Neighbors of water entry

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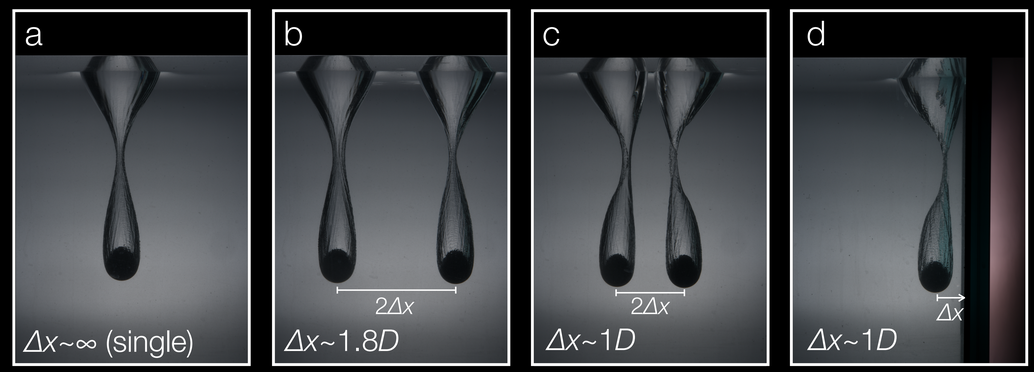
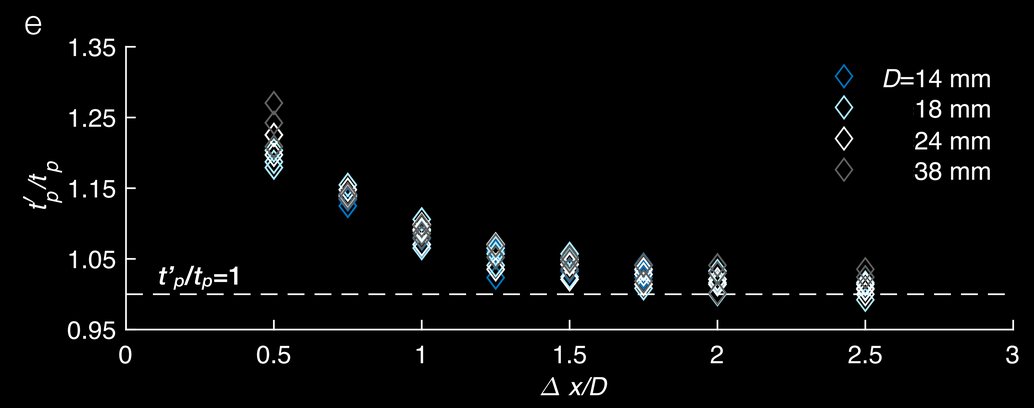
When two neighboring spheres fall simultaneously into water side-by-side they create asymmetric cavities that are so similar to one another it is hard to tell that there is no mirroring trick used (left). The images also reveal the asymmetric pinch-off alters the singularity. In contrast, when a single steel sphere (diameter, D) falls onto a free surface an axially symmetric cavity emerges underwater (a). The axial symmetry also occurs for the two sphere case if they are dropped far enough apart ($\Delta x = 1.8D$, b). As the distance between them decreases, the likelihood of antisymmetry increases, for instance ($\Delta x = 1D$, c). Perhaps obvious to a fluid mechanician, a very similar phenomenon can be achieved by replacing the neighboring sphere by a solid wall ($\Delta x = 1D$, d).

The potential flow theory predicts that a dimensionless parameter $\Delta x/D$ should scale the neighboring effects on one another, which it does (e). The dimensionless pinch off time t'_p/t_p shows the diminishing return between neighbors ($\Delta x/D$), where t'_p is the time of pinch off of that case and t_p is the time of pinch off of a single sphere (a).





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