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The growth of embryos considering SPH-collision studies

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Abstract

We present N-body simulations of the embryo growth taking into account real collisional studies. In this context we show the mass-loss and water-loss for Moon- and Mars-sized bodies after collision where we consider various impact angles which have been determined in N-body simulations [1].

1. Introduction

Studies of terrestrial planet formation usually use perfect merging for the growth of celestial bodies. It is well known that this assumption is weak point of such studies which needs to be improved. Taking into account results of SPH (Smooth Particle Hydrodynamics) simulations of colliding embryos in the N-body computations yield a more realistic formation scenario.

2. SPH simulations

SPH simulations of colliding embryos provide the necessary information about volatile and material loss during impact [2,3]. Therefore, we use an N-body—SPH combination to get more realistic results for the growth of bodies and the water transport via collisions on terrestrial like planets in the habitable zone.

3. N-body – SPH approach

We study collisions of Moon and Mars sized objects moving in the habitable zone of a Sun-like star (i.e. between 0.9 and 1.7 au) perturbed by a Jupiter-mass planet at 3 au and a secondary star at distances of 25 – 50 – 75 and 100 au. In addition to the comparison of the different binary-star—planet configurations we consider a similar planetary system orbiting a single star. Taking into account the impact velocities and impact angles from N-body simulations [1] in the SPH collision study, we show the mass-loss and water-loss during collision depending on masses, impact velocity and impact angle.

4. Results

The mass-loss for Moon and Mars sized bodies during collisions is summarized in Figure 1 where we show the results of SPH simulations for different impact angles.

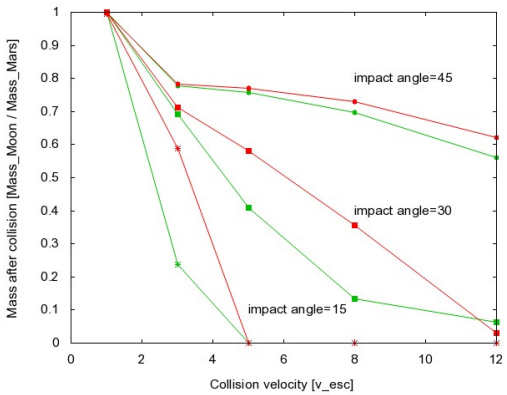

Figure 1: Mass-loss for Moon- (green lines) and Mars- (red lines) sized bodies during collisions of same sized bodies using different impact angles.

The result for the different impact angles of 15° – 30° and 45° show a similar behavior for Moon and Mars sized bodies when the impact velocity is increased up to 12 times the escape velocity. For impact angles less than 45° the mass-loss is higher for the smaller bodies. A similar behavior has been found for the water loss.

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