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Results from the EU-ESA workshop on size determination of potentially hazardous near-Earth objects

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In November 2024, ESA's Planetary Defence Office (PDO) organized the EU-ESA workshop on size determination of potentially hazardous near-Earth objects, held at ESOC in Germany [1]. The workshop explored how the minor body community can improve the size determination of NEOs. For an Earth impacting object, its size is the key factor in assessing potential ground damage [2]. Newly discovered objects lack detailed physical information and their size is poorly defined. This can lead to scenarios where an object may either be considered harmless, or require the evacuation of populated areas.

Key representatives from the photometric, thermal infrared, polarimetric, and stellar occultation communities were gathered. For each field, review talks were provided and methods to obtain the size or the albedo were presented and discussed.

Asteroid size estimates from photometric observations are often poorly characterized due inconsistent data. Size is derived from the absolute H_{V} magnitude, geometric albedo p_{V}, and equivalent diameter [3], but determining H_{V} requires phase curve modeling and low phase angle observations [4], which are often not available for NEOs. Even low phase angles can be observed, data remain sparse. To address this, surveys could target fields where known objects are at their lowest phase angle, optimizing observation sequences without reducing overall scientific returns. Additionally modern model

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like H, G_1, G_2, [5] should be utilized, as they can provide albedo information when sufficient data is available to constrain the G parameters.

In thermal infrared, the size is obtained directly by modeling the absolute thermal emission flux of the object, which depends on its temperature and size [6]. The community stresses that it is important to remember that thermal infrared measures the size and not the albedo [7]. The result of the discussion points to the need for a consolidated database aggregating all the thermal infrared observations obtained not only by all the space missions but also by the ground-based observatories.

The main advantage of polarimetric observations is their ability to determine an object's albedo independently of its size [8]. Unlike both the $H_{\rm V}$ absolute magnitude, and thermal infrared observations, polarization is not affected by the object's instantaneous cross-section on the sky. Polarimetry was recognized as the preferred technique to obtain albedos of NEOS. While $H_{\rm V}$ estimates from photometric observations remains the simpliest method for determining the size of NEOs, efforts should focus on equipping large telescopes with more polarimeters. This would improve the albedo-polarimetry calibration, and allow polarimetric observations of recently discovered, potentially hazardous objects. Notably, while $H_{\rm V}$ is still needed to estimate an object's size, combining polarimetric and thermal observations may allow full characterization of an object without it.

Stellar occultation was also highlighted as a crucial technique to obtain direct size measurement of NEOs.

We would like to deeply thank all the participants of the workshop without whom this work would not have been possible. The list of participants, the presentations and the recordings of the talks can be found on the website of the event[1].

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