A FAST ANALYTICAL TOOL TO MODEL CRATERING ASYMMETRIES ON SYNCHRONOUS SATELLITES.

E.M. Alessi[1] and G. B. Valsecchi[1,2] and A. Rossi[1], [1]IFAC-CNR, via Madonna del Piano 10, 50019 Sesto Fiorentino (FI), Italy (em.alessi@ifac.cnr.it, a.rossi@ifac.cnr.it), [2]IAPS-INAF, via Fossi del Cavaliere 100, 00133 Roma, Italy (giovanni@iaps.inaf.it).

Introduction. In a recent work [1], we provided a simple analytical tool to estimate the distribution of impacts on the surface of a synchronous planetary satellite, given a population of planet-crossing small bodies with inclined orbits. On the basis of the extension of the Öpik theory developed in [2], the heliocentric orbital elements a,e,i of the impactor and the longitude of the satellite in its planetocentric motion are used to derive the classical Öpik variables U_p,θ_p,φ_p *relative to the satellite*. Then, the coordinates of the collision point, and in particular the distance from the apex, can be computed by considering a uniform distribution on the *b*-plane. The theory was applied to the Earth—Moon system by taking two different distributions of NEAs, derived from NEODyS (http://newton.dm.unipi.it/neodys). The first distribution was composed by NEAs with H<16; this set is essentially complete but has a relatively small number of members, with a median geocentric speed of about 24 km/s. The second distribution was composed by NEAs with H<25; this is a much larger population, with median geocentric speed of about 15.7 km/s, and is largely incomplete, being dominated by low-MOID objects with low geocentric speeds. The distribution of impacts as a function of the distance from the apex presented a slight apex/antapex asymmetry, of 1.18 and 1.40, respectively.

The main difference between the proposed approach and previous works, e.g., [3-6], is that an extensive computational work is not required. The geometry of the problem is fully represented by the simple underlying dynamics, and this is supported by the results, that are in agreement with more sophisticated numerical simulations which take into account additional gravitational effects, long integration time spans and larger test populations.

Present work. In this work we apply our approach to the larger debiased synthetic distribution of impactors described in [7], to explore the changes caused by the use of this projectile sample on the results found previously [1] for the Earth—Moon system. In Fig. 1 it is shown the relative percentage of impact computed in the three cases, as a function of the distance to the apex α. The apex/antapex ratio is 1.57 for the third population.

Future developments. We aim at applying the technique to other planet-satellite systems to see

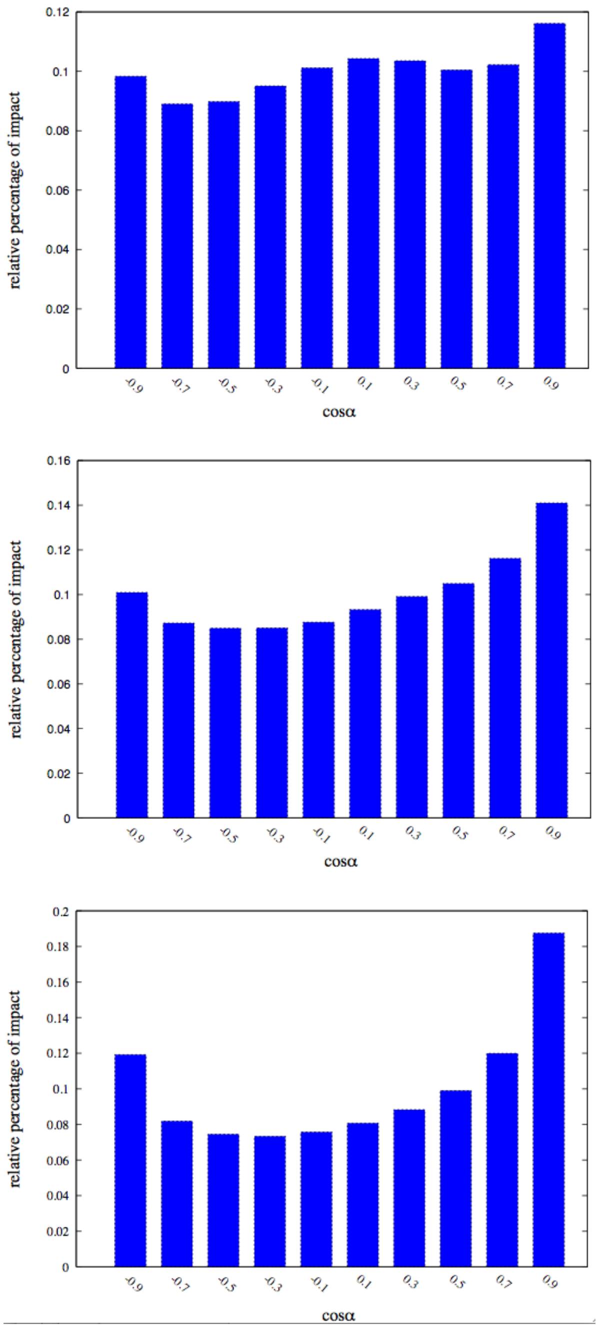

Figure 1. Relative percentage of impact on the surface of the Moon as a function of the distance to the apex α. The population of impactors considered is composed by NEAs with H<16 (top), with H<25 (middle), and the one described in [7] (bottom).

whether the approximations introduced by the model might affect substantially the outcome in some cases. To this end, apex/antapex and nearside/farside ratios will be computed in the Jupiter system, taking various comets and asteroidal population as a reference, and evaluating the role of the gravitational focusing exerted by the planet.

References: [1] Valsecchi G. B. and Alessi E. M. and Rossi A. (2014) *CMDA, 119,* 257–270. [2] Valsecchi G. B. et al. (2003) *Astron. Astrophys., 408,* 1179–1196. [3] Gallant J. and Gladman B. and Ćuk M. (2009) *Icarus, 202,* 371-382. [4] Ito T. and Malhotra R (2010) *Astron. Astrophys., 519,* A63. [5] Zahnle K. et al. (2001) *Icarus 153,* 111-129. [6] Le Feuvre M. and Wieczorek M. A. (2011) *Icarus 214,* 1-20. [7] Chesley S. R. and Spahr T. B. (2004) *In: Belton, M.J.S., Morgan, T.H., Samarashinha, N.H., Yeomans, D.K. (Eds.), Mitigation of Hazardous Comets and Asteroids. Cambridge University Press, Cambridge*, 22-37.