PROBING THE MASS OF METEOROIDS BASED ON WELL-KNOWN IMPACTS WITH THE EARTH S. Anghel[1,2], M. Birlan[1,2], D. A. Nedelcu[1,2], [1]Astronomical Institute of the Romanian Academy, 5 - Cutitul de Argint Street, 040557 Bucharest, Romania (Simon.Anghel@astro.ro), [2]IMCCE, Observatoire de Paris, PSL Research University, CNRS UMR 8028, 77 Av. Denfert-Rochereau, 75014 Paris Cedex, France.

Introduction: The Earth's atmosphere is constantly bombarded by cosmic objects, including meteoroids, which interact with air particles upon entry. Despite their small size, these objects carry significant implications for understanding the Earth's impact history. To better understand the size and frequency of impacts, calibrated multi-detector observations are essential, spanning from cameras [1] to infrasound arrays and seismic detectors.

Purpose: This study delves into techniques for measuring the pre-atmospheric mass of meteoroids, focusing on those with trajectories well-documented which were also the subject of successful meteorite recovery campaigns. Specifically, we address meteoroids causing ton TNT-scale atmospheric impacts [2], where widespread detection methods (e.g. infrasound, seismic) may exhibit limitations, leading to poorly constrained mass estimates e.g., [3], [4].

Methodology: First we obtained the meteoroid-derived measurements from existing literature, along with their calibrated energy in the visible spectrum (light curve). Next, we computed the total radiated light during the disintegration and the kinetic energy based on the velocity and mass estimates given by the authors.

Results & Discussion: An empirical relation was derived between source energy and optical energy (Figure 1), revealing a strong correlation between kinetic energy at entry and the object's capability to radiate light during deceleration, despite the variations in fragmentation and ablation profile. The obtained relation offers a more constrained method [2], which can be used for refining other widespread methods able to estimate the size of Earth impactors.

Conclusion & Implications: The resulted relation contributes to refining existing models, for more frequent, lower scale impactors. Moreover, the applicability of this relation extends beyond camera-based methods, offering opportunities for calibrating the light of larger impactors with the use of radiometers [6] or next-generation lightning mappers [7]. By coupling these advancements with trajectory triangulation from ground-based fireball networks e.g., [1], [8], [9], we can obtain accurate distribution of meteoroid masses. This, as a consequence, will facilitate cross-calibration of detection methods, thus, informing assessments of the size-frequency distribution of impacts. Ultimately, this knowledge aids in safeguarding Earth's infrastructure against potential threats posed by cosmic impacts, and fill the gap in the size-frequency distribution of objects in the Solar System.

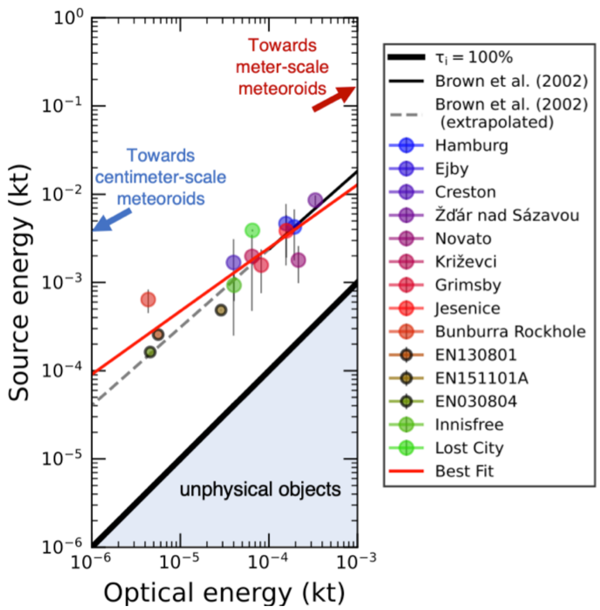

Figure 1. *The source energy vs radiated energy correspond- ence for the well-known list of bolides. The thick line repre- sents a luminous efficiency of 100%. The relation presented by [5] is extrapolated to this low energy regime using a dotted line. The red line represents the best fit line thorough the data.*

References: [1] Colas F. et al. (2020) *Astronomy & Astrophysics* 644:A53. [2] Anghel S. et al. (2021a) *Monthly Notices of the Royal Astronomical Society* 508:5716. [3] Edwards W. N. et al. (2006) *Journal of Atmospheric and Solar-Terrestrial Physics* 68:1136. [4] Ens T. A. et al. (2012) *Journal of Atmospheric and Solar-Terrestrial Physics* 80:208. [5] Brown P. G. et al. (2002) *Nature* 420:294, [6] Rault J. L. and Colas F. (2019) *arXiv*: 1911:04290. [7] Stuhlmann R. et al. (2005) *Advances in Space Research* 36:975. [8] Anghel S. et al. (2021b*) in LPI Contributions Vol. 84*, Abstract #6027. [9] Vida D. et al. (2021) *Monthly Notices of the Royal Astronomical Society* 506:5046.