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.

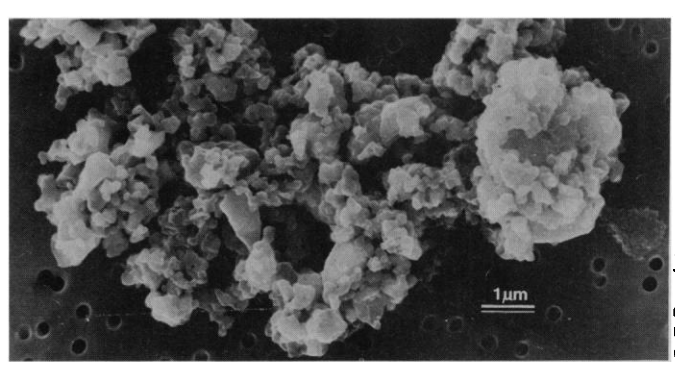
Sykes has found four more pairs of bands in the IRAS observations. Only one of the new band pairs is associated with any of the generally agreed upon families, and some families that would be expected to produce bands, such as the Flora family, do not. Sykes concludes from this that it is not simply 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.



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.*

These microanalyses confirmed that dust particles suggestive of comet dust in appearance also resemble comet dust chemically. The 45% of the particles studied that look the way comet dust is expected to—they are highly porous, laced with an organic tar, and composed of submicrometer mineral grains—have a distribution of compositions that rules out chemical alteration by liquid water. That is consistent with the porous dust being cometary because comets are thought to have been frozen since their formation; the most primitive meteorites, the carbonaceous chondrites, clearly had their original minerals altered by water. The 37% of dust particles that are smooth and nonporous, on the other hand, show clear evidence of alteration by liquid water, just as carbonaceous chondrites do. "It is likely," the group concludes, that the porous particles are cometary and the smooth ones asteroidal.

That conclusion was strengthened by studies of the composition of Halley dust particles as determined by instruments on the Soviet Vega and European Giotto spacecraft that flew through Halley's dust. In the most recent study, Mark Lawler, Brownlee, Scott Temple, who are all at Washington, and Wheelock selected only the highest quality data from the instruments, which identified the elemental ions created when individual dust particles slammed into the spacecraft at 250,000 kilometers per hour.

Looking at the proportions of magnesium, silicon, and iron in about 500 particles, the group concluded that it has "good evidence that Halley is not composed of aqueous alteration material," according to Brownlee. "You can show that Halley is unlike the carbonaceous chondrites, even though the average bulk composition is similar. Halley is more akin to [porous interplanetary dust] particles. They are the best match that we have for Halley."

As confidence grows in the laboratory, more attention might be given to determining which specific objects are being sampled. For example, asteroidal dust collected in Earth's atmosphere may broaden the range of asteroids sampled by the 10,000 meteorites now in hand. They are probably supplied by the few dozen asteroids from which Jupiter's gravity can send objects toward Earth. When compared with the 10,000 meteorites, 85% of interplanetary dust particles, the large majority of asteroids, and Halley dust most closely resemble two classes of carbonaceous chondrites that constitute only 3% of meteorite falls. Wherever asteroidal interplanetary dust comes from, it seems to be more representative of the asteroids than all the known meteorites.

■ Richard A. Kerr

U.N. Considers Biodiversity Convention

Concerned that existing international laws are not sufficient to halt the rapid disappearance of many of the world's species, the United Nations Environment Programme (UNEP) has taken the first step, in what is usually a 10-year process, to draft a new global convention for the conservation of biological diversity.

The proposal is likely to be controversial, as several other global conventions already address biodiversity, and few countries want to add another layer of international bureaucracy or to support another secretariat.

The problem with the existing instruments, according to an ad hoc experts panel that met at UNEP in Nairobi, Kenya, in early September, is that they provide at best only patchwork coverage of biodiversity; thus the need for a new "umbrella" convention to fill in the gaps. No one is thinking of another "motherhood" convention, says Kenton Miller of World Resources Institute, who was on the panel, but rather one with a funding mechanism that can be used for training or for establishing reserves, among other things.

However, getting nations to kick in a substantial share to international agreements has proved difficult in the past. The United States, for one, is notably behind on its payments to all the global conventions and to the United Nations, though the latter is at last being at least partially addressed.

The reason an umbrella convention is needed, says panel member Peter Raven of the Missouri Botanical Garden, is that each of the existing conventions protects only a very small percentage of global biological diversity, and each is signed by a different set of nations. And most of these conventions, like those to protect world cultural and natural heritage, migratory species, and endangered species, were established for other purposes and protect biodiversity as a by-product.

Moreover, while these global and regional conventions add prestige and underscore the importance of certain areas, they do not add much in terms of real estate, or new land, since many of the sites they designate are already protected by national laws. Says WRI's Miller: "The vast majority of sites considered critical for the conservation of biological diversity are not covered by any international agreement."

Perhaps the key element of the convention, as now envisioned, is a funding mechanism to support conservation efforts in countries that could not afford them otherwise. The nations with the greatest diversity are often least equipped to deal with it, financially and technically.

The tricky question, obviously, is where money for the fund will come from. One possibility is voluntary contributions by governments, another is a tax on the use of genetic resources.

As described in the expert panel's draft report, which is just the first of many versions, the convention would also establish a technical committee that would maintain a world list of areas particularly important for biodiversity.

This same technical committee would review grant applications to the fund, which would be used, for instance, for establishing new sites or improving existing ones, for example, as Dan Janzen is doing through restoration ecology in Costa Rica. The fund would also provide long-term financial support, where needed, to the international research and training centers, such as those in Serengeti and the Galápagos Islands.

How well any of this works depends, of course, on how much money there is. Sentiment was strong at the meeting, according to Miller, that "unless there is a firm commitment from governments for a serious funding mechanism, there would be little value to negotiating and launching this global instrument." Miller adds: "We are talking about real money, millions and millions of dollars a year." But those commitments can be hard to extract and harder still to enforce, as the U.S. example makes clear.

The panel, assembled at the behest of UNEP's governing council to advise UNEP on the adequacy of existing conventions and ways to "rationalize" them, included Miller, Raven, Thomas Lovejoy, and Michael Soulé from the United States, and Jeffrey McNealy and Martin Holgate of the International Union for the Conservation of Nature and Natural Resources (IUCN), Reuben Olembo of UNEP, Perez Olindo of Kenya, and David Munro of Canada.

The next step is a meeting of government experts this November in Switzerland. That panel will review the biologists' report and advise UNEP on how it might be shaped into a politically acceptable convention. In the spring Mostafa Tolba, UNEP's executive director, will return to UNEP's governing council with his recommendation. Meanwhile, IUCN is already working on a draft of the convention, incorporating ideas from the Nairobi meeting.

■ Leslie Roberts