RAL
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RUTHERFORD APPLETON LABORATORY
SCIENCE AND ENGINEERING RESEARCH COUNCIL

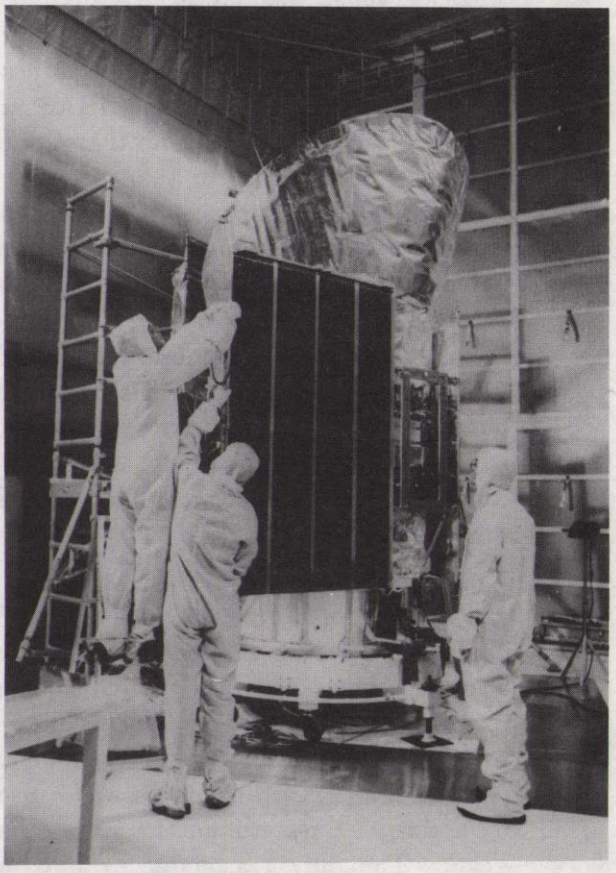
The InfraRed Astronomical Satellite (IRAS)

Introduction

IRAS was an international project designed to survey the whole sky and measure the infrared radiation (heat) from astronomical objects, for example stars and galaxies. The satellite was 3.60m (almost 12ft) high and 3.24m (10.5ft) wide when the solar panels were extended (see opposite), and at launch it weighed over 1000kg (about 1 ton). The spacecraft was built by the Dutch, the USA provided the telescope, the detectors and the launch. The UK provided satellite control facilities at RAL, to receive the data, send instructions, and check the day-to-day functioning of the satellite. IRAS was launched on 26 January 1983 at 2:17am GMT, from Vandenberg Air Force Base in California, using a two-stage Delta rocket with 9 strap-on booster rockets. The mission lasted 10 months, from February 1983 (after testing was completed) until 23 November 1983. It ended when the liquid helium, used to prevent the satellite from measuring its own heat, ran out.

The Instrument

At the heart of IRAS were the 62 detectors, sensitive to infrared radiation with wavelengths between 8μm and 120μm (1μm is $\frac{1}{1000}$ mm). Our eyes are most sensitive around 0.5μm, so the infrared has wavelengths between the visual and radio regions of the spectrum. The telescope field of view was the size of the full moon (0.5 degrees), (not that IRAS could look at the full moon because it is so bright that IRAS would have exploded due to the sudden heat input). Data were transmitted from the satellite to the Chilton Ground Station at RAL twice a day, using the 12 metre antenna in the grounds. The data were transmitted at over 1 million bits per second, so that a half-day's data could be sent in less than 3 minutes. At the same time, commands were sent to the satellite telling it where to look during the next half day.



Results from IRAS

The catalogue of sources that IRAS found contains 245,839 entries. More than half of these are probably stars in our Galaxy. IRAS was very good at detecting cold dust, either around stars or in between the stars. The detectors (since they measure heat) are most sensitive to dust with temperatures between 300K and 30K (water freezes at 273K, and air freezes around 80K).

The IPMAF (IRAS Post Mission Analysis Facility) group at RAL help UK scientists access IRAS data and analyse it. Six years after IRAS flew, new discoveries are still being made from IRAS data, and new ways of studying the data are still being developed.

Solar System

IRAS first "hit the headlines" as a co-discoverer of the comet IRAS-Araki-Alcock, which was visible to the naked eye. IRAS discovered 6 comets during its lifetime. The eye sees the gas associated with a comet, whereas IRAS saw the dust, and scientists found that comets have more dust in them than previously thought. One of the most intriguing discoveries from IRAS concerned the zodiacal light. This is caused by dust in our own solar system, concentrated in the region of the asteroid belt. IRAS found that it came from not one band (as previously thought) but from many bands, each associated with a different family of asteroids, and possibly caused by collisions between family members.

The Galaxy

The international group of scientists working at RAL during the IRAS mission had a surprise when one of their standard stars (a star about which "everything" is known) was found to be much brighter than expected. The extra brightness was caused by a ring of dust around the star, called Vega. The only reasonable explanation for this dust disk is that planets tried to form around Vega and failed, leaving a disk of large dust grains (and probably small gravel).

IRAS was very good at finding young stars, just forming, deep within large dust clouds in our Galaxy. The dust clouds are 10,000 times as massive as the Sun. We are unable to see these stars using optical telescopes because the dust hides the new stars, but in the infrared they shine brightly. Astronomers have been amazed at the numbers of stars seen in these dust clouds, they had been expecting only a few new stars per cloud but, in fact, they found ten times as many.

The dust between the stars is very cold (around 30K), but it is everywhere in our Galaxy. IRAS can see it very clearly, and it gives the appearance of a slightly cloudy sky, so it is called cirrus. Although some features had been seen before, astronomers had not realised how widespread the cirrus was.

Other galaxies

The same kinds of stars and dust which glow brightly in our own Galaxy can be used to find other galaxies. There is a special class of them, called star-burst galaxies, of which large numbers were observed by IRAS. These galaxies are incredibly bright because large numbers of new stars are being formed in them. There are regions in the Universe where astronomers using optical telescopes find very few galaxies, these are called voids. This fact is regarded as very important for theories of how the Universe developed. Recently it was announced in the USA that IRAS had observed galaxies in the best known of these voids, so theoreticians will have to change their views.

For further information:—
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