Research shows why meteoroids explode before they reach Earth

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Our atmosphere is a better shield from meteoroids than researchers thought, according to a new paper published in *Meteoritics & Planetary Science*.

When a meteor comes hurtling toward Earth, the high-pressure air in front of it seeps into its pores and cracks, pushing the body of the meteor apart and causing it to explode.

"There's a big gradient between high-pressure air in front of the meteor and the vacuum of air behind it," said Jay Melosh, a professor of Earth, Atmospheric and Planetary Sciences at Purdue University and co-author of the paper. "If the air can move through the passages in the meteorite, it can easily get inside and blow off pieces."

Researchers knew that meteoroids often blew up before they reach the Earth's surface, but they didn't know why. Melosh's team looked to the 2013 Chelyabinsk event, when a meteoroid exploded over Chelyabinsk, Russia, to explain the phenomenon.

The explosion came as a surprise and brought in energy comparable to a small nuclear weapon. When it entered Earth's atmosphere, it created a bright fire ball. Minutes later, a shock wave blasted out nearby windows, injuring hundreds of people.

The meteoroid weighed around 10,000 tons, but only about 2,000 tons of debris were recovered, which meant something happened in the upper atmosphere that caused it to disintegrate. To solve the puzzle, the researchers used a unique computer code that allows both solid material from the meteor body and air to exist in any part of the calculation.

"I've been looking for something like this for a while," Melosh said. "Most of the computer codes we use for simulating impacts can tolerate multiple materials in a cell, but they average everything together. Different materials in the cell use their individual identity, which is not appropriate for this kind of calculation."

This new code allowed the researchers to push air into the meteoroid and

let it percolate, which lowered the strength of the meteoroid significantly, even if it had been moderately strong to begin with.

While this mechanism may protect Earth's inhabitants from small meteoroids, large ones likely won't be bothered by it, he said. Iron meteoroids are much smaller and denser, and even relatively small ones tend to reach the surface.

Provided by Purdue University