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Implications of Asteroidal Satellites

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ASTEROID MOONS MAY HOLD CLUES TO METEORITES

Newly discovered companions to asteroids may help astronomers better understand the properties and origin of meteorites, many of which are thought to be pieces of asteroids.

Asteroids are mostly found in the main asteroid belt, a collection of thousands of rocky objects that orbit between Mars and Jupiter. Some asteroids have orbits that pass near or actually cross the orbit of Earth. Many meteors (called “meteorites” if they land on Earth) are small chunks of rock believed have been broken free during collisions among asteroids of various sizes. These rocks may then be hurled inward toward Earth, primarily by the disruptive effects of Jupiter’s gravity.

A small number of meteorites also come from Mars and the moon, a connection that has been confirmed by chemical analysis of these planetary bodies during past space missions. Making the connection between parent asteroids and the majority of meteorites that fall on Earth is more difficult. However, the recent discovery that some asteroids have moons may lead to answers.

As recently as 8 years ago, there was no definitive evidence that any asteroid was other than a single body on a lonely journey through the inner solar system. Then, in 1993, the Galileo spacecraft, en route to its mission at Jupiter, flew past asteroid Ida. In the process, it spotted a small, 2-km-sized “moonlet” orbiting the 31-km asteroid. This discovery surprised some astronomers, because it was uncertain whether the weak gravity of an asteroid would be enough to keep a moon in orbit.

Since that early spacecraft discovery, however, astronomers have detected about a dozen additional moons of asteroids directly from Earth using new observing techniques on large telescopes as well as with ground-based radar.

The first Earth-based image of an asteroid moon came in 1998, when an international team, led by Dr. William Merline of the Southwest Research Institute in Boulder, Colorado USA, found a 13-km-sized moon in orbit around the 215-km asteroid Eugenia. This discovery was made possible through the use of a revolutionary technique called adaptive optics. When stars or asteroids are viewed through the Earth's atmosphere, they appear blurred, much like viewing an object underwater. Adaptive optics removes the blurring by use of what is effectively a "fun-house" distortable mirror. The resulting images are now comparable with those taken from above the Earth's atmosphere, such as with the Hubble Space Telescope.

Although this method works well for far-away, large asteroids, radar is superior for observing those asteroids that are small and come near the orbit of the Earth. With this technique, radar waves are sent out by a large dish-antenna on the Earth; the waves bounce off the asteroid and are received again by the dish. The size and speed of an asteroid, and any companions, can be detected in this manner.

Small moons of asteroids or even double asteroids are likely formed also by collisions, in much the same way that meteor fragments are created. In this way a smaller broken-off piece of asteroid can end up as a moon circling a larger piece. The study of the types of moons that exist, and the possible ways that they form, is expected to yield clues to the formation of those samples of asteroids that eventually hit Earth as meteorites.

The presence of a moon allows scientists to determine the mass of an asteroid by observing the effects of the primary asteroid's gravity on its small companion. Knowing the mass of an asteroid as well as its size (the size of most asteroids is known), researchers can calculate its density (how heavy the object is for its size). The density then gives a clue to the asteroid's makeup, either in terms of composition or structure.

Once scientists have an idea of the composition or structure of different asteroids, they can then compare these data with the measured composition or structure of different meteorite samples on Earth. The goal is to connect specific meteorite types with their parent asteroid types. The result should be an improved understanding of asteroids and meteorites, without the expense of sending spacecraft to their source.

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Southwest Research Institute is an independent, nonprofit, applied research and development organization based in San Antonio, Texas, with more than 2,700 employees and an annual research volume of $315 million.

The Meteoritical Society is a nonprofit organization founded in 1933 to promote the study of extraterrestrial materials, ranging from meteorites, asteroids, and comets to interplanetary dust and lunar samples. The principal sponsors of the 2001 meeting are: Vatican Observatory (Italy); Lunar and Planetary Institute (USA); Alenia Spazio S.p.A. (Italy); Fondazione Cassa di Risparmio di Torino (Italy); Compaq Italia (Italy), and Kuoni Incoming S.p.A. (Italy).