## SCIENCE NEWS of the week

# Throwing Wide the IR Window

The infrared sky is a place of spectacular—yet largely unseen—wonders. It has been viewed by IR telescopes built on mountaintops, slung from balloons and mounted in aircraft, but such instruments have been limited either in their time aloft or to the areas visible from their fixed locations, and none have been able to see through more than a crack in the IR "window," since most IR emissions are filtered out by earth's atmosphere. The U.S.-Dutch-British Infrared Astronomy Satellite (IRAS), however, has thrown the window wide.

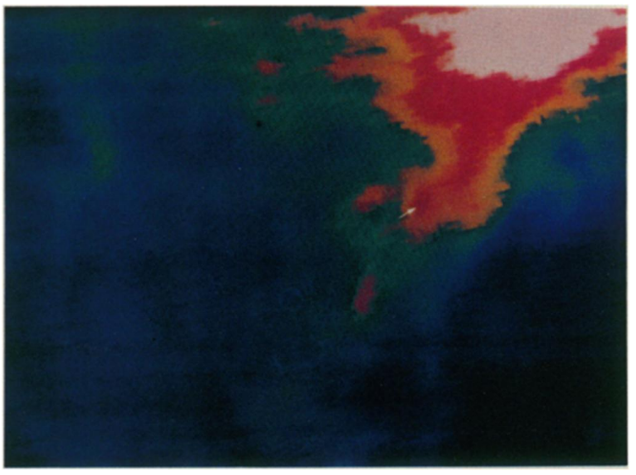
Launched Jan. 25, it has surveyed the entire sphere of the heavens, and its telescope is unexpectedly proving so long-lived that it is now enabling delighted astronomers to improve the reliability of their data by repeating the task. Freed of the atmosphere, it has been detecting long-wavelength emissions from otherwise invisible sources that are only a few degrees above absolute zero. The survey, says project scientist Nancy Boggess of the National Aeronautics and Space Administration (NASA), is "our first roadmap." And there are many sights along the road.

Last week, IRAS scientists described some of their early findings, though they have barely begun to analyze the more than 200,000 IR sources detected by the satellite.

The most-discussed topic, perhaps, has been the discovery of emissions from what are believed to be small (roughly BB-sized) solid particles orbiting the star Vega (SN: 8/13/83, p. 100)—the first direct evidence of solid material around a star other than the sun. There is no evidence of planets (contrary to some press reports), and only theory to suggest even that Vega may be "a solar system in formation." So intriguing are the possibilities, however, that IRAS scientists have narrowed some 9,000 promising stars—those with a Vega-like excess in their IR emissions—down to about 50 whose IR excesses cannot be readily explained any other way than Vega's. (The IRAS team has also found no signs yet—contrary to rumors—of a "10th planet" in the solar system. Irregularities in the orbital motions of Uranus and Neptune have suggested that one is possible, however, and "if it's there," says an IRAS scientist, "it's in our data.")

Vega is much younger than the sun, but IRAS has detected many stars that are younger still. Numerous small clouds of gas and dust where stars are actually being born, for example, have been found by IRAS within 650 light-years of earth. Specific sites of star-formation have been pinpointed within the Andromeda galaxy, and the process appears far more active in

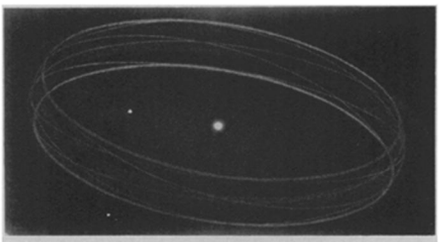
Illustrations: NASA



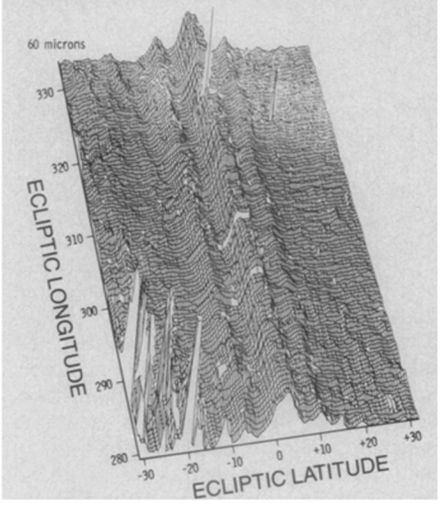
*False-color IRAS image (above) shows a dark, molecular-hydrogen cloud called Barnard 5, thought to be a region where new stars are being born, including one object (arrow) believed to resemble our early sun. Radiating IR energy at about 10 times the sun's present rate, it may be a sunlike star in its first 100,000 years of existence.*

*Only the most intensely emitting portions (white, in this false-color image, above left) of this region around the star Rho Ophiuchus had been recognized as sites of active star formation, until the 100-micron emissions (shown) and others monitored by IRAS revealed additional detail including the presence of numerous other young stars. (Jagged line is due to missing data.)*

*Viewed when facing the center of our own Milky Way galaxy, stars in the galactic plane (left) are nearly invisible at optical wavelengths (dark band across inset), due to absorption of their light by interstellar dust and gas. IR emissions, however, penetrate the interstellar material, even revealing sources on the galaxy's far side (though the heated dust also glows by IR).*

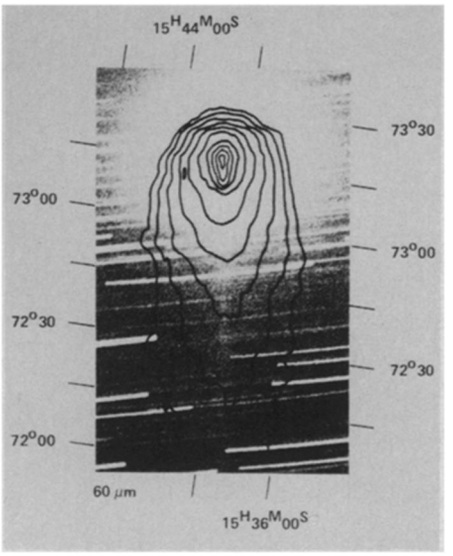


*Painting shows broad ring of dust discovered between the orbits of Mars and Jupiter. Possibly formed of debris from colliding asteroids (or an asteroid and a comet), it appears brightest where particles concentrate at its edges and central region, as shown in IRAS data (below).*




many spiral galaxies, including our own Milky Way. Furthermore, IRAS has been able to spot the formative stages not only of giant stars previously studied from earth, but of objects (such as one in a hydrogen cloud called Barnard 5) expected to collapse into stars no bigger than the sun.

Thanks to the long-wavelength, 100-micron emissions visible to an "eye" beyond the atmosphere, IRAS has been able to reveal a host of other scenes to which terrestrial astronomers heretofore have been literally blind. The center of the Milky Way, for example, has been hidden to visible-light observers on earth (who look in from about 30,000 light-years away) by concentrations of dust and gas that simply block the view. At 100 microns, however, IRAS can see not only details near the center, but formerly unguessed-at sources all the way out on the far side. Elsewhere throughout the galaxy, the data show

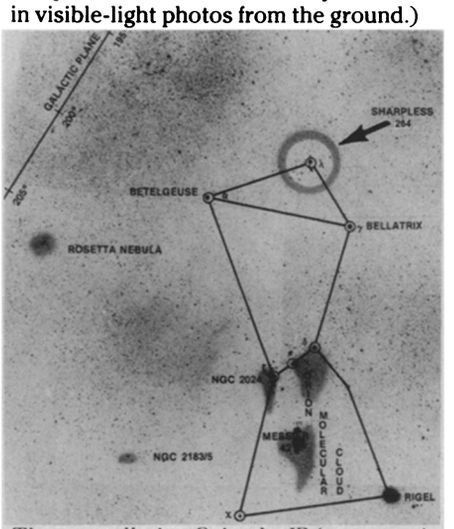



*The extensive, nearly invisible dust tail of comet IRAS-Araki-Alcock (superimposed on a visible-light photo that shows only the comet's thin ion tail) is revealed by IR brightness-contour lines prepared from IRAS data at a wavelength of 60 microns.*

wispy but widespread dust-and-gas clouds that the IRAS team has dubbed "infrared cirrus," as well as a yet-unexplained component of IR background radiation spreading yet more broadly across the sky.

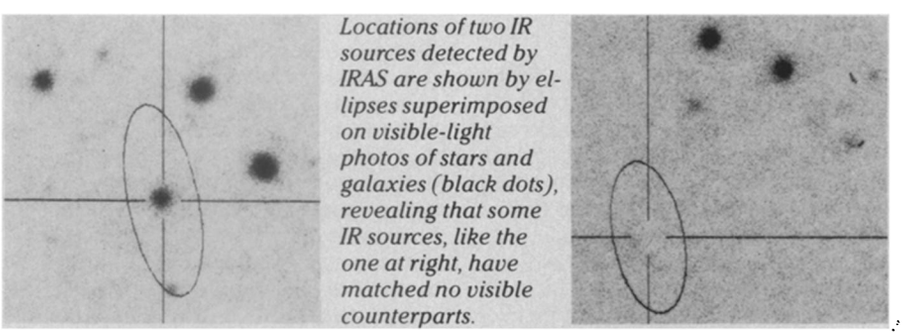
Many of the discrete IR sources detected by IRAS have been readily found to match up with known, visible objects. Many — but not all. An initial study of 133 cold, pointlike sources, for example, turned out to include nine that were clearly visible to IRAS in uncrowded regions of the sky, had no visible counterparts, and could not be identified as objects of any known sort. Subsequent observations have revealed dozens more. Some may be protostars, or old stars hidden by surrounding dust, or even galaxies that for some reason are detectable only by IR (IRAS has found sources whose IR emissions are as much as 100 times brighter than their visible light) — but for now, they are mysteries.

Not all of the satellite's findings are from beyond the solar system. IRAS has been credited with the discovery of five comets and five "minor planets." In four of the minor-planet cases, the phrase is a synonym for asteroids. The fifth, however, designated 1983 TB, has an orbit almost exactly like that of the sun-circling trail of debris whose periodic interceptions of earth's atmosphere produce the well-known Geminid meteor shower. Certain comets are believed to be the "parent bodies" of other such meteor trains, and "it appears," says one scientist, "that IRAS has found the parent body of the Geminid meteors." Yet the object has revealed neither the fuzzy appearance nor the bright tail that would clearly mark it as a comet nucleus. Perhaps, the researchers suggest, it is a "defunct" nucleus, which has been stripped of its volatile material by repeated trips around the sun. Indeed, this would mean that 1983 TB passes closer to the sun — about 15 million kilometers, well inside the orbit of Mercury — than any other known comet. On the other hand, it is merely an asteroid, its greatest distance from the sun — just outside the orbit of Mars — is smaller than that of any other known asteroid. (IRAS has also detected an extensive, 400,000-km tail of debris behind another comet, Tempel 2, which has shown only a faint tail in visible-light photos from the ground.)




*The constellation Orion by IR (see cover) differs greatly from its visible-light appearance (above). Here, the circle corresponds roughly to a huge dust ring (upper part of cover), about 200 light-years across, centered on the star Lambda Orionis in the ionized hydrogen cloud Sharpless 264. On cover, the light-blue dot just outside the ring at about 8 o'clock is the star Betelgeuse (which has an oddly asymmetric dust ring of its own).*

IRAS has also found what appear to be three vast rings of dust around the inner solar system, between the orbits of Mars and Jupiter and arranged one above another like a stack of records. They are believed, however, to be parts of a single, thick ring, which shows three bright regions because of how the particle concentrate at its edges and center. One theory is that the ring, tilted about 9° to the plane of the ecliptic, was produced when a comet, approaching on a path at a 9° angle, hit one of the myriad asteroids in the region, producing a debris cloud that spread out into the ring-shape. —*J.Eberhart*



*Locations of two IR sources detected by IRAS are shown by ellipses superimposed on visible-light photos of stars and galaxies (black dots), revealing that some IR sources, like the one at right, have matched no visible counterparts.*