Astronomy

Ron Cowen reports from Houston at the annual Lunar and Planetary Science Conference

Do asteroids come in pairs?

A new study suggests that when they plow into a planet, a small but significant number of asteroids literally pack a double whammy — because they come in pairs.

Several intriguing observations prompted William F. Bottke and H. Jay Melosh of the University of Arizona in Tucson to analyze paired asteroids. Recent radar studies have shown that some asteroids whose orbits cross Earth's, including Castalia and Toutatis, may be two or more objects barely touching one another. If the components of these "contact binary asteroids" pull apart but remain gravitationally bound, traveling together as they collide with a planet, they might produce the double craters detected on Earth, the moon, and, most recently, Venus.

To produce two distinct craters, the asteroids must break apart well in advance of a collision. Neither atmospheric friction nor the tidal force encountered by an asteroid just before it strikes a planet would draw the fragments far enough apart to make separate impacts.

But most asteroids pass by a planet one or more times before colliding with it. After a number of such near misses, tidal forces from the planet can pull apart a binary asteroid and create two or more well-separated fragments. Indeed, Jupiter's tidal force broke Comet Shoemaker-Levy 9 into more than 20 large chunks 2 years before the comet crashed into the giant planet.

The breakup of a contact binary asteroid leads to one of three possible outcomes, says Bottke. The pieces may part company altogether, collide and merge, or pair off in orbit around each other. For example, the Galileo spacecraft recently discovered a tiny moon orbiting the asteroid Ida. Only in the third case will the fragments have the chance, should they eventually strike the planet, to create two neighboring craters.

In their computer simulation, Bottke and Melosh traced the evolution of thousands of contact binary asteroids that were initially far from Earth but came within 5 Earth diameters of our planet. Depending on their initial velocity, many of the binaries ended up as well-separated fragments orbiting each other.

Extending their model further, the Arizona scientists find that among binaries eventually striking Earth, 5 percent have the minimum separation required to form crater pairs. That's an intriguing number, Bottke notes, because it's close to the actual percentage of large, paired craters on Earth.

The computer simulation began with the assumption that all asteroids big enough to make craters more than 20 kilometers across were contact binaries. This premise was only intended as a crude approximation; however, the close agreement between the model and the number of large crater pairs on Earth suggests that most large, near-Earth asteroids are binaries, Bottke speculates. If he's right, then asteroids such as Toutatis may prove commonplace rather than atypical oddballs. Moreover, many asteroids may have a moon orbiting them.

If double asteroids have struck Earth, it seems likely that such pairs would also have bombarded Venus, notes Cheryl M. Cook of the University of Arizona. Examining Magellan radar images of Venus, Cook, Melosh, and Bottke found that among large craters there, only 2.5 percent, or one-fourth the terrestrial percentage, come in pairs. Cook suggests that the smaller members of some asteroid binaries disintegrated in Venus' thick atmosphere instead of striking the surface.

JPL/NASA

Magellan radar image shows crater pair on Venus.

Technology

A swell gel

The quest for "smart" synthetic tissues, which can respond to changing conditions inside a human body, rests on the capacity of materials to react to their environment. In the case of artificial heart valves or muscle tissue, scientists want a material that can expand and contract quickly on demand.

With this in mind, biomedical engineer Teruo Okano of Tokyo Women's Medical College and his coworkers have come up with a new spongelike material. In the March 16 NATURE, the team reports that when this new polymer hydrogel absorbs and expels water, it swells and shrinks faster than other materials designed for the same purpose. This feat results from "tailoring the gel architecture at the molecular level."

The material has specially crafted, crosslinked molecules, or "comb-type grafts," they say. These molecules, vaguely resembling combs, have long polymer chains studded with small, toothlike side chains. The small side chains contain surfaces that help to expel water as the material shrinks.

"Whereas similar gels lacking the grafted side chains can take more than a month to undergo full de-swelling, our materials collapse in about 20 minutes," the researchers state.

Batteries lose weight

Batteries are heavy, an annoying fact that makes many portable devices hard to lug around. Weighty power sources limit the range of many machines, from electric cars and motorized wheelchairs to laptop computers.

The crux of the problem lies in energy density — that is, how much power one can pack into a small place. Generally speaking, the higher the energy density, the lighter the battery.

Reporting in the Feb. 16 NATURE, Noboru Oyama, a chemist at the Tokyo University of Agriculture and Technology, and his colleagues describe a new type of rechargeable lithium battery with a peak energy density 50 percent greater than the best commercially available lithium batteries.

Specifically, the new battery operates with an energy density of 600 watt-hours per kilogram, compared to 400 for standard lithium cells. Performance tests show that the new battery holds up well in continued use. Even after 100 rechargings, it retained 80 to 90 percent of its original capacity, tests reveal.

The key to the new battery lies in a "composite organic cathode," based on a mixture of dimercaptan and polyaniline. "The use of organic materials has attracted interest," the scientists say, because they combine high energy densities "with low weight and good mechanical strength."

These features, they conclude, are likely "to prove advantageous in applications where weight, rather than volume, is a critical factor."

A bicycle built for you

A wearying haul up that long hill — panting, perspiring. No one wants to be a pedal pusher on a bike in the wrong gear.

What if a bicycle could handle all that gear shifting for you?

Ezra Gold, a mechanical engineer at the University of Rochester (N.Y.), and his coworkers have built a "smart" bike that indeed shifts gears automatically. Taking cues from the rider and the terrain, a special computer chip measures how fast the cyclist is pedaling, how fast the wheels are going, and how taut the chain is.

The computer gets to know the cyclist's habits — how fast he or she likes to pedal — and puts the bike into the best gear.

The shifting system (with its chip, small motor, and two 7.2 volt batteries) weighs less than 2 pounds and would cost about $200, the team reports. "This lets the rider keep the right cadence," says Gold, an avid cyclist. "It's also easier to ride."