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# Telescope-to-Fireball Characterization of Earth Impactor 2022 WJ1

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The sixth-discovered Earth Impactor, 2022 WJ1, was a meter-scale near-Earth asteroid found only hours before it contacted the upper atmosphere over the Great Lakes in November of 2022. In this presentation, we will describe our international observational campaign to understand WJ1 as an asteroid in space (through photometric observations with the 4.3 m Lowell Discovery Telescope) and how it broke up in the atmosphere (through video observations with a network of ground-based meteor camera stations). Connecting asteroidal observations to fireball data provides ways to debias both datasets, from a clearer understanding of what kinds of meteorites might be on the ground to the mechanical properties of the smallest asteroids that are usually inaccessible to remote sensing techniques.

Both sets of analyses appear to be in broad agreement – the fragmentation profile of the fireball, its photometric mass, and the asteroid photometric colors indicate an object with a stony composition, likely analogous to the ordinary chondrites. This implies a moderate albedo (~25%) for the asteroid, and thus makes 2022 WJ1 the smallest designated asteroid meaningfully characterized in space – less than half a meter in diameter. The in-space and fireball-derived pre-impact orbits for the object are statistically identical, and while much of the smaller 1 - 100 g meteorites are likely underwater in Lake Ontario, the main ~20 kg fragment landed on the ground and is yet to be found. This was the first time an object was detected in space and so thoroughly characterized by ground-based facilities so thoroughly (now followed by a second event in France, 2023 CX1). This kind of event will become much more common thanks to upcoming surveys.

We will present and elaborate on these results as well as constraints on the rotation rate of WJ1 prior to contact with the atmosphere, refinement of the fragmentation modeling and relative movement of the individual fragments, as well as lessons learned on how best to characterize these rare events.