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THE FINAL COS-B DATABASE - NOW PUBLICLY AVAILABLE

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ABSTRACT

The data obtained by the gamma-ray satellite COS-B have been processed, condensed and integrated together with the relevant mission and experiment parameters into the 'Final COS-B Database'. The database contents and the access programs available with the database are outlined. The final sky coverage and a presentation of the large-scale distribution of the observed Milky-Way emission are given. The database is anounced to be available through the European Space Agency.

1. Introduction: Gamma-ray astronomy in the energy range from about 50 MeV up to several GeV is based at present on the data obtained by only two successful satellite experiments, both using the sparkchamber technique: the first flown in 1972-1973 on the SAS-2 satellite of NASA, the second flown on the ESA satellite COS-B. SAS-2 operated ≈7 months and aquired about 8,000 gamma-ray events (1), COS-B was in successful operation from August 1975 until April 1982 and recorded about 210,000 gamma photons. A presentation of part of the COS-B database was given by Mayer-Hasselwander et al. (2).

The two datasets differ in the following respects: a) The low orbit of SAS-2 was well shielded by the earth's magnetic field against the cosmic-ray flux, ensuring a very low instrumental background level; the highly eccentric orbit (due to practical constraints) of COS-B exposed the satellite to the full cosmic-ray intensity, inducing a comparatively high instrumental background level, which is variable with the solar 11-year cycle. b) The COS-B experiment was supplemented by an energy calorimeter, providing good energy information for each recorded photon. c) Due to the differences in experiment configuration the low-energy threshold of SAS-2 was somewhat lower (≈30 MeV), than for COS-B (≈50 MeV). d) The COS-B experiment achieved a complete coverage of the galactic ridge. Its long lifetime, allowing for repeated observations in regions of special interest, enabled detailed analyses of the spatial distribution and of possible time variations of the observed emission.

The databases of SAS-2 (3) and of COS-B will remain for several years the only available gamma-ray survey data, and after the forthcoming experiments GAMMA-1 and EGRET, these databases will remain of interest e.g. in the search for possible secular and periodic time variations of celestial gamma-ray objects. Although considerable analysis effort already has been invested to

exploit the data, certainly much more can be done by applying new methods or by using the data together with upcoming new results in other ranges of the electromagnetic spectrum. So it appeared to be mandatory to establish and to make available the COS-B database in a way which will make possible future analysis also by scientists not familiar with the experiment.

2. The COS-B experiment and mission: The European Space Agency's satellite COS-B was dedicated to gamma-ray astronomy in the energy range 50 MeV to 5 GeV and carried a single experiment: a sparkchamber telescope (4), developed in collaboration by six European institutes. The experiment became operational on August 17, 1975 and was switched of on April 25, 1982, when onboard resources were exhausted. During this timespan 65 observations, mostly of a month duration, were performed. The satellite was spin stabilized, with the telescope axis along the spin axis and circular sky regions of about 40 degree diameter were covered in each observation. The majority of the pointings were distributed along the galactic equator, 15 observations were devoted to regions at high ($\geq$20°) galactic latitudes. Several regions of specific interest were repeatedly observed. The overall coverage of the sky is illustrated by Figure 1.

The highly eccentric polar orbit of COS-B with an apogee around 90,000 km, chosen to maximize useful observation time while allowing real-time data transmission, exposed the experiment to the solar modulated interplanetary cosmic-ray flux. The unexpectedly long operational life of the experiment, specifically of the sparkchamber, was acompanied by a long-term degradation and by short-term disturbances of its performance and consequently of the experiment sensitivity. The instrumental background and its variation and the changes in instruments sensitivity were thoroughly investigated. The corrections finally adopted and incorporated in the final database were derived by the method described in a subsequent paper (5). The possible impact of their statistical and systematic uncertainties must be considered in any type of analysis. It is emphasized that the corrections are averages over complete periods.

3. The database content and organisation: The database consists of several parts: A) the observation period, basic dataset, and individual gamma-ray event information, B) the experiment sensitivity, energy dispersion and pointspread functions as derived by accelerator and inflight calibrations, C) programs for easy and efficient access of the database, which produce event lists and skymaps for selected data parameters and time intervals, D) binned skymaps of the galactic disc.

Part A) consists of 3 files: the first one contains a list of the parameters of the 65 observations, including background and sensitivity corrections for each period; the second provides similar information for the 5,943 datasets which correspond to the uninterrupted time intervals during original data recording; the third contains 209,537 entries, one for each accepted gamma-ray event.

Part B) contains the instrument response functions. The sensitivity, energy-dispersion and pointspread-function files are derived from prelaunch calibration; the latter is also based on analysis of the brightest gamma-ray source, the Vela pulsar.

In part C) a collection of Fortran-77 programs is provided, which should allow for easy handling and efficient access of the database. Included are programs to move the database between tape and disc, to make event selections on event parameters and time intervals, and to produce binned skymaps of intensities, counts and exposures. Since these programs access the files in direct access mode, the database has to reside on disc, requiring about 25 Mb of disc space. The system was developed and used under various IBM operating systems (360/OS, MVT, MVS; VM/370, CMS), but also after moderate adaption,

has been successfully used on a VAX computer.

Part D) contains an atlas in several energy bands of the Milky Way.

Figure 2 gives as an illustration a map of the galactic disc emission (150 MeV), produced by a maximum entropy algorithm (7) using the database.

A more detailed description of the gamma-ray data and instrument response functions is in preparation (6). In view of the complexity of the data it is recommended to consult or to collaborate with members of the 'Caravane' collaboration when detailed analysis of the data is undertaken. It is hoped, that the release of this unique database will promote the full exploitation of the data, which appears mandatory in view of the enormous efforts in acquiring it.

The database is available on tape from the COS-B project scientist, Dr.K. Bennett, at the Space Science Department of ESA.

References:

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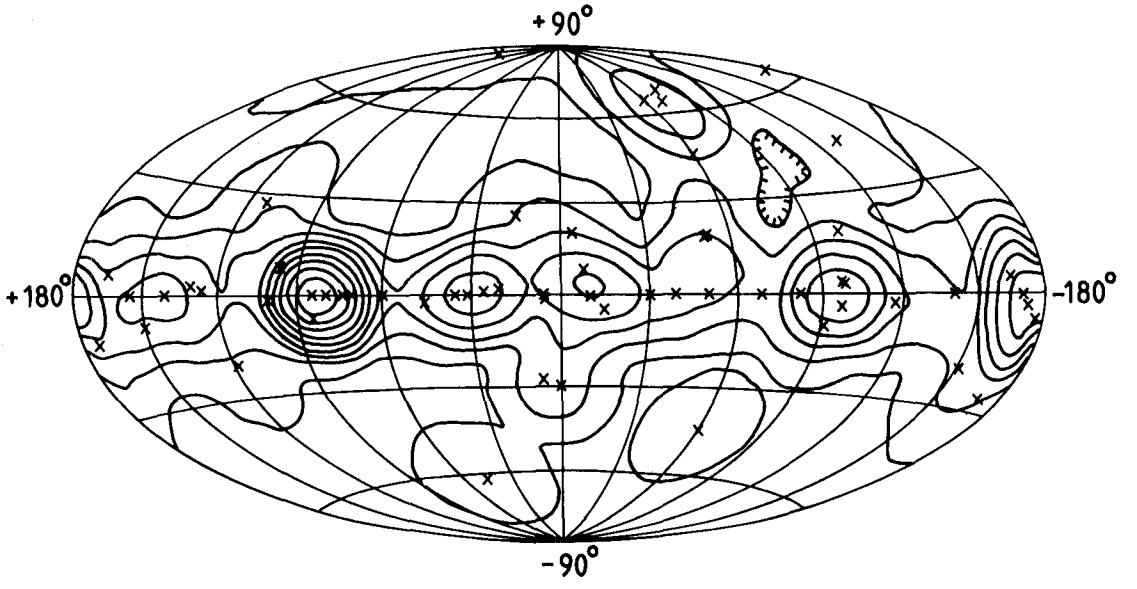
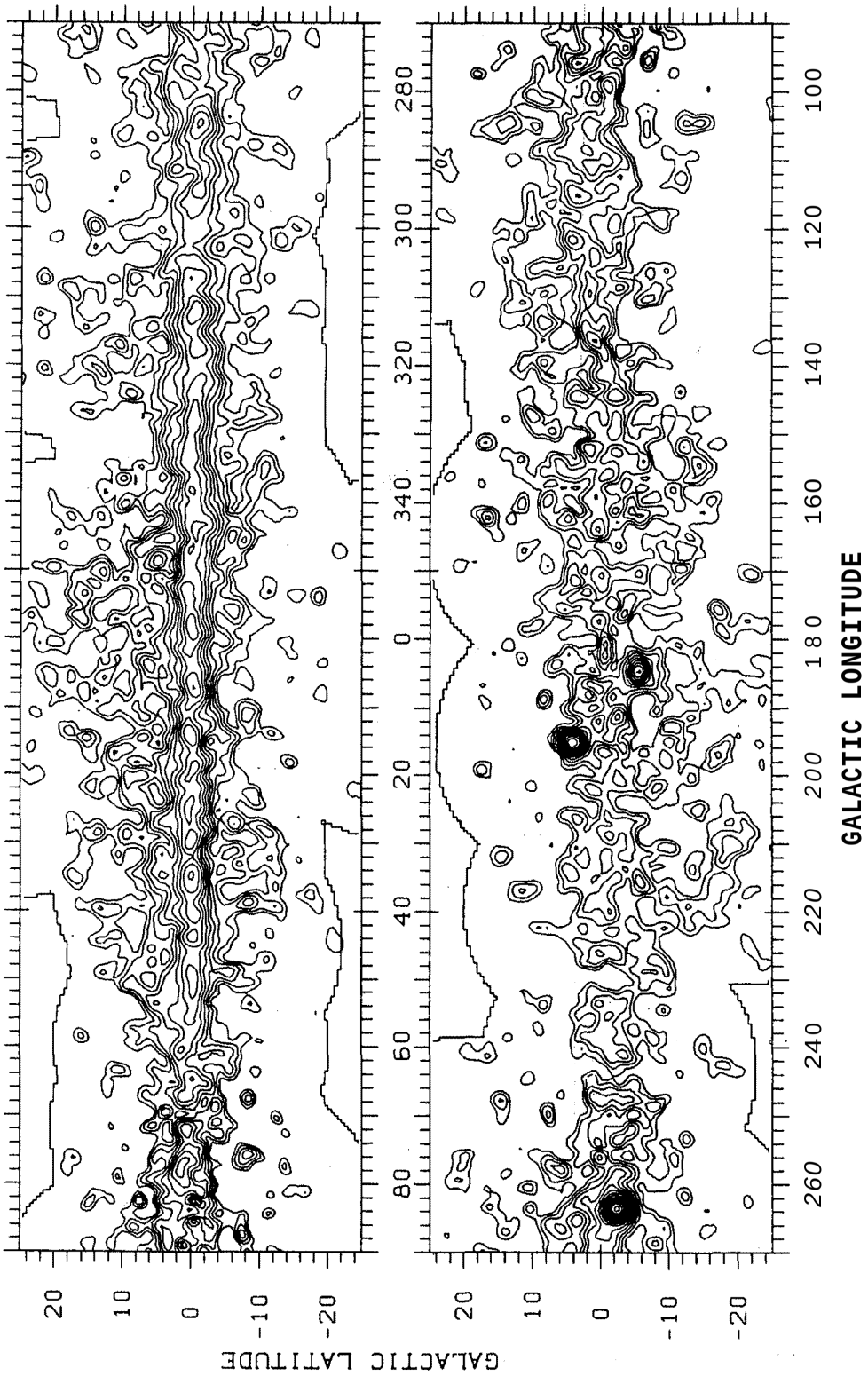


Figure 1: Approximate sky exposure achieved by the COS-B experiment. The contour levels are in 32 d steps, the lowest being 8 d (the exposure time is weighted with the inclination dependance of the sensitivity). The crosses indicate the pointing directions of the 65 observation periods.

Figure 2: Preliminary 'maximum entropy' deconvolved map of the galactic disk, indicating the structure in the emission seen in the energy range 150 MeV to 5 GeV, derived from the database described in this paper. An approximately logarithmic intensity scale was chosen to allow the display of structure in both intense and weak emission regions. This presentation does not give accurate absolute intensities.


GALACTIC LATITUDE
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GALACTIC LONGITUDE