AIP | Physics of Fluids

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Citation: Phys. Fluids **22**, 091104 (2010); doi: 10.1063/1.3481432
View online: http://dx.doi.org/10.1063/1.3481432
View Table of Contents: http://pof.aip.org/resource/1/PHFLE6/v22/i9
Published by the American Institute of Physics.

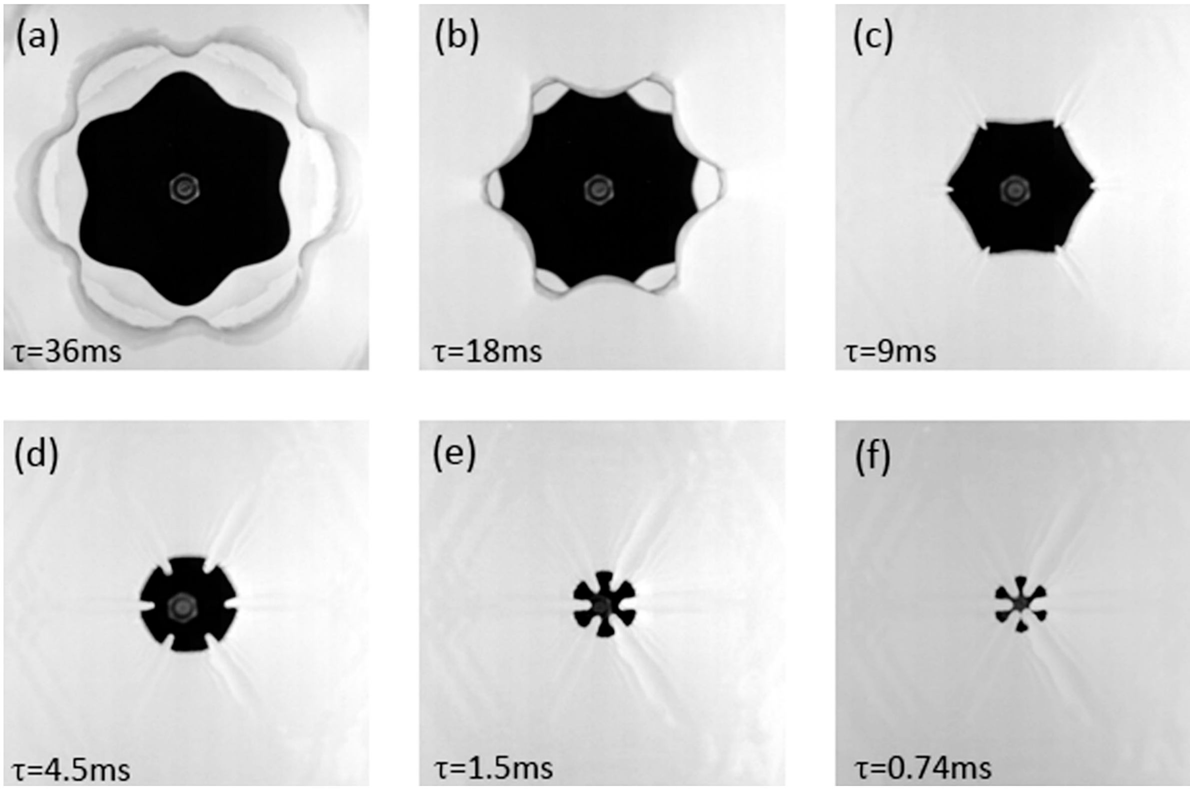

FIG. 1. A nonaxisymmetric disk impacts with $v_{disk}=1$ m/s. Phase inversion of cavity shape with respect to disk orientation takes place early in the collapse [(a) and (b)]. Afterwards, ridgelike jets are formed [(c) and (d)], which subsequently thicken and come in contact in the center [(e) and (f)] forming seven subcavities. τ is the remaining time until collapse. The memory effect is visible at all times. (Enhanced online) [URL: http://dx.doi.org/10.1063/1.3481432.1].

Collapse of nonaxisymmetric cavities

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(Received 2 August 2010; published online 30 September 2010)
[doi:10.1063/1.3481432]

Upon collision of a solid body onto a liquid reservoir, air is entrained, forming a cavity which eventually collapses due to hydrostatic pressure. When the impactor is axisymmetric, the created void retains such a feature and its closure follows a universal power law behavior with logarithmic corrections.[1,2] It has been conjectured that the introduction of a nonaxisymmetric perturbation induces a long term memory effect which leads to a phenomenon that is no longer universal but remembers its initial conditions due to a conserved quantity.[3] We probe this assertion by impacting "flower-shaped" thin metal disks with controlled speed onto a water surface, and recording top views of the evolution of the created cavities with a high-speed camera. The shape of the impactors is characterized by single-mode harmonic disturbances of amplitude a_m to a round geometry.

In Fig. 1 and the linked video, we illustrate the differences induced in the collapse process when axial symmetry is perturbed. The usual energy-focusing singularity of the axisymmetric collapse is preempted by the disturbance. We observe a clear phase inversion of the cavity shape as it shrinks, and the geometry of the impacting disk is patent almost until the pinchoff moment. This behavior is explained by continuity: regions with higher curvature experience a larger acceleration and eventually overtake the small curvature ones. Higher disturbance modes have larger curvatures and thus overtake faster. Small amplitude perturbations lead to linear oscillations of the cavity shape during collapse, while large amplitudes give rise to spectacular nonlinear effects like cusp formation, ridgelike jet impingement, and subcavity formation.

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1070-6631/2010/22(9)/091104/1/$30.00