Impact Crater Size-Frequency Distribution (SFD) on Saturnian Satellites and Comparison with Other Solar-System Bodies. N. Schmedemann[1], G. Neukum[1], T. Denk[1] and R. Wagner[2]
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Introduction: The examination of the geologic history of the Saturnian satellites is a major goal of the Cassini imaging experiment (ISS) [5]. The study of the impact crater-SFD is necessary to derive ages of the saturnian satellite surface units. Furthermore it can be used for resolving the main impactor source and the impactor orbital characteristics for understanding the nature of the bombardment.

Methods: While large and old areas are suited to measure the branch of large crater sizes, smaller craters can be found in a state of production only at relatively young areas on the saturnian satellites. The impact-crater SFD is derived only from such crater populations which are in production. Hence the measurement of the whole production function in one specific area is impossible. Therefore we have to measure it piece-wise in crater size range in a number of suitable areas. On Iapetus the production function has been measured in seven crater size range pieces, covering a crater size range from 0.15 km to 700 km. At the same crater size, these areas have somewhat different crater frequencies, since they are of different ages. The crater frequency differences of the respective pieces to each other have to be taken out, in order to obtain continuous curves. We have achieved that by normalizing the frequencies measured on the older surface units at the respective smallest crater sizes to the tail ends of the crater frequencies for the largest craters on the younger surface units. The resulting continuous curves give us a reliable production SFD over the whole accessible range. Doing so, we assumed that the production SFD has not changed over time in the parts of the SFD not directly accessible by measurement. Hence the resulting SFD curve is a consequence of a compilation of measurements taken in different areas.

Results: Intensive analyses of the crater diameter SFD of the lunar surface have revealed a characteristic W-shaped curve, when it is R-plotted. Crater counting on other planetary surfaces such as Mercury, Venus, Mars, Gaspra, Callisto, Ganymede and Mimas have revealed similarly shaped crater diameter SFDs e.g. [4]. While those SFD curves are equally shaped, the whole curves with their characteristic W-shapes appear to be shifted along the diameter axis. Most likely, this shift is primarily the result of different impact velocities. Other factors of scaling relationships between crater diameter and projectile diameter such as density and gravity on different target bodies are of secondary importance.

The measurements of the crater diameter SFD on the saturnian satellites Tethys, Dione, Rhea, and Iapetus also show high similarities to the lunar W-shaped curve. The most complete and statistically valid data set was generated in the case of Iapetus (Fig.1). We have been able to measure crater sizes over four orders of magnitude.

The most likely impactor source for the craters in the inner solar system is the asteroid belt orbiting the sun between Mars and Jupiter e.g. [3],[4]. The asteroid body diameter SFD has more recently been analyzed by [2] using the latest discoveries and the absolute geometric albedo of the asteroids. Those albedo values have been converted to asteroid-body diameters using the method of [1]. The body SFD of the asteroid belt in the range from its inner border out to the 5:2 resonance gap gives a very good match to the lunar SFD (Fig.2). The same W-shape characteristics is found at the jovian and saturnian satellite SFD curves as mentioned earlier. Based on these observations and similarities, it is reasonable to suspect asteroids as the major contribution for the outer solar system bombardment in the range of Saturn as well.

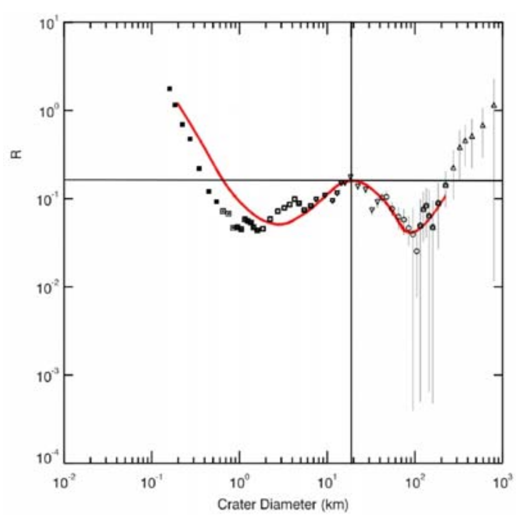

Fig. 1: Shifted lunar crater-size frequency distribution (red curve) superimposed to reconstructed continuous measurements of the SFD on Iapetus.

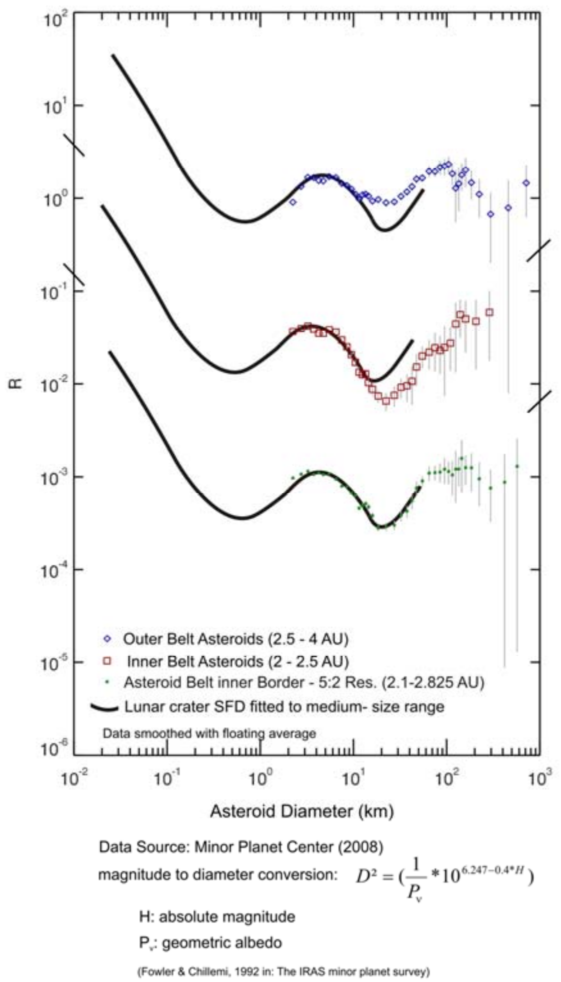

Fig. 2: SFD of asteroid body diameters in the Outer and Inner Asteroid Belt in comparison with the shifted lunar curve. The asteroid body SFD from 2.1 to 2.825 AU shows a high similarity to the shifted lunar curve.

References:

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