Asteroid and Comet Dust in Space . . .

The most abundant members of the solar system, the innumerable grains of dust that orbit the sun between all the planets, have also been the most mysterious. Such basic properties of solar system bodies as size, mass, and composition are only educated guesses in the case of interplanetary dust. Even its origin has been a matter of fashion. Most recently, it was assumed that comets provide essentially all interplanetary dust, although only a tenth of the required number of comets are known to exist.

Now there is strong evidence that asteroids contribute a fair share of interplanetary dust. They may even be the dominant source. This new view is based on observations made in 1983 by the Infrared Astronomical Satellite (IRAS). Before IRAS, astronomers' usual perspective on interplanetary dust was much like anyone's on a dark night far from city lights. Just after evening twilight and just before morning twilight, the micrometer-size particles of interplanetary dust scatter the light of the unseen sun into a pyramidal pillar of light whose soft glow may extend from the horizon halfway up the sky before fading to near invisibility.

IRAS's version of this so-called zodiacal light appeared much as expected, except for three vanishingly faint bands of extra brightness. A broad band straddled the ecliptic, the plane in which Earth orbits, and two narrower bands lay on either side. The emission temperature of these bands placed the dust responsible for them within the asteroid belt.

That initial loose connection between dust and asteroids has been largely nailed down. Stanley Dermott and Philip Nicholson of Cornell University have run computer simulations of the view from Earth of over 100,000 dust particles orbiting the sun under the influence of the planets and sunlight. They reported at last month's meeting of the International Astronomical Union in Baltimore that the match between the simulated bands and the IRAS bands is good enough to link them with two specific families of asteroids, the Themis family in the case of the central band and the Eos family with the adjacent bands.

Dermott and Nicholson see the bands as the wisps of dust that must be continually produced as asteroids are slowly ground down by collisions of all sizes. Families of asteroids naturally stand out as dust producers, they say. A family forms when two large bodies collide and destroy themselves, leaving a group of smaller asteroids clustered in similar orbits. The present families formed hundreds of millions or billions of years ago, but interplanetary dust survives only about 10,000 years, so the dust from these ancient catastrophic collisions is gone. Dermott and Nicholson believe today's dust bands are probably the end products of the steady rain of smaller members of the asteroid belt—boulders, pebbles, and larger dust—on the known family members and the unseen smaller debris that must accompany them.

Given that 10% of all known asteroids produce the observed bands, "the whole asteroid belt must produce a large fraction of the dust," said Dermott, "over 50% and maybe a lot more."

Mark Sykes of the University of Arizona's Steward Observatory reported at the meeting that he has also found a good match between bright dust bands and asteroid families. In addition, he managed to split the central band into two pairs of bands, one associated with the Themis family and the other with the Koronis family. Sykes agrees that asteroids contribute a sizable proportion of the dust, but he has a different view of where it happens.

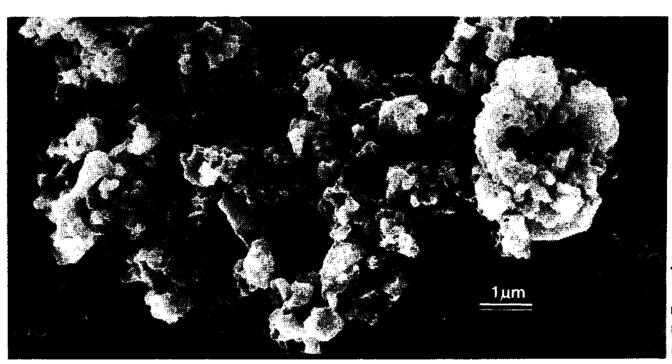
Sykes has found four more pairs of bands in the IRAS observations. Only one of the new band pairs is associated with any of the generally agreed upon families, and some families that would be expected to produce bands, such as the Flora family, do not. Sykes concludes from this that it is not simply a matter of a steady erosion of all the objects in the asteroid belt contributing more or less equally to the observed dust, as Dermott would suggest. Most of the dust comes from the continuing comminution of the unseen debris in the major families and from the comminution of the debris from the collision of less massive asteroids, ones not capable of producing identifiable families.

How the relative roles of a few catastrophic collisions versus widespread erosion can be sorted out remains unclear. Either way, the linking of specific asteroid families to dust production may have some practical implications when researchers come to consider exactly where the extraterrestrial dust collected in Earth's stratosphere comes from. As the following story reports, that dust appears to be about one-third asteroidal. ■ RICHARD A. KERR

. . . And in the Laboratory

An armada of five spacecraft flew by Comet Halley in 1986, but none of them brought back even a speck of comet dust to Earth. Such a comet return mission is at least a decade away. In the meantime, researchers are increasingly confident, thanks in part to analyses made on-the-fly at the Halley encounters, that they have already collected comet dust as it drifted down through Earth's stratosphere. They are also tentatively identifying another portion of the interplanetary dust as asteroid dust.

The most extensive characterization to date of the composition of cosmic dust was reported by Donald Brownlee of the University of Washington last month at the International Astronomical Union meeting in Baltimore. Linda Schramm, Brownlee, and Maya Wheelock, who is now at the University of New Mexico, determined the major element composition of 200 interplanetary dust particles. Analyzing such particles, all of which were between 4 and 40 micrometers in diameter, takes a delicate touch. Using an energy dispersive x-ray analyzer, these researchers consumed just 1 microgram of dust in performing 200 analyses for five major elements.



D. E. Brownlee

Interplanetary dust *collected in the stratosphere appears to come from comets, as pictured here, and asteroids. This fluffy aggregation of mineral grains fits the description of dust studied by the spacecraft that flew by Comet Halley.*