Emerging 'dipolar' vortex structures in 2D and 3D accelerated inhomogeneous flows (Richtmyer-Meshkov and Rayleigh-Taylor)

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We show that '*vortex projectiles*' *(VPs)* emerge as ubiquitous coherent vortex structures in nonlinear evolutions of accelerated inhomogeneous (density-stratified) flows. These 'mushroom' objects arise because of baroclinic vorticity depostion, e.g. Rayleigh-Taylor and Richtmyer-Meshkov environments. We exhibit *several* spatial configurations and parameter domains from both numerical simulations (inviscid) and laboratory experiments, where these VPs arise. In particular, the (fast/slow): shock-planar inclined layer (or 'curtain'); shock-spherical bubble (both simulated in 2D & 3D with PPM) and gravitational impulsive 'reacceleration' of a falling tank (simulations with the 2D incompressible CASL code and classic experiments of Jacobs and Niederhaus). In the 2D planar and axisymmetric environments, nearby dipolar vortex layers [(+)and (-)] are a frequent occurrence. Perturbations cause these unstable physical states to rapidly roll-up and 'bind'. In 3D, ring-like objects arise and instability results in reconnection. We compare the upstream and downstream VPs of the shock-curtain interaction to Lamb-Chaplygin vortices and quantify the turbulent domains between them. We comment on the convergence and accuracy of simulations. We conjecture that VPs could explain some of 'explosion fragments', etc. in the vicinity of astrophysical supernova remnants and planetary nebulae.

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