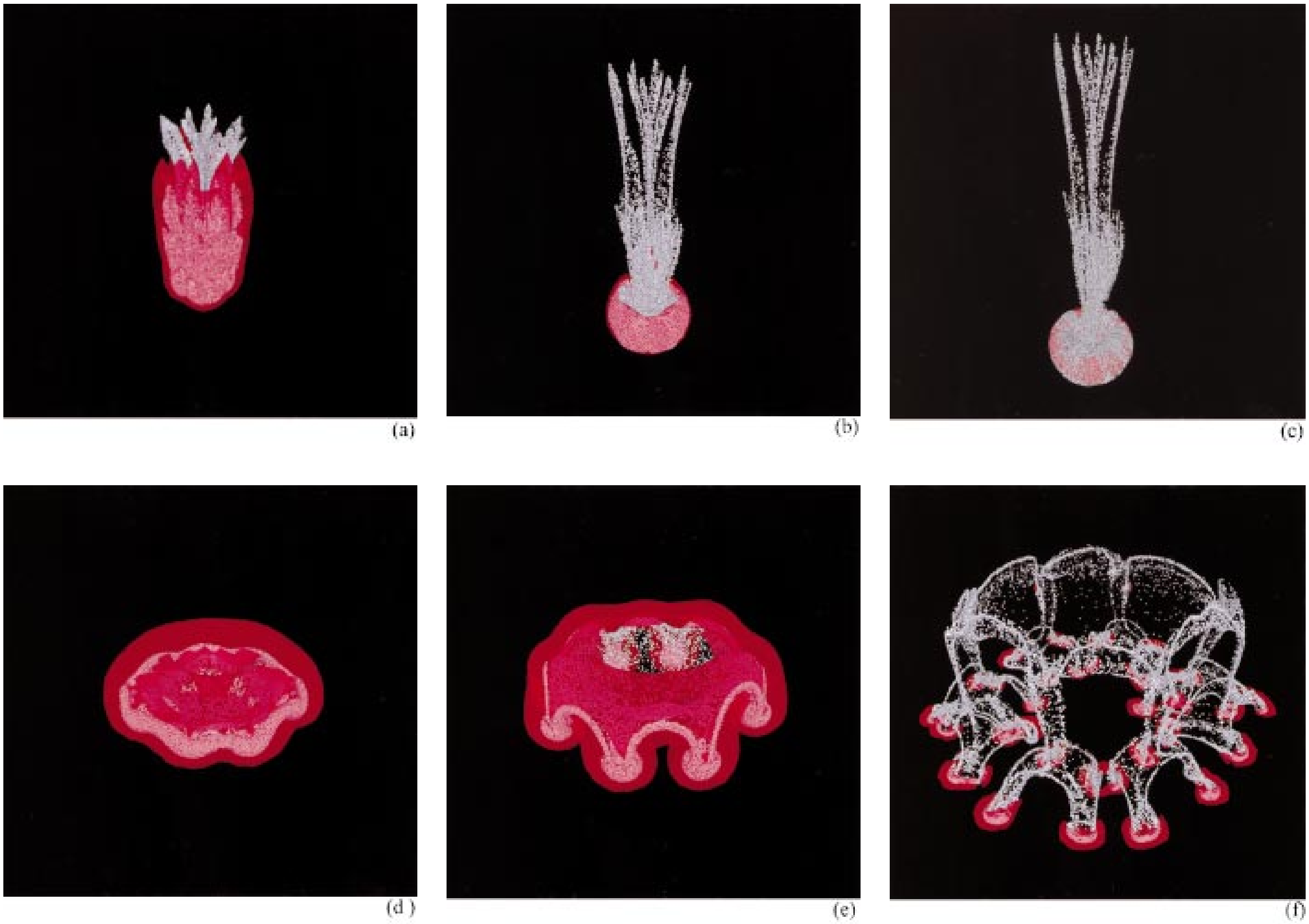

FIG. 1. Visualization of fluid vorticity (red) and solid particles (white) of an initially spherical suspension falling due to gravity. Case A: (a)–(c); Case B: (d)–(f).

Simulation of Particle Laden Flows Using Particle Methods

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We present simulations of an initially spherical suspension of solid particles falling due to gravity in a viscous incompressible fluid. The numerical simulations are performed using three-dimensional viscous, vortex methods[1] with a *two-way* coupling between the fluid and the particles.[2]

We consider two cases: (A) the suspension is falling in a nonzero initial vorticity field, generated by allowing, for a short time, only one-way viscous coupling and (B) the suspension is inserted in a fluid with no initial vorticity field.

In case A [Figs. 1(a)–(c)], the particle suspension is entrapped by the initial vorticity field which dominates the dynamics of the flow. The solid particles are wrapped around the core of the vortex ring and are shed in its wake. This results in the formation of ''Tintenpilze.''[3] In case B [Figs. 1(d)–(f)], the falling of the solid particles imparts vorticity on the fluid elements, forming a vortex ring. The vortex ring becomes unstable and induces a bifurcation of the suspension of particles which in turn creates new vortex rings in a cascade-like fashion. The phenomena are qualitatively similar to experimental observations of liquid drops injected in lighter fluids.[4]

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[4] J. J. Thomson and H. F. Newall, Proc. R. Soc. **39**, 417 (1885).

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