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Mass Depletion of the Asteroid Belt Estimated by Impact Chronology Models

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Abstract

Since its existence, the solar system has undergone a bombardment by large bodies as documented by cratering records on planetary surfaces as seen in several high-resolution imagery investigations. The well-investigated lunar cratering record reveals a typical size-frequency distribution leading to the well known impact-chronology model proposed by [1, 2]. Comparisons of size-frequency distributions of the cratering record of the inner solar system with observed Near-Earth-Asteroid (NEA) populations of the asteroid belt [3, 4, 2] has led to the conclusion that the asteroid belt is the major source of the impactor population. This, however, is still in discussion for the outer solar system. While [5] proposes the asteroid belt as major source due to comparable size-frequency distributions of cratering records on Saturn's moons, [6] proposes the Oort cloud and Kuiper belt as major sources of cometary impactor populations.

Impact-chronology models derived from measurements of the size-frequency distribution of the lunar cratering record with the assumption of a common time-invariant size-frequency distributed population of impactors hold the key to the answer to the source for impactors.

Comparisons of the size-frequency distribution of the lunar cratering record with those of cratering records on the moons of the saturnian system and with most recently estimated size-frequency distributions of catalogued asteroids (Minor Planet Center, AstORB (Lowell) Catalogue) [7] have led us to the conclusion that the asteroid belt also is the source of the impactors of the jovian as well as the saturnian system.

In a first approach we target the problem of finding evidence for the hypothesis that the asteroid belt is the major source of impactors for the jovian and saturnian system by comparing the size-frequency distributions of the cratering records from Cassini high-resolution imagery surveys with estimated size-frequency distributions of objects of the asteroid belt catalogued most recently. With application of suitable scaling laws for mapping crater size-frequency distributions into impactor size-frequency distributions as proposed by [8, 9, 2] it should be possible to estimate both the mass accumulated over time on the planetary surface and dynamical time-constraints of the source of the impactors by integration of the impact chronology function for which numerical results are expected.

References

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