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Committee on the Peaceful Uses of Outer Space

Note verbale dated 12 December 2002 from the Permanent Mission of Italy to the United Nations (Vienna) addressed to the Secretary-General

The Permanent Mission of Italy to the United Nations (Vienna) has the honour to communicate the following information: on 30 April 2002, the Italian Space Agency (ASI) switched off the Italian scientific satellite BeppoSAX, launched in 1996 (document A/AC.105/INF.400), which successfully completed its mission during the six years of its activity.

The switch-off procedure applied to BeppoSAX is irrevocable and the satellite can no longer be commanded from the ground. Consequently, it is now space debris without attitude control and is only subject to the law of orbital decay.

In December 2002, the orbiting altitude of BeppoSAX was in the range of 403-409 km and, considering the conditions of atmospheric density at that altitude, re-entry to the dense layers of the atmosphere (100 km) is expected to take place in spring 2003 (the exact date will be made available at a later stage). Approximately 40 fragments with a total mass of 650 kg will reach ground level; the heaviest fragments should not exceed 120 kg.

In order to provide the fullest possible information on the re-entry of BeppoSAX to all States whose territories may be affected by the impact of the fragments, including those States whose aircraft or ships may enter the area concerned (between plus and minus four degrees latitude), as well as to the international authorities regulating air and sea navigation and the relevant committees of the United Nations, the competent Italian authorities undertake:

(a) To provide a best estimate of the date of re-entry of the BeppoSAX satellite with a progressively precise indication of the time window of the expected impact and all other re-entry conditions (such as the geographical area of impact of the fragment shower, an evaluation of the casualty risk, indicating the inclusion or exclusion of major population concentrations and so forth);

(b) To establish a web site, as of January 2003, at <http://www.asdc.asi.it/bepposax/reentry/>;



(c) To disseminate pertinent information through diplomatic channels;

(d) To institute a special BeppoSAX team responsible for receiving data and transmitting information to interested States and competent international organizations (the Committee on the Peaceful Uses of Outer Space, the European Space Agency, the International Civil Aviation Organization and the International Maritime Organization). The team will monitor the re-entry twenty-four hours per day as the date of re-entry approaches;

(e) To request interested States to designate as soon as possible a local focal point responsible for receiving and circulating the information provided and for taking all the necessary measures to protect the population.

The present note verbale, together with the technical bulletin (see annex) which represents an integral part of it, is therefore provided as preliminary information only. More details will be provided at a later stage and disseminated via the above-mentioned web site and through the media.

Annex to the note verbale dated 12 December 2002 from the Permanent Mission of Italy to the United Nations (Vienna) addressed to the Secretary-General

Introduction

The present document is the first of several reports dealing with the technical aspects of the re-entry to Earth of the Italian satellite for X-ray astronomy, "BeppoSAX", as a consequence of orbital decay. The BeppoSAX satellite is owned by the Italian Space Agency (ASI) of Rome.

The goal of this first report is to define the general scenario of the re-entry and to provide useful information to the Governments of States whose territories are likely to be affected by this event, as well as to the international authorities regulating air and sea navigation and relevant United Nations committees.

ASI and the Italian Government are devoting particular attention to the re-entry of BeppoSAX and have activated a programme for disseminating information on this event by means of the issue of periodical reports that will be transmitted through diplomatic channels and made available to the public via the Internet at the following address from 1 January 2003: <http://www.asdc.asi.it/bepposax/reentry/>

The BeppoSAX mission was a programme of ASI for the launch and operation of an orbiting observatory for the study of X-ray radiation of celestial origin. ASI was joined in this programme by the Netherlands Agency for Aerospace Programmes (NIVR), which provided financial support and part of the flight hardware. The scientific instruments on board were provided by Italian space industries, by the European Space Agency (ESA) and by the Space Research Organization—Netherlands.

The name of the satellite was originally Satellite per Astronomia X (SAX) but was changed, following the successful launch into orbit, to BeppoSAX, after the well-known Italian astrophysicist Giuseppe "Beppo" Occhialini.

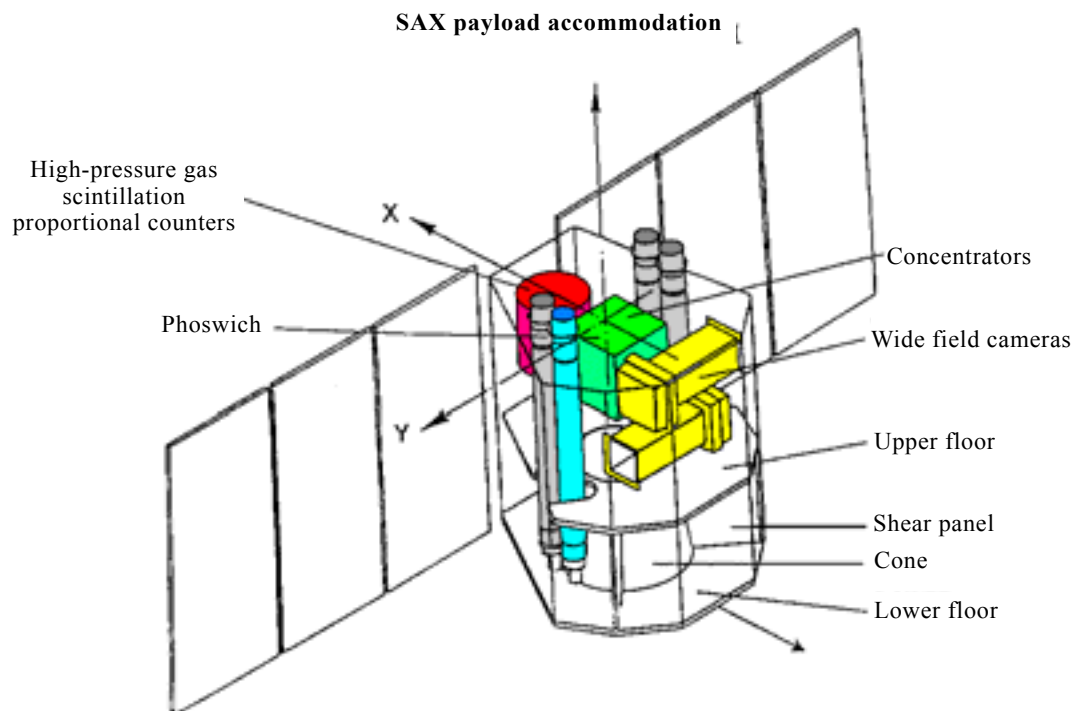
The spacecraft was designed and assembled by Alenia Spazio of Turin and controlled in orbit by Telespazio of Rome. The operation control centre was located in Rome at the Telespazio premises, while the ground station was the ASI Malindi ground station in Kenya.

The mass of BeppoSAX is about 1,400 kg and its spatial dimensions are 2.4 m x 3.6 m x 18 m, of which the largest extension (18 m) consists of the solar arrays.

BeppoSAX was launched into space from the National Aeronautics and Space Administration (NASA) Kennedy Space Center in Florida, United States of America, on 30 April 1996 at 0431 (GMT) by an Atlas/Centaur vehicle. The injecting orbit was circular, at an altitude of 600 km and essentially equatorial (3.95° inclination).

BeppoSAX is shown below, with the accommodation of the scientific instruments (figure 1).

Figure 1
BeppoSAX with the accommodation of the scientific instruments



Current status of BeppoSAX

During the course of its six-year lifetime, BeppoSAX successfully completed a set of observation programmes which provided general and deep coverage of X-ray radiation of celestial origin. In addition, the BeppoSAX results were crucial in the recent breakthrough of the gamma-ray burst astrophysics that eventually led to significant international awards such as the 1998 “Bruno Rossi” prize awarded to the BeppoSAX team by the American Astronomical Society.

The operative life of BeppoSAX ended in the spring of 2002, following the ASI decision to deactivate the satellite. The long and successful life of the satellite was essentially owing to the excellent performance of the on-board instrumentation and to the bus subsystems.

The decision to end the operative life of BeppoSAX was taken on the basis of two converging factors:

- The progressive and irreversible ageing of the on-board nickel cadmium (NiCd) batteries.

- Progressive decaying of the orbiting altitude to the level of 450 km, at which the attitude control subsystem was no longer able to counterbalance the disturbance torques.

During the first quarter of 2002, those factors significantly reduced the observing efficiency and eventually lowered the cost-effectiveness of the mission.

BeppoSAX was switched off from the control centre in Rome on 30 April 2002 using a procedure that successfully ended at 1318 (GMT).

The switch-off procedure was designed to provide full compliance with the international agreements for mitigation of space debris production and for satellite re-entries. The main guideline was the inhibition of all residual energy sources present on board in order to prevent any explosion of the satellite before the re-entry phase.

The switch-off procedure applied to BeppoSAX is irrevocable and the spacecraft can no longer be commanded from the ground. Accordingly, since 30 April 2002 BeppoSAX is space debris, without attitude control and subject only to the law of orbital decay.

The rear tank of BeppoSAX still contains 26 kg of hydrazine (N_2H_4) and 0.5 kg of gaseous nitrogen oxidant. BeppoSAX does not contain any fissionable element.

General forecast of the re-entry of BeppoSAX

At the time of writing (2 December 2002) the orbiting altitude of BeppoSAX was in the range 403-409 km and, considering the actual conditions of the atmospheric thermo-density at that altitude, the re-entry to the dense layers of the atmosphere (100 km) is expected to take place in the spring of 2003.

This forecast is based on the current thermo-density profile of the atmosphere, which is, in turn, dependent upon solar activity in the ultraviolet domain. The solar activity is presently following the decreasing phase of the 11-year cycle of the Sun. However, an unexpected rise in solar activity may induce a consequent increase in atmospheric density, with an acceleration of the orbital decay of BeppoSAX. This event, while possible, has a low probability and may be quantified, in the worst case, in the re-entry date being brought forward by one or two months. Conversely, a stronger than expected decrease in solar activity could put back the re-entry date to late 2003.

ASI commissioned a detailed study of the destructive re-entry of BeppoSAX to Earth from a respected European firm that specializes in this field. The results of the study are as follows:

- The destructive re-entry of BeppoSAX will start at an altitude of 100 km and will conclude in approximately 40 minutes.
- BeppoSAX will be subject to progressive fragmentation, with some fragments completely vaporized by the atmospheric drag and some other fragments reaching ground level.

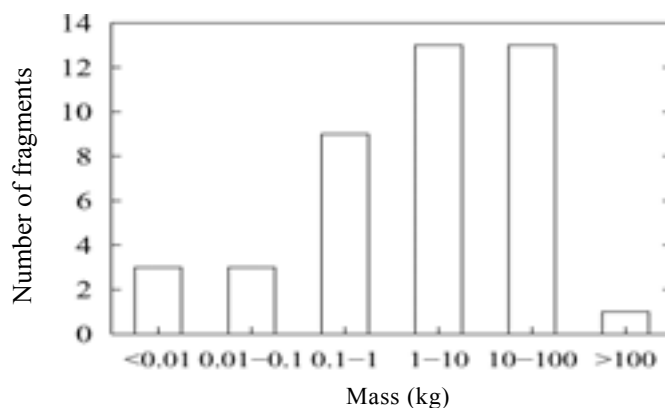
- Approximately 40 fragments, with a total mass of 650 kg, will reach ground level; the heaviest fragment may have a mass of the order of 100 kg.
- The fragment shower will impact on the equatorial belt; the affected area will have an extension of 10,000 km², probably in the form of a strip 315 km x 32 km.
- The fragment velocity of impact on the ground will be in the range 60-460 km/h.
- The summed cross-section of the fragments reaching the ground will be 30 m²; this figure is higher than the “attention” cross-section threshold applied by NASA of 8 m².

These results should be retained as “order of magnitude” and not precise determinations, given the stochastic nature of the event and the approximations inherent in the BeppoSAX model that was used.

In figure 2 the mass distribution of the fragment shower reaching the ground is shown.

Figure 2

Expected mass distribution of BeppoSAX fragment shower



States likely to be affected by the BeppoSAX re-entry and the dissemination of information relating to it

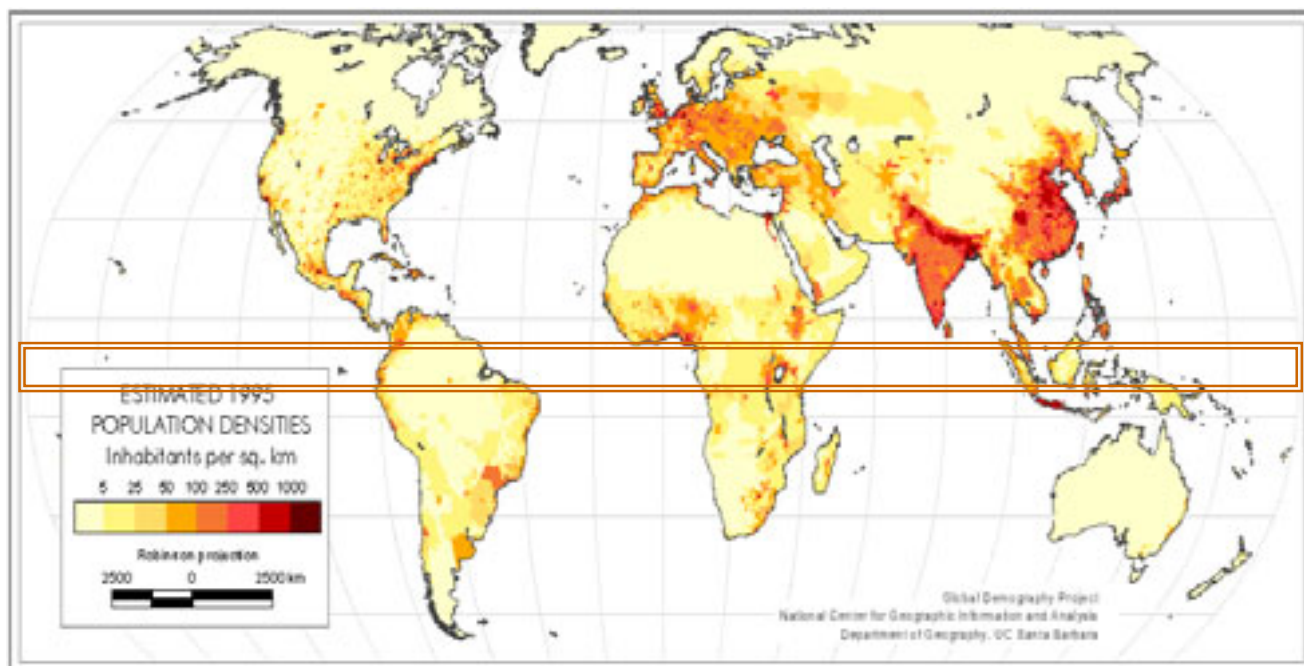
Figure 3 shows the equatorial belt likely to be affected by the BeppoSAX re-entry and the table lists all the States whose territory lies inside the range of latitude of plus or minus four degrees. For the affected countries, the 1990 population distribution is listed in cells measuring 1° longitude x 1° latitude.

ASI, on behalf of the Government of Italy, has actively spurred the process of mitigation of the space debris generation and applies the guidelines listed in the following documents:

- (a) Technical Report on Space Debris, adopted by the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space (A/AC.105/720);

Figure 3

Position of the equatorial belt likely to be affected by the BeppoSAX re-entry and population density, 1990



(b) European Space Debris Safety and Mitigation Standard, European Debris Mitigation Standard Working Group, Issue 1, Revision 0, 27 September 2000;

(c) Inter-Agency Space Debris Coordination Committee Space Debris Mitigation Guidelines, Working Group 4, draft of 23 March 2001.

Within this context, ASI is willing to provide complete and transparent information about the re-entry of BeppoSAX to all States whose territories may be affected by the impact of the BeppoSAX fragments, as well as to the international authorities regulating air and sea navigation and the relevant committees of the United Nations. This information will be contained in periodical reports listing the following items:

(a) The best estimate of the BeppoSAX re-entry date with a progressively precise indication of the time window of the expected impact of the fragment shower;

(b) The best estimate of the geographical area of impact of the fragment shower;

(c) An evaluation of the casualty risk associated with the BeppoSAX re-entry, with indication of the inclusion or exclusion of major population concentrations.

All communications relating to this event will be available via the Internet at the following address as of 1 January 2003: <http://www.asdc.asi.it/bepposax/reentry/>

	Lat. grid cell centre								
Country or area	-3,5	-2,5	-1,5	-0,5	0,5	1,5	2,5	3,5	Total
Brazil	5 378 966	2 490 739	4 253 907	1 279 590	1 419 701	874 176	621 693	1 183 369	17 502 141
Burundi	4 086 645	1 049 801							5 118 446
Cameroon							705 928	2 102 566	2 808 494
Central African Republic							10 579	137 532	148 111
Colombia	17 300	51 900	138 400	69 200	951 501	1 720 034	1 993 372	3 232 162	8 173 869
Congo	165 761	165 762	110 508	118 402	94 721	94 720	78 934	23 680	852 488
Democratic Republic of the Congo	2 245 638	2 045 346	1 825 772	1 815 660	2 190 856	1 532 700	1 544 490	1 796 956	14 997 418
Ecuador	788 532	3 359 418	1 924 028	2 727 834	1 348 636	159 422			10 307 870
Equatorial Guinea						204 500	40 899	106 600	351 999
Ethiopia								260 139	260 139
French Guiana							905	14 480	15 385
Gabon	33 941	113 135	235 240	340 416	402 329	22 627	11 313		1 159 001
Guyana						27 273	72 727	63 636	163 636
Indonesia	15 283 464	16 415 928	15 620 317	16 827 805	12 516 741	8 587 570	5 019 991	6 359 982	96 631 798
Kenya	1 905 823	1 429 368	6 457 150	4 556 902	4 124 781	1 238 786	1 238 785	571 746	21 523 341
Kiribati			47 376					23 624	71 000
Malaysia						2 491 112	2 579 772	4 272 030	9 342 914
Papua New Guinea	455 484	112 005							567 489
Peru	818 169	266 148	156 557	78 279					1 319 153
Rwanda		3 548 006	3 478 995						7 027 001
Sao Tome and Principe					96 821	22 179			119 000
Singapore						2 710 000			2 710 000
Somalia			238 303	317 737	675 192	983 847	1 696 440	953 213	4 864 732
Sudan								57 006	57 006
Suriname								16 324	16 324
Uganda			643 054	2 204 756	5 893 169	4 225 782	2 572 215	2 021 025	17 560 001
United Republic of Tanzania	2 116 776	1 702 500	1 050 124						4 869 400
Venezuela						124 352	226 093	79 133	429 578
Total	33 278 499	32 750 056	36 179 731	30 336 581	29 714 448	25 019 080	18 437 760	23 251 579	228 967 734

Population distribution in countries and areas in the equatorial belt likely to be affected by the re-entry of the BeppoSAX, divided into cells measuring 1° longitude x 1° latitude

