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Constraining the cratering rates on large asteroids using VLT/SPHERE observations

A. Drouard (1), P. Vernazza (1), M. Brŏz (2), L. Jorda (1), M. Marsset (3), B. Carry (4), J. Hanuš(2), M. Viikinkoski (5) and the HARISSA team.
(1) Aix Marseille Univ, CNRS, CNES, Laboratoire d'Astrophysique de Marseille, Marseille, France (alexis.drouard@lam.fr)
(2) Institute of Astronomy, Charles University, Prague, V Holešovičkách 2, CZ-18000, Prague 8, Czech Republic (3) Department of Earth, Atmospheric and Planetary Sciences, MIT, 77 Massachusetts Avenue, Cambridge, MA 02139, USA (4) Université Côte d'Azur, Observatoire de la Cote d'Azur, CNRS, Laboratoire Lagrange, France (5) Department of Mathematics, Tampere University of Technology, PO Box 553, 33101, Tampere, Finland

Abstract

Cratering rates have been shown to be a powerful tool to both study the collisional history of the Solar System [1, 2] and understand the surface evolution of small bodies [3, 4]. Although space missions have been so far the only way to directly image main-belt asteroid craters in the visible, the observations led by the ESO HARISSA large program by using the SPHERE/ZIMPOL camera on the Very Large Telescope [5] have brought significant advances for detecting craters on large (D>100km) asteroids [6] [7]. As we are now able to resolve large craters (D>40km) from ground-based observations, this offer us the opportunity to compare asteroid cratering rates between several targets.

In this work, we present the method that has been developped to characaterize craters on the asteroids targeted by VLT/SPHERE. Starting from the indentification step by using brightness profiles, we detail the different image corrections and hypotheses that have been made to estimate the diameter of the craters and their planetocentric coordinates.

We then consider asteroids that offer the most important number of craters to compute their surface cratering rates. This includes the very peculiar surface of the second largest asteroid (2) Pallas and most of the largest S-type asteroids such as (3) Juno, (7) Iris, and (6) Hebe. Specifically, we discuss both similarities and variegations observed by comparing these cratering rates with respect to their surface properties and dynamical environnement. The slopes of our crater size distributions are ultimately confronted to the data retrieved by space missions.

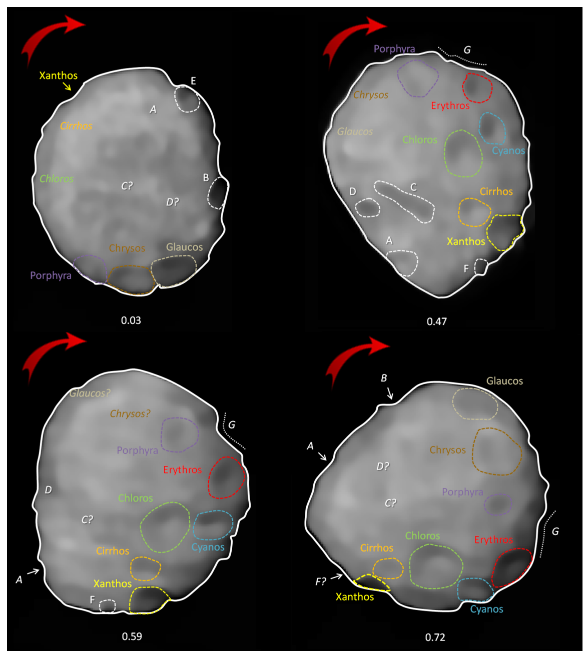

Figure 1: The cratered surface on (7) Iris seen by VLT/SPHERE presented by Hanuš et al. (2019).

These results show that ground-based observations are now capable to probe the cratering rates at the surface of main-belt asteroids. Althougth only the large end of the crater size distribution can be investigated so far, this gives access to new constraints on the dynamical evolution within the main asteroid belt and the surface properties of its members not yet imaged by space missions. Finally, the methods proposed in this work for both crater extraction and cratering rate derivation offer a new insight for the future of ground-based observations.

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