THE ASTEROID CRITICALITY INDEX: AN ASTEROID RAKING TO EASE THE PLANNING OF FUTURE SPACE MISSIONS. M. Fenucci[1], B. Novaković[1]. [1]Department of Astronomy, Faculty of Mathematics, University of Belgrade, Studentski trg 16, 11000 Belgrade, Serbia.

Introduction: Today, more than one million small Solar System's objects are known, and digging into the large amount of available data is not always an easy task. For this reason, the need for ranking and prioritization to help navigating into asteroid databases has grown during the last decade. Several asteroid rankings have been developed so far, each of them having a different purpose and addressed to different kind of audiences. For instance, the Palermo Impact Scale [1] ranks potential impact events, and it is addressed to professional astronomers. Follow-up priority lists [2] have been developed to optimize the realization of astrometric observations, and it is designed for amateur and professional astronomers. Moreover, the interest in the exploitation of resources stored on asteroids has grown with the advent of private space companies, and for this reason a raking of mining-mission targets has been recently developed [3].

When planning a small-body space exploration mission, the large amount of data gives us the opportunity to choose among a large variety of targets. However, determining which one realizes the best costs-to-benefits ratio is still challenging. In this abstract, we introduce the concept of Asteroid Criticality Index (ACI), i.e. an asteroid ranking that evaluates how important an object is to be studied by means of a space mission, that could help in the planning and implementation of future small-body missions.

The Asteroid Criticality Index: To evaluate the relevance of a small body for a space mission, the ACI takes into account: 1) the scientific knowledge returned; 2) the impact threat caused by the small body; 3) the value of in-situ resources; 4) the accessibility of the object. Due to this general definition, the index is addressed to a wide audience, including the planetary science community, public and private space companies, and policy makers. In addition, it could be used as a tool to ease the communication and support the endorsement of the public opinion.

The ACI is designed for the population of near-Earth and main-belt asteroids, main-belt comets, Jupiter-family comets, and Jupiter Trojans, and it is defined as

$$\mathrm{I_{crit}} = w_1 \mathrm{I_{sci}} + w_2 \mathrm{I_{imp}} + w_3 \mathrm{I_{res}} + w_4 \mathrm{I_{acc}}$$

where $\mathrm{I_{sci}}$, $\mathrm{I_{imp}}$, $\mathrm{I_{res}}$, $\mathrm{I_{acc}}$ are functions assuming values between 0 and 1, and measuring the scientific return, the impact threat, the value of the resources, and the accessibility of a given object, respectively. The values w_i, $i = 1,2,3,4$ are positive weights such that their sum is unitary.

Scientific relevance. Asteroids and comets are small bodies that did not accrete, and most of them suffered less changes than planets and major moons since their formation. Their exploration could therefore reveal answers on the origin of the Solar System, and on how life on Earth started. The term $\mathrm{I_{sci}}$ evaluates the importance of a small body to understand: 1) the formation process and the initial conditions of the Solar System; 2) the evolution of the Solar System; 3) the processes in an active Solar System; 4) the delivery of elements to sustain life.

Impact threat. Near-Earth asteroids pose a threat because they may impact the Earth, causing significant damage to people and infrastructure [4]. The term $\mathrm{I_{imp}}$ evaluates the relevance of a given asteroid for planetary defense purposes, taking into account its probability of impact with the Earth.

Value of resources. Small bodies are considered to be reservoirs of raw materials such as semiconductors, volatiles and water, and rare platinum group metals. These materials could be either processed in-situ, enabling otherwise unaffordable missions, or collected and brought back to Earth. The term $\mathrm{I_{res}}$ of the ACI estimates the value of in-situ resources, according to the known information about size and composition.

Accessibility. The most relevant parameter indicating the feasibility of a space mission, in terms of costs, is the total impulse needed (ΔV) to reach the target. The term $\mathrm{I_{acc}}$ evaluates the accessibility of a small body through a ΔV estimation of a rendezvous transfer orbit [5].

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References: [1] Chesley S. R. et al. (2002), *Icarus*, 159, 423-432, [2] Boattini A. et al. (2007), *Earth Moon and Planets,* 100, 31-41, [3] Xie R. et al. (2021), *Acta Astronautica,* 181, 249-270. [4] Popova O. P. et al. (2013), *Science*, 342, 1069-1073. [5] Taylor A. et al. (2018), *Acta Astronautica,* 146, 73-82.