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Early Results From ISO

From: <awyn@cybercom.net>
Date: Sat, 14 Dec 1996 08:26:26 -0500 (EST)
Fwd Date: Sat, 14 Dec 1996 23:31:51 -0500
Subject: Early Results From ISO

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Date: Fri, 13 Dec 1996 22:00:54 -0500
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Date: 96-12-11 17:34:05 EST

European Space Agency
Paris, France 28 November 1996

PRESS INFORMATION NOTE Nr. 21-96

Enthusiasm for Europe's space telescope ISO

A special issue of the journal Astronomy and Astrophysics, published in the latter part of November 1996, is devoted to early results from the European Space Agency's Infrared Space Observatory. Ninety-one scientific papers tell of unprecedented inspections of the cool universe and its hidden corners, as ISO and its four excellent instruments rewrite the astronomical textbooks.

"Are the most luminous galaxies powered by extreme rates of star formation, or do they harbour black-hole-powered active nuclei as well?" Scientists lead by Reinhard Genzel at Max Planck Institut fur extra terrestrische Physik in Garching, Germany, have used ISO's Short Wavelength Spectrometer to give an answer. Writing in the London journal Nature, an independent commentator, Gerry Gilmore of the Institute of Astronomy in Cambridge, considers that their papers in Astronomy and Astrophysics give a clear answer to this question. The "remarkable result" according to Gilmore is that none of three ultra-luminous infrared galaxies studied by ISO requires an active nucleus to account for the emissions, which arise from rapid star formation. About another ISO target Gilmore writes:

"In one lovely example, of two intersecting disk galaxies known as the Antennae, it is even possible to resolve the spot where the two disks currently cross, and to see the progression of star formation across the disk as the two galaxies orbit through each other." (Nature, 21 November 1996, p. 211)

One year after its launch, ISO is exceptionally popular among astronomers, not only in Europe but worldwide. A panel of American astronomers, reporting

to NASA on the scientific merits of eight astrophysical space missions, gives ISO the highest ranking and calls it "the major infrared mission of the decade". At a time when NASA is reducing its budgets for some astrophysical missions, its funding of ISO-related research is increasing.

The demand for a share in ISO's unique view of the infrared universe is insatiable. ESA has been overwhelmed by new proposals for observations, coming from 511 groups of astronomers in ESA's own Member States and in the USA and Japan. Although ISO is extremely efficient, performing an average of 45 observations a day, it could not cope with 16,000 observations requested as additions to ISO's already busy programme for 1997. The time allocation committee has had to turn down 75 per cent of the proposed observations. Nevertheless the allocations announced this month will meet the wishes of most groups of applicants at least in part.

ISO is now about half way through its operating life. An Ariane 44P launcher put it into orbit on 17 November 1995. ISO's superfluid helium which keeps the telescope and instruments cold, will last about six months longer than required in the specification. Operations are expected to continue until December 1997, with the benefit that the chemically rich and starmaking clouds of the important Orion region of the sky will be observable by ISO.

Tracing the origin of planets

Observations of the Antennae galaxies, and some of the other ISO results now described in full technical detail in *Astronomy and Astrophysics*, were outlined in earlier ESA Information Notes, 02-96 and 14-96. These include examinations of star formation in many galaxies and within dust clouds in our own Galaxy, the Milky Way. ISO has also given a big boost to astrochemistry by identifying infrared signatures of many materials, which play a physical as well as a chemical role in the evolution of galaxies and stars. The materials seen by ISO include ionized carbon atoms, sooty carbon compounds, hydrogen molecules, water molecules, and frozen carbon dioxide and methane. The latest results tell of mineral crystals, which may shed light on the origin of the Earth itself.

Disks of dust around some stars, of the kind from which planets might evolve, were a major discovery in infrared astronomy by ISO's predecessor, the Dutch US UK satellite IRAS (1983). The prototype was the bright northern star Vega. It showed excess emissions of long-wavelength infrared rays, which could not come from the star itself. Subsequent studies confirmed the dust disks of Vega and a few other stars, and the search for more such disks is a major programme for ISO, relying particularly on measurements by the photometer ISOPHOT across a wide range of infrared wavelengths.

Several new candidate Vega-like dust disks are reported in *Astronomy and Astrophysics* by Harm Habing of Leiden in the Netherlands, and his colleagues. Their preliminary conclusion is that the dust disks are a common feature of ordinary stars as massive as the Sun or heavier, but they are by no means ubiquitous. Further measurements on Vega itself show relatively low emissions at the longest wavelengths, which implies that the dust grains are small.

In a related programme, a Belgian-led team has used ISO's Short-Wavelength Spectrometer to probe the composition of dust near very young stars. It reports the discovery of crystals of olivine, a silicate mineral and a major constituent of the Earth's own rocky mantle. The firm detection of olivine crystals builds a bridge from the stars to the minerals of the solar system.

Most mineral grains in interstellar space lack the crystalline forms of common minerals, even if they have the same chemical composition. Hints of infrared emissions from olivine crystals, detected by ground-based telescopes at around 11 microns wavelength, are confused by emissions coming also from carbon compounds. ISO, with its unhampered view at longer wavelengths, sees signatures of magnesium-rich olivine crystals at 20, 24 and 34 microns.

The minerals crystallize when gravity concentrates them near a young star, and intense radiation from the star modifies the grains. ISO also sees similar materials in the dust shells of old stars, in a project headed by the Dutch astronomer Rens Waters, who is also closely involved in the work on young stars. Apparently the mineral crystals do not survive in interstellar space, but have to be refashioned near young stars.

The most clear-cut evidence for olivine crystals comes from the vicinity of HD 100546, a young blue star about 500 light-years away near the Southern Cross. It is thought to be only a few million years old and it is a strong infrared emitter. The star also shows peculiar ultraviolet absorptions, recorded by the NASA ESA UK International Ultraviolet Explorer, which apparently result from comets or asteroids splashing into HD 100546.

"A tremendous cloud of comets seems to surround this young star," says Christoffel Waelkens of Leuven, Belgium, who leads the project that discovered the olivine crystals. "We believe that it was from just such a comet cloud, around the young Sun, that the Earth and the other planets were born. Now we compare notes with colleagues who study minerals in our local comets and meteorites. ISO has seen olivine in Comet Hale-Bopp. So not the least of ISO's successes is a reunification of stellar astrophysics and solar-system science."

Newborn stars and stellar jets

Astronomers in Stockholm, Sweden, are the lead authors of papers concerning the search for newborn stars and related phenomena in the southern constellation Chamaeleon. At about 800 light-years a feature called the Chamaeleon Dark Clouds, sprawling across more than one degree of the sky, is one of the closest regions of present-day star formation. The camera ISOCAM has obtained more than 23,000 images of the region, in two wavelength bands around 7 and 15 microns. Out of hundreds of objects detected, the team identified 65 young stars, of which more than 40 per cent were not previously known.

Another lead author from Stockholm reports on the use of ISO's Long-Wavelength Spectrometer to examine a strange luminous patch in the Chamaeleon Dark Clouds called HH 54. It is a Herbig-Haro object, named after an American and a Mexican astronomer, in which a jet of gas from a very young star creates luminosity by shock waves, at a great distance from the star. ISO has for the first time detected emissions from water vapour in an HH object.

This result not only confirms ISO's pioneering role as a cosmic water diviner, but gives new insight into the mechanisms creating the HH object. Practically all of the energy of a 10 kilometre-per-second shock is dissipated by infrared emissions from water vapour, hydroxyl and carbon monoxide molecules. A related paper, with a lead author from Frascati, Italy, compares HH 54 with other nearby objects HH 52 and HH 53, again using the Long-Wavelength Spectrometer. A conclusion is that HH 54 is energized by a young star different from the one that may be responsible for the other two objects.

"The 91 papers published this month, covering observations from planets to galaxies, are still only a foretaste of many hundreds to be expected as the observing programmes and the data-processing mature," says Martin Kessler, ISO's project scientist based at Villafranca, Spain. "For example, ISOCAM is engaged on a systematic survey of a section of the Milky Way. In Astronomy and Astrophysics only one per cent of the survey is reported yet already there are thousands of infrared sources and plenty of surprises. Although ISO has only one more year of operation, its impact on astronomy will continue for many years."

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