Moon-forming giant impacts with an icy impactor

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We present a series of Moon-forming giant impact simulations which explore the “icy impactor” scenario. A large range of impact conditions and various properties of target and impactor are investigated.

The influence of the thickness of the water ice layer on top of the impactor as well as the pre-impact spin of the proto-Earth are studied. The highest fraction of debris disc originating from the proto-Earth is found when the spin is anti-aligned to the impactor's trajectory (retrograde rotation). However, discs which are least as massive as the Moon are only found for prograde pre-impact rotation. The best matching cases are found for prograde rotation, where the disc mass is the largest. We find a more similar origin of the silicate material than in the canonical impact scenario.

We further study the one case with a model that include additional physics (solid strength) and also test the dependence of the disc mass on the numerical resolution. The results in terms of disc mass and material origin show differences of the order of 15%. However the disc’s iron content is more sensitive to a change of resolution. The effects of the target’s initial temperature profile and the material rheology were also investigated in two specific cases. We find only relatively small differences in the disc properties.

Overall, our study suggests that the icy impactor scenario explored here leads to promising results, but would require some specific initial conditions to match the observed properties of the Moon.