Experiments on the impact and fragmentation of a liquid onto a lighter immiscible liquid

Augustin Maller[1], Maylis Landeau[1], Sébastien Charnoz[1]

Université Paris Cité, Institut de Physique du Globe de Paris, 1 rue Jussieu, Paris, France
maller@ipgp.fr

The Earth formed by high-energy collisions between planetary embryos [1]. These impacts set the composition of our planet. We present laboratory experiments on the fluid dynamics of these giant impacts.

We investigate the impact of a centimeter-sized liquid volume onto a pool of a lighter immiscible liquid at large Weber numbers, which measures the relative importance of inertia to surface tension effects (Fig.1). Our impactors are larger than in previous drop impact experiments to minimize the effect of surface tension during impact cratering [2,3]. We find that the impacting liquid fragments into drops when the Froude number, which measures the relative importance of inertia to gravity, is large enough, regardless of the value of the Weber number. This result contrasts with previous studies on drop impacts [2]. In our experiments, when inertia is comparable to gravity, i.e. $Fr < 10$, the impactor remains coherent. In contrast, when $Fr > 40$, the impactor fragments into millimeter-sized droplets. This fragmentation results from the growth of a turbulent Rayleigh-Taylor instability at the interface between the impacting liquid and the target pool. We obtain a scaling law for the mean drop size as a function of the Weber number that characterizes the turbulent Rayleigh-Taylor instability.

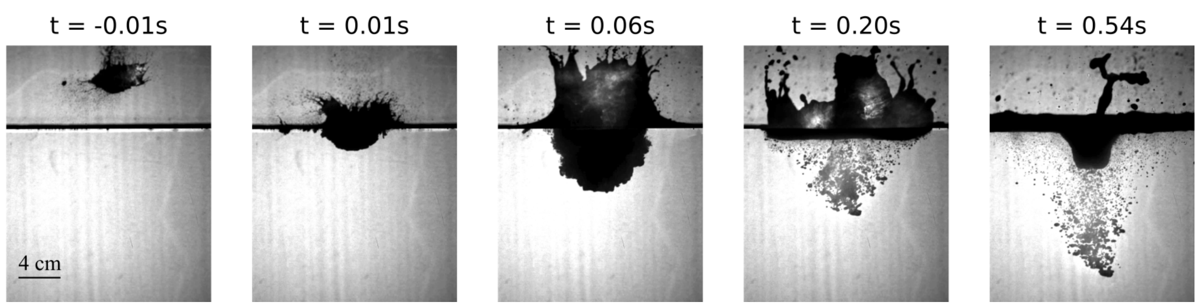

Figure 1. Experiment on the impact of a liquid volume onto a pool of a lighter immiscible liquid.

References

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