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NUMERICAL MODELING OF INTERACTIONS OF A LANDER WITH LOW-GRAVITY ASTEROID REGOLITH SURFACES

F. Thuillet[(1)], C. Maurel[(1,2)], P. Michel[(1)], J. Biele[(3)], R.-L. Ballouz[(4)] and D. C. Richardson[(4)]

[(1)]*,Université Côte d'Azur, Observatoire de la Côte d'Azur, CNRS, Lagrange Laboratory, CS 34229, 06304 Nice Cedex 4, France, tel.: +33 6 43 01 93 72, email: fthuille@oca.eu*

[(2)] *Department of Earth and Planetary Sciences, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139, USA*

[(3)] *DLR_German Aerospace Center, Micro-Gravity User Support Center, 51147 Cologne, Germany*

[(4)] *Department of Astronomy, University of Maryland, College Park, MD 20742, USA*

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ABSTRACT

The objectives of asteroid mitigation missions may include in-situ measurements on the asteroid target surface and therefore may require the deployment of a lander to perform these measurements (surface composition, radar tomography). For instance, the Asteroid Impact Mission during the Phase A/B1 study by ESA, included the deployment of the MASCOT2 lander to perform internal structure measurements with a bistatic low-frequency radar (Michel et al. 2016). Moreover, the asteroid sample return mission Hayabusa2 (JAXA) carries the European (DLR/CNES) lander MASCOT that will perform in-situ measurements on the carbonaceous asteroid Ryugu in 2018-2019 (Ho et al. 2016). It is thus criticial to determine the behavior of a

lander at contact on an asteroid surface, which is in very low gravity and typically composed of regolith (granular material).

We have developed numerical simulations of lander bouncing on low-gravity asteroid surfaces using the N-body code pkdgrav. This code includes the Soft-Sphere Discret Element Method that allows computing the interaction of grains composing the regolith with a landing device.

We first applied our modeling to the landing of the lander MASCOT onboard the japanese sample return mission Hayabusa2 (Maurel et al. 2017). We developed a numerical model of the lander, accounting for its geometry and the presence of the infra-red spectrometer MicrOmega and performed bouncing simulations, varying the impact speed, angle and lander rotation rate as well as the orientation of the lander itself at impact (e.g. corner, facet, egde …). We also considered different kinds of regolith surfaces characterized by the friction coefficients of the grains and the grain size distributions. We thus performed more than 450 simulations.

We will present the results of these simulations in terms of bouncing coefficient of restitution, distance between the first two bounces, and traces left by the lander at the first impact point. The aim is to generate a database that provides the lander behavior as a function of the impact conditions (lander and surface properties), which can support the choice of the landing site. The knowledge gained can then be used for other landing scenarios in mitigation missions.

References: Ho, T.-M. et al. 2016, Space Science Reviews, 10.1007/s11214-016-0251-6; Maurel, C. et al. 2017, ASR, submitted; Michel, P. et al. 2016, ASR 57, 2529-2547.

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