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Probing the history of Solar System through the cratering records on Vesta and Ceres

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Dawn mission will provide detailed images of Vesta and Ceres surfaces and supply crucial information to constrain their mineralogical and elemental composition through VIR, its imaging spectrometer. Thanks to these data, we will be able to study in depth the crater record on the surface of both Vesta and Ceres. We discuss the cratering process of Vesta and Ceres at the time of Jupiter formation. In our model we consider Jupiter's gas accretion and displacement due to angular momentum exchange with the surrounding nebula. The gas accretion model used has been described in Coradini et al. (2004). Jupiter's migration has been included to estimate the effect of increasing displacements. To explore the early collisional history of Vesta and Ceres we simulated the dynamical evolution of a section of the young Solar System at the time of Jupiter's core formation and the subsequent accretion of the gaseous envelope. Our scheme of the forming Solar System was composed of the Sun, the accreting Jupiter and a swarm of massless particles representing the planetesimals. The massless particles were initially distributed into a limited spatial region, which has been chosen after a set of numerical experiments aiming to determine the region of Solar System influenced by the forming Jupiter on the considered timespan to optimise the computational requirements. We didn't model the giant planet formation process directly through hydrodynamical computations. In our simulations we reproduced the evolution of Jupiter through an analytical approach: the parameters on which the model was based, however, were derived from the results of hydrodynamical simulations performed with the code described in Coradini et al. (2004). During the dynamical evolution of our template of the Solar System we evaluated through a statistic approach the probability of planetesimals impacting against Vesta and Ceres. In the following subsections we will describe in detail the initial conditions and the physical parameters and constrains of the model.. Our results suggest that the cratering histories of Vesta and Ceres is correlated to the timescale of Jupiter formation and to its radial displacement. If Vesta or Ceres formed before Jupiter's core reached its critical mass, the expected crater distribution on the surfaces of the two asteroids should show different effects at different times. At the beginning, the crater distribution is dominated by impacts of small rocky bodies that should have lead to an intense and uniform craterisation. These low-velocity impacts could have contributed to the accretion of the asteroids. After Jupiter starts to accrete gas, a second phase of more energetic impacts takes place. Due to their lower number, planetesimals formed beyond the Snow Line contribute less to the craterisation but, with their higher impact energies, they affect the resurfacing and the thermal histories of the asteroids. A significant fraction of resonant inner rocky bodies should have impacted the asteroids at supersonic speed, contributing to their excavation and fragmentation. Jupiter's migration should have important effects on this picture, changing the impact speeds and the relative abundances of rocky inner and icy outer populations. The marked dynamical differences between the families of impactors and the strong effect of Jupiter migration should help in interpreting and dating the different features that Dawn will observe on Vesta's and Ceres' surfaces.

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