-278	100	208
GRO 1655-40	20	12

Tab. I High energy sources used in the 10^5 s GC pointing simulation. The detection level takes into account the active coded area for each source.

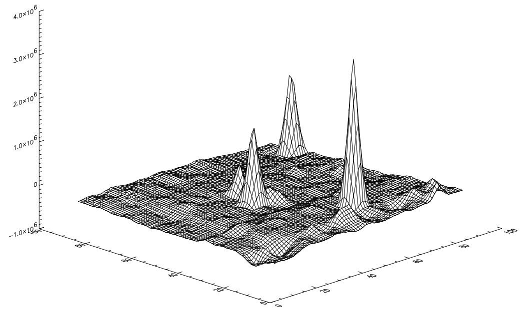

Fig.3 Simulated image of a 3.5 x 3.5 degrees region centered on SgrA, in the energy range 20-100 keV. The observation time is 10^5 s.

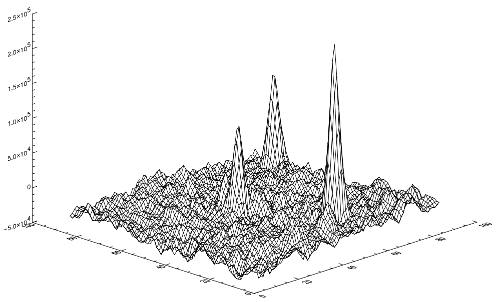

Fig.4 Same as Fig. 3, in the energy range 100-300 keV.

REFERENCES

Bazzano et al., these proceedings.
Ubertini et al., these proceedings.