Astronomy

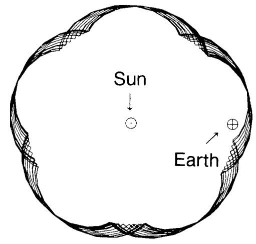
Ron Cowen reports from Boulder, Colo., at the annual meeting of the American Astronomical Society's Division for Planetary Sciences

New link between Earth and asteroids

Astronomers have found indirect evidence that Earth is embedded in a ring of asteroidal dust particles that orbits the sun. According to Stanley Dermott and Sumita Jayaraman of the University of Florida in Gainesville and their colleagues, the ring may funnel asteroidal dust – which includes carbonaceous material that may help foster life – into Earth's atmosphere.

This intriguing conclusion stems from the overlap of two studies – an investigation of the dynamics of interplanetary dust particles and observations taken in 1983 with NASA's Infrared Astronomical Satellite (IRAS), notes Dermott.

Researchers have long known that asteroids collide, creating micrometer-size dust particles. The influence of solar radiation causes the particles to leave the asteroid belt, which lies between Jupiter and Mars, and spiral toward the sun. But on their way they encounter the terrestrial planets – Mars, Earth, Venus, and Mercury. Dust particles may become temporarily trapped in ring-shaped solar orbits, some of which brush past these planets.



Courtesy Arizona State Univ.

Drawing shows location of proposed dust ring, inferred from IRAS data, that would orbit the sun and come close to Earth. The ring may act as a funnel, transporting asteroidal dust into Earth's atmosphere.

Jayaraman and Dermott calculate that about 20 percent of asteroidal dust particles 12 micrometers or more in diameter form such a ring near Earth. Each particle remains trapped in the ring for some 10,000 years, but the ring is constantly replenished by new arrivals. Earth sits in a tiny cavity in the ring.

Their simulation indicates that the portion of the ring trailing Earth is denser and closer to the planet than the part in front. This model, says Dermott, matches exactly IRAS observations that a brighter cloud of dust trails Earth than leads it at all times of the year. The researchers speculate that this dust ring near Earth creates a bottleneck, impeding the passage of particles on their way to the sun and increasing the likelihood that Earth's gravity will pull these bits of asteroids into our atmosphere.

Probing Ida's magnetic personality

When the Galileo spacecraft passed by the asteroid Ida on Aug. 28, it did more than capture close-up images of the rocky body (SN: 10/2/93, p.215). The craft's magnetometer detected several shifts in the direction of the solar wind's magnetic field near the asteroid. The solar wind consists of a stream of charged particles blowing outward from the sun.

Because several types of interactions between Ida and the solar wind could account for the switches in field direction, the data don't prove that the asteroid possesses a magnetic field, cautions physicist Margaret Galland Kivelson of the University of California, Los Angeles. For instance, if the asteroid had sufficient electrical conductivity, it could generate a current that might disturb the solar wind and alter its magnetic field.

Kivelson says that one of the Galileo findings in particular surprised her. Galileo detected a shift in the wind's magnetic field just *before* the craft's closest approach to Ida. She and her colleagues had modeled the solar wind and its magnetic field as a river flowing swiftly through space. The team reasoned that when this river meets an obstacle such as Ida, it drapes around it, creating a disturbance "downstream" from the rocky body. Indeed, Kivelson notes, Galileo detected a downstream disturbance in the solar wind's magnetic field when the craft passed near the asteroid Gaspra two years ago.

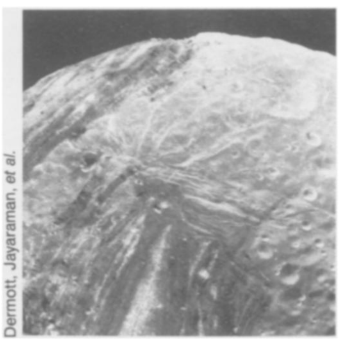
Kivelson suggests that the solar wind's magnetic field near Ida was more closely aligned with the direction of the solar wind than the magnetic field near Gaspra was. She says this could account for the upstream change in the field, which Galileo detected for the five minutes preceding the craft's closest approach to Ida and for a shorter period just after. The nature of the disturbance suggests that it was carried through the solar wind by a so-called whistler wave, which transmits higher frequencies at a faster speed.

In the case of tiny Gaspra, adds Kivelson, analysis has revealed that the area over which the solar wind's magnetic field changed direction was much larger than the asteroid's 14-kilometer diameter. These changes imply that Gaspra may have its own magnetic field.

Miranda: Shattering an old image

Measuring a mere 470 kilometers across, Uranus' moon Miranda has barely enough gravity to maintain its spherical shape. Yet its scarred surface seems more appropriate for a planet 10 times that size. When astronomers got their first close-up view of this icy moon, in images from the Voyager 2 spacecraft in 1986, they were struck by a strange feature – three ovoid regions, now known as coronas, that contain sets of parallel ridges, troughs, and scarps.

Researchers initially proposed that the rough-hewn surface formed because Miranda, after being struck by a comet or other large object early in the history of the solar system, shattered and then reassembled under the influence of Uranus' gravity. That scenario has appeared in several textbooks as well as popular accounts of Miranda's evolution. But in reanalyzing the Voyager images, Robert T. Pappalardo, Ronald Greeley, and Stephen J. Reynolds of Arizona State University in Tempe say they have found evidence to demolish that notion.



Dermott, Jayaraman, et al.

This view of Uranus' moon Miranda shows faulted valleys and icy lava flows within two coronas. Miranda's Arden corona lies at upper left, the Inverness corona at bottom.

Pappalardo and others note that if the breakup theory were correct, the moon's rocky, denser chunks would have sunk toward the reassembled core of the satellite. Internal currents created by the sinking would have formed the coronas by compressing the surface, and the ridges and troughs would represent compressional folds within the coronas. But when he and his colleagues examined the Voyager images using a filter that highlighted Miranda's unusual topography, they found no evidence of compression.

Instead, says Pappalardo, the coronas appear to have formed atop giant upwellings of material from the moon's interior. The alternating ridges and troughs were created when internal forces pulled the surface apart – in much the same way that such features were formed in the American Southwest and on Jupiter's moon Ganymede, he notes.

Images of Miranda's Arden and Inverness coronas indicate that giant blocks of material, some more than 10 kilometers wide, have been tugged apart and rotated like a stack of dominoes to create fault scarps, Pappalardo says. He suggests that tidal stretching and distortion by Uranus' gravity could have supplied the heat source necessary to fuel such uprisings.