Some small asteroids can abruptly explode

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Impact of asteroid 2023 CX1 on February 13, 2023, as seen from the Netherlands. Credit: Gijs de Reijke

Some asteroids are more dangerous than others, according to a report published in *Nature Astronomy* by an international team of researchers, led by astrophysicist Auriane Egal of the Montreal Planetarium in Canada. The team had presented their findings of an investigation into

the impact of small asteroid 2023 CX1 over France in February 2023. This new paper revealed that small asteroids can explode on atmospheric entry.

"The asteroid was discovered in space about seven hours before entering Earth's atmosphere over Normandy," said astronomer and senior author Peter Jenniskens of the SETI Institute and NASA Ames Research Center. "I immediately phoned my brother in the Netherlands, who went outside and saw the fireball."

Other observers were alerted to the imminent impact and recorded spectacular images and videos of the resulting meteor.

"Our team determined that the asteroid was nearly spherical and measured about 72 centimeters in diameter, just under a yard," said Egal. "It had an estimated mass of about 650 kg."

That photographic and video data revealed that the calculated asteroid orbit was slightly off because not all observatories reported their elevation in the same geodetic framework. This has since been corrected.

"This was the third announced impact over land," said Jenniskens, who had earlier guided the recovery of the first two impacts of asteroids 2008 TC3 in Sudan and 2018 LA in Botswana.

For this fall, Jenniskens teamed up with astronomer François Colas of the Paris Observatory, the lead of the FRIPON fireball camera network. They guided a team of volunteers from FRIPON/Vigie-Ciel to their first find just hours after arriving in the small town of Saint-Pierre-le-Viger in Normandy.

"This recovery was difficult because of strong winds that blew the

meteorites off course," said Jenniskens. "The atmosphere tends to sort the stones by mass, but the first stone found was much heavier than I had expected, so we still didn't quite know where the center line of the strewn field was located."

Second recovered meteorite from asteroid 2023 CX1, found by Peter Jenniskens in searches with astronomer François Colas (right) and volunteers. Credit: Peter Jenniskens

After scanning the area systematically with a group of about 12 searchers from FRIPON/Vigie-Ciel, Jenniskens himself found the second meteorite, a small 3-gram mass, late the next day, a meteorite

that is now in the Natural History Museum in Paris.

"The meteorite was so small that it only stood out because the rock sat on top of moss in short grass," says Jenniskens. "With a large stone on one end and a small stone on the other, that finding established the location of the strewn field."

Analysis showed that the meteorite was a common type—the most frequently falling and recovered on Earth—a low-iron 'L-type' ordinary chondrite.

"Such types are also common among larger asteroid impacts," said Jenniskens. "What made this impact unusual was the bright double flare towards the end of the fireball."

The team concluded that this particular asteroid held together well until deeper in the atmosphere, where it lost 98% of its kinetic energy in a fraction of a second.

"The asteroid disintegrated abruptly around 28 km altitude, generating a concentrated spherical shock wave," said Egal.

Calculations performed at NASA Ames Research Center by co-author Darrel Robertson showed that the area affected by high overpressures was four times larger than for a typical asteroid impact, where the energy is released over a longer distance, starting higher in the atmosphere. The closer the blast occurs to the ground, the more pronounced these differences will be.

"Our team confirmed the existence of a new population of asteroids linked to L-type chondrites, capable of fragmenting abruptly in the atmosphere and releasing almost all their energy at once," said Egal. "Such asteroids must be accounted for in planetary defense strategies, as

they pose an increased risk to populated areas."

More information: Auriane Egal et al, Catastrophic disruption of asteroid 2023 CX1 and implications for planetary defence, *Nature Astronomy* (2025). DOI: 10.1038/s41550-025-02659-8.

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