Integral

Integral is Europe's latest gamma-ray observatory and continues the pioneering work begun in 1975 with ESA's COS-B gamma-ray satellite. Its acronym stands for the International Gamma-Ray Astrophysics Laboratory.

Gamma rays are a million times more energetic than visible light and can pass through matter with hardly any interaction. Integral uses two specially designed gamma-ray telescopes to register these elusive rays: One provides the sharpest images of the gamma-ray sky ever seen and the other measures the energies of the gamma-rays with unprecedented accuracy.

These telescopes are complemented by two other instruments: an X-ray monitor and an optical camera. All four instruments work simultaneously and point at the same region of the sky. This is the first time scientists have been routinely able to take measurements concurrently and it will allow a clearer identification of the gamma-ray sources.

Objectives

Integral's task will be to gather the most energetic radiation in the Universe, giving insight into the most violent processes in the Universe. Gamma-rays are even more powerful than X-rays (used in medical examinations). However, they are blocked by the Earth's atmosphere so gamma-ray astronomy must be largely space-based. Integral's varied observation programme includes studying:

- How black holes interact with their surroundings
- The explosion of supernovae and their role in forming chemical elements
- The nature of the powerful gamma-ray bursts
- Transient sources that suddenly change their brightness
- Making the most sensitive map of the distribution of gamma-ray sources in our Galaxy

Scientific highlights to date

- First map of parts of the Galactic plane in the light of nuclear gamma-rays emitted by decaying atomic nuclei. These are the signature of the most violent processes in the Universe.

- Discovery of what seems to be a new class of astronomical objects. These are binary systems, probably including a black hole or a neutron star, embedded in a thick cocoon of cold gas. They have remained invisible so far to all other telescopes.

- Solving a thirty year old question by resolving the diffuse glow of gamma rays in the centre of our galaxy and showing that most of it is produced by a hundred individual sources.

- Finding more evidence (together with XMM-Newton) that massive black holes are surrounded by a doughnut-shaped gas cloud, called a torus.

- Gamma-ray burst GRB 031203, detected by INTEGRAL, is the closest cosmic gamma-ray burst on record. It is also the faintest gamma-ray burst on record – this suggests that an entire population of sub-energetic gamma-ray bursts has so far gone unnoticed.

Cost

The mission cost to ESA was 330 million Euro. This includes the spacecraft and the two years of ground operations but excludes the launch and the payload. The launch was provided by Russia in exchange for observing time. As is usual for ESA science missions, the payload was provided by national funds.

Launch

17 October 2002, using a Russian Proton rocket from the Baikonour Cosmodrome in Kazakhstan. The Proton is Russia's largest operational launch vehicle. It is more than 57 metres tall and its mass at liftoff is around 700 tonnes.

Orbit

Integral was first placed in a low parking orbit around the Earth. About 50 minutes after launch, an attached upper stage rocket fired, putting Integral into a transfer orbit. The upper stage rocket then separated and Integral used its own manoeuvring rockets to reach its operational orbit of 72 hours. Its lowest point is 9000 kilometres and its highest point is 153 000 kilometres. Such an elongated orbit is essential to keep Integral as much as possible out of the Earth's harmful radiation belts, which distort the view of the high-energy Universe.

Planned mission lifetime

Integral is designed to have a mission lifetime of at least five years. At present, the mission is funded until 2008.

Spacecraft

Design: Integral consists of two main sections: the service module and the payload module. The payload module contains the four scientific instruments and is joined to the service module, which houses essentials such as power distribution, communications and satellite control. To keep costs down, the service module design is the same as that used in XMM-Newton. The whole spacecraft is three-axis stabilised, allowing it to be pointed with a high degree of accuracy at its targeted celestial objects.

Dimensions: 5x3.7x3.7 metres. The deployed solar panels are 16 metres across.

Mass: 4 tonnes at launch, including 2 tonnes of payload.

Industrial involvement: The prime contractor is Alenia Spazio leading an industrial consortium involving 26 companies from 12 European countries and one company in the United States. Approximately 1400 people were involved in the production of Integral, including the scientists and engineers responsible for the instruments, ground segment, and science data centre.

What's on board?

Imager on Board the Integral Satellite - IBIS
IBIS provides sharper gamma-ray images than any previous gamma-ray instrument. It can locate sources to a precision of 30 arcseconds, the equivalent of measuring a person standing in a crowd, 1.3 kilometres away.
Principal Investigators: P. Ubertini (IAS/CNR Rome, Italy), F. Lebrun (CEA Saclay, France), G. Di Cocco (ITESRE Bologna, Italy).

Spectrometer on Integral - SPI
SPI measures the energy of incoming gamma-rays with extraordinary accuracy. It is more sensitive to faint radiation than any previous gamma-ray instrument and allows the precise nature of gamma-ray sources to be determined.
Principal Investigators: J.-P. Roques, (CESR Toulouse, France), V. Schönfelder (MPE Garching, Germany).

Optical Monitoring Camera - OMC
OMC automatically takes an image of the sky at optical wavelengths whenever the gamma-ray telescopes are working. This allows astronomers to match the gamma-ray source with an optical counterpart, thus permitting further investigation with ground-based optical telescopes.
Principal Investigators: M. Mas-Hesse (INTA/LAEFF Madrid, Spain).

Joint European X-Ray Monitor - JEM-X
JEM-X performs a similar task to the OMC but at X-ray wavelengths. It provides X-ray images with similar positional accuracy as IBIS. These data allow astronomers to simultaneously study the behaviour of gamma-ray sources at X-ray wavelengths. Previously, such investigations have never been routinely possible.
Principal Investigator: N. Lund (DSRI Copenhagen, Denmark).

Operations

Ground control: The Integral Mission Operations Centre (MOC) is located at the European Space Operations Centre (ESOC) in Darmstadt (Germany). It communicates with Integral using ground stations at Redu (Belgium) and Goldstone (California, United States).

Science Operations:
The Integral Science Operations Centre (ISOC) is located at the European Space Technology Research Centre (ESTEC) in Noordwijk (the Netherlands). It coordinates ob-servers' requests and determines when Integral will observe each of the approved targets.

The Integral Science Data Centre (ISDC) in Versoix, near Geneva (Switzerland) collects raw science data and processes them for distribution to astronomers, worldwide. This includes searching for gamma-ray bursts and other interesting phenomena in the Integral data.

ESA Mission Manager: Arvind Parmar
ESA Project Scientist: Christoph Winkler

For further information please contact:

ESA Science Programme Communication Service
phone: +31 71 565 3273
fax: +31 71 565 4101
email: ibruckne @ esa.int

ESA Media Relations Service
phone: +33 1 5369 7155
fax: +33 1 5369 7690

This fact sheet, images and other press material can be found at:
http://www.esa.int/esaSC/spk.html

ESA Science news releases from Integral and other missions can be found at:
http://www.esa.int/science/media

General information about this and other ESA Science missions can be found at: http://www.esa.int/science

Detailed technical and scientific information about Integral can be found at: http://www.rssd.esa.int/Integral/