

PDC2025
Stellenbosch, Cape Town, South Africa

□ Earth Impact Effects & Consequences

Ab initio strewn field for small asteroids impacts

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Keywords: *imminent impactors, strewn field, meteorites*

In recent years, eleven small near-Earth asteroids were discovered a few hours before colliding with Earth. They were all about one meter in diameter and they all disintegrated in the atmosphere, generating bright fireballs without causing damage. In some cases – namely 2008 TC₃, 2018 LA, 2023 CX₁, and 2024 BX₁ – several meteorites have been recovered. In cases like these, it is not always possible to triangulate the fireball generated by the asteroid fall as taken by on-ground cameras to circumscribe the strewn field position. For this reason, it is important to compute a strewn field *ab initio* [1], i.e. by propagating the asteroid trajectory in the atmosphere starting from the initial conditions at 100 km altitude obtained directly from the heliocentric orbit, coupled with some reasonable hypotheses about the mean strength and the mass of the fragments to sample the strewn field.

By adopting a simple fragmentation model and a real atmospheric profile, useful results can be obtained to locate the strewn field, as we showed for the recent falls of asteroids 2023 CX₁, 2024 BX₁ and the historical case of 2008 TC₃. It was possible to locate the strewn field of our study cases with an uncertainty of the order of one kilometer with a mean strength in the range 0.5 - 5 MPa and the mass of the possible final fragments in the range 1 g - 1 kg. We finally give possible strewn fields of two other recent asteroids discovered before impact: 2022 WJ₁, impacted near Toronto, and 2024 XA₁, impacted over the Sakha Republic (Russia) [2].

[1] Carbognani et al. (2025), *Ab initio strewn field for small impacting asteroids*, Icarus 425

[2] Gianotto et al. (2025), *The fall of 2024 XA₁ and the location of possible meteorites*, submitted for publication

Comments:

Oral presentation preferred over poster