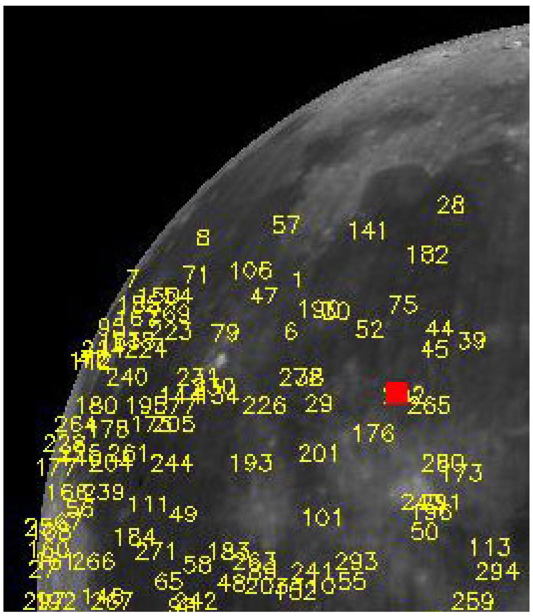
Lots of Rocks Hit the Moon and Mars

High-definition images of the Moon and Mars show that their surfaces take hundreds of hits each year from space rocks.

Last week I wrote about the brightest lunar impact ever captured by a research team at NASA's Marshall Space Flight Center. The March 17th blast momentarily reached 4th magnitude — it might have been observable to a keen-eyed observer just looking at the Moon.



Over an 8-year span, observers with NASA's Meteoroid Environment Office used 14-inch telescopes to record nearly 300 impact flashes on the Moon. A red dot marks a very bright one on March 17, 2013. Click on the image for a larger view.
NASA / MEO

Based on that bright flash, the team estimates that the wayward space rock was perhaps the size of a beach ball. In this case, the team assumes the impactor one member of a salvo, traveling through space with others seen streaking through Earth's atmosphere at roughly the same time. Given that, they deduced a common orbit and an impact velocity of 57,000 miles per hour (25.6 km per second).

But converting the brightness of an impact flash to mass and velocity is something of a black art, one often applied to bright fireballs in Earth's atmosphere (February's megameteor over Russia, for example). Many of the hundreds of other lunar flashes seen throughout the NASA team's eight years of observations occurred during meteor showers such as the Geminids, so their impact velocity was known. Even so, the impactors' sizes are really educated guesses.

Fortunately, the advent of supercameras on orbiting spacecraft — LROC on the Lunar Reconnaissance Orbiter and HiRISE on the Mars Reconnaissance Orbiter — has made it possible to identify hundreds of fresh but very small impact craterlets on both the Moon and Mars. These offer a much tighter constraint on the kinetic energy of each strike and, from that, better estimates of the impactors' sizes.

LROC has been recording details on the Moon down to 8 inches (20 cm) for nearly four years, and it's starting to see lots of lunar real estate with nearly identical illumination. Shane Thompson and Mark Robinson (Arizona State University) have combed through the camera's thousands of images and turned up 69 "temporal anomalies" that are definite or likely cratering events. About 20% of these show distinct craters, the largest 24 feet (7.3 m) across. A summary of their work to date reveals two striking results (no pun intended).

First, most of the fresh markings are *darker,* not lighter, than the background surface. We've all been taught that fresh lunar craters kick up a splash of light-toned dust that gradually darkens with exposure to radiation. But apparently, at least for the small fry, that's not usually the case. Thompson notes that these murky smudges aren't in known lava deposits covered by a layer of disguising dust ("cryptomare"), so their origin is a mystery. (Curiously, both GRAIL spacecraft churned up dark ejecta when they struck the Moon last December.)

The second eye-opener is that Thompson and Robinson found so many cratering candidates in just 31 pairs of images. Based on those statistics, they estimate that the Moon gets peppered with 180,000 impacts per year that could be picked out by LROC's high-resolution camera. This corresponds to about one hit annually in an area the size of the District of Columbia — the kind of frequency that would pose a small but very real risk of damage to future lunar colonies.

In the case of Mars, the crater-hunting challenge is a little easier because the planet's atmosphere, though quite thin, keeps the ejecta suspended longer and thus helps to expand the surface area disturbed around each strike. The first reports of newfound craters came from the Mars Orbiter Camera, which spotted 20 impacts — the largest 500 feet (150 m) across — over a 7-year stretch.

HiRISE researchers recently detailed the 248 fresh impact craters they've spotted on the Martian surface over the past decade. Based on those finds, Ingrid Daubar (University of Arizona) and others estimate that each year the Red Planet gets more than 200 new craters at least 12.8 feet (3.9 m) across. More than half of the impacts in this size range form clusters. These are created by strikes by asteroid or comet fragments no more than 3 to 6 feet (1 to 2 m) across.

Put another way, each year Mars gets one crater of that size or larger for every 230,000 square miles (600,000 km^2) of its surface. That's actually well below the rate expected by extrapolating downward to such small sizes from counting larger craters. As Daubar and others note in the July issue of *Icarus,* they might be overlooking a few new pits in dusty areas. But more likely, they conclude, "order-of-magnitude uncertainties persist" in our ability to model the planet's long-term cratering rate, especially at small diameters.

Posted by Kelly Beatty, May 29, 2013