

Why the Meteor Hit the Moon

"Come, behold the works of the LORD" (Psalm 46:8)

On September 11, 2013, an approximately 1 meter-meteor hit the Moon at close to 40,000 mph, creating a crater 50 meters wide. The glow from its impact explosion lasted 8 seconds and was the brightest flash of light ever recorded on the Moon. Humans looking in that direction could have seen it with the naked eye. The event was caught on camera and can be seen at http://www.slate.com/blogs/bad_astronomy/2014/02/24/lunar_impact_video_of_an_asteroid_hitting_the_Moon.html.

The Earth is much larger than the Moon, and so its gravitational pull is much stronger. For that reason we get hit by several meter-sized meteors several times a year even while no one ever notices a thing. The major explosion over Chelyabinsk, Russia the same year, from which a thousand people were injured, was, by contrast, caused by a meteor estimated to be 19 meters across (and therefore nearly 20 times the diameter of the "Moon-bomb"). So to the question why the Moon got hit on September 11 (ironically), the short answer is as simple as the answer to why a chicken might not in the end succeed in crossing the road. That meteor hit the Moon because the Moon was right in the way of its journey to the other side of the solar system!

The longer answer to the question, however, is much more interesting. To get there, I want to share a recent discovery of mine as the result of a reading assignment for the class, "Historical Perspectives in Science and Religion," for my *Science and Religion* MA degree program. It was my delight to read Galileo's account of the first time he ever looked at the Moon through a telescope (which, of course, was the very first time *ever* that anyone *in history* had seen the Moon magnified *at all!*). Portions of his 1610 pamphlet, "The Starry Messenger," can be read in the article, "Neither Known Nor Observed by Anyone Before," from Dennis Danielson, ed., *The Book of the Cosmos*, (Perseus, 2000), p.145f. The magnitude (no pun intended) of his discoveries are better understood by first clarifying the hindering role that Aristotle's (384-322 BC) cosmology played in the apprehension of the heavens many centuries later in Galileo's time (1564-1642 AD). Aristotle believed, and the Western world for 2,000 years largely accepted, that the heavenly bodies above, including the Moon, belong to a realm altogether separate from the natural laws and conditions on Earth. These bodies were characterized as unchanging, perfectly smooth, and perfectly round spheres (corresponding to the Greek notion of ideal shapes and forms).

Galileo, by contrast, wrote after his lunar observations, "[I do not] *perceive the surface of the Moon to be perfectly smooth, free from inequalities and exactly spherical (as a large school of philosophers believes concerning the Moon and other heavenly bodies), but to the contrary to be full of inequalities, uneven, full of hollows and protuberances. It is like the surface of the Earth itself, which is everywhere varied with lofty mountains and deep valleys...The grandeur, however, of such prominences and depressions in the **Moon seems to surpass both in magnitude and extent the ruggedness of the Earth's surface***" (p.147,8, **boldface mine**).

What science had yet to discover in Galileo's time, was that the depressions he observed through his scope were in fact craters that were caused by the impact of explosions from meteors hitting the Moon's surface, utterly un-impeded by an atmosphere (the Moon has none). Earth's far stronger gravity attracts many more times the number of meteors than does the Moon. That doesn't mean that the Moon never gets hit at all. But the atmosphere on Earth burns up the vast majority of them before they could ever reach its surface. Consequently Earth has few such depressions ("Meteor Crater" in Arizona is one example) to show for its entire bombardment history.

So the *real* question of how the meteors aimed at the Moon make it *all the way to its surface*, has a simple and obvious answer: it has no atmosphere in place that will cause them to burn up and disintegrate. Nevertheless, from our vantage point as Earthlings this answer ought to amaze and fill us with gratitude for our own living arrangements. The entire range of benefits that result from the possession of an atmosphere of the kind that we happen to enjoy on Earth, is too lengthy to describe in this essay. But this exhaustive list of benefits must surely include the *protective* aspect of our atmosphere which prevents such harmful objects from otherwise making their way to the surface, thereby bringing damage to such a degree that life here on Earth would be impossible.

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