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Improvement of the Crater Size-Frequency Distributon and Results on Surface Ages of the Saturnian Satellites

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The examination of the geologic history of the Saturnian satellites is a major goal of the Cassini imaging experiment (ISS). Crater counting for the determination of model ages is a powerful tool to understand stratigraphic relationships between different terrain units.

We assume that Iapetus holds a lunarlike cratering record. That is indicated by the shapes of the measured crater-size frequency distributions which follow remarkably close the distribution of Earth's moon on an interval of three orders of magnitude in crater size [1]. This fact implies not just a similar impactor origin but also a similar behaviour of the target material. To take into account different impact velocities between Earth's moon and the Saturnian satellites, we have to shift the lunar-size frequency distribution horizontally to match the measurements. In case of Iapetus the lunar curve is shifted by a factor of 5 toward smaller crater diameters (fig.1). A shift in vertical direction is the indicator for the age of the measured surface unit.

At this stage, we are deriving native polynomials for several Saturnian satellites (e.g. Rhea, Dione, Mimas, Epimetheus and Iapetus; for Iapetus the sample points in fig.1 are used). It is possible to translate the size-frequency distribution from the lunar case to the Saturnian satellites by scaling laws. In that way, constrains for the orbital characteristics and nature of the impacting bodies might be derived.

An age of 4.5622 to 4.5647 Gyr was published for Iapetus by [2] based on [3]. A cooling time of about 100 Myr is assumed for forming a rigid crust capable to hold the cratering record [2]. Hence we use the oldest surface units as marker horizons to calibrate our dating technique for Iapetus and other mid-sized Saturnian satellites.

Following the models of [2] and [1], an age of 4.4 Gyr is expected for the oldest parts of Iapetus's surface. Based on these models, we measured ages at adjacent morphologic units to unveil their stratigraphic relationships. A small part of the equatorial ridge near 99°W longitude and an "average" dark terrain sample north of the ridge shows densely cratered surfaces which represent the most ancient areas (~4.4 Gyr). The central areas of two basins on the leading side at 40°N/93°W and 17°N/28°W, as well as another basin on the trailing side at 46°S/242°W are featuring slightly younger ages of about 4.3 Gyr.

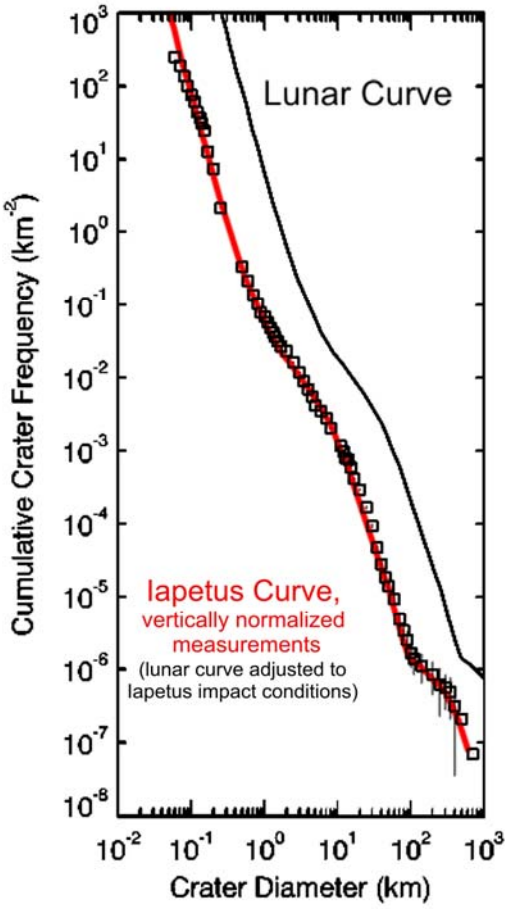

fig. 1: Comparison between the lunar crater-size frequency distribution and the shifted curve to account for Iapetus's impact conditions.

The examination of the most recent data (targeted flyby on Sep 10, 2007, [4]) with spatial resolutions down to 10 m/pxl revealed a set of relatively bright and therefore presumably young craters on the dark side at a size range of dozens of meters. From this data set we estimate the timescale and development of the darkening process. To do so, photometric measurements are applied to all craters with an obviously brighter appearance than their surroundings. After sorting the dataset for crater luminosity, the age of the area is iteratively recalculated after removal of the brightest crater from the dataset. The resulting scatter plot is approximated by a power function which shows a steep drop at the youngest ages. The crater brightness drops to 1/2 of the initial value in the order of 10^4 yr and to 1/5 in the order of 10^7 yr. The

transition to the complete darkening is hard to define but is in the order of about 1 Gyr (fig.2).

In addition to Iapetus results, we will present crater measurements of the major units of other Saturnian satellites like Mimas and Epimetheus for comparison with Iapetus. Mimas is characterized by heavily cratered plains, which indicates a high surface age almost similar to Iapetus. Although the surface of Mimas is heavily cratered, it is not saturated by craters larger then 2.5 km (the data limit). Even the surfaces of Dione and Rhea are not saturated [5], while Iapetus's surface is saturated with craters below 10 km in diameter.

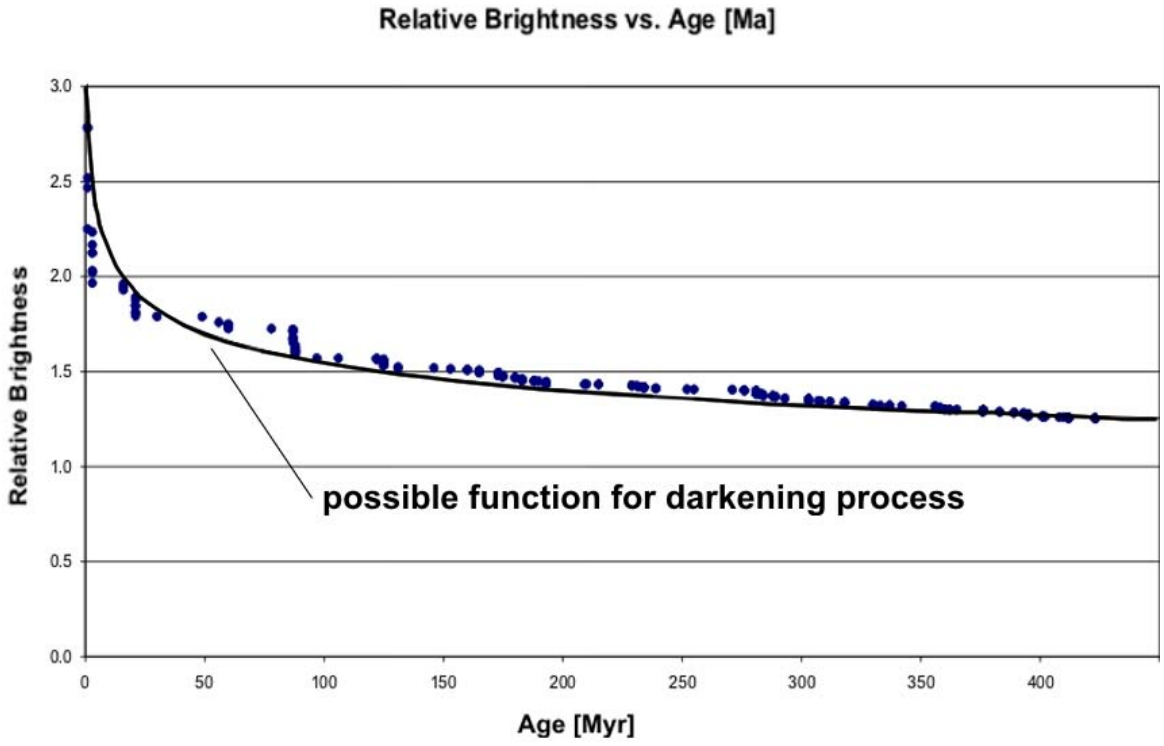

fig.2: Derived function of the darkening process with a steep drop at youngest ages.

References

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