Childress, S.; **Ierley, G. R.**; **Spiegel, E. A.**; **Young, W. R.**

Blow-up of unsteady two-dimensional Euler and Navier-Stokes solutions having stagnation-point form. (English) Zbl 0674.76013

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Summary: The time-dependent form of the classic, two-dimensional stagnation-point solution of the Navier-Stokes equations is considered. If the viscosity is zero, a class of solutions of the initial-value problem can be found in closed form using Lagrangian coordinates. These solutions exhibit singular behaviour in finite time, because of the infinite domain and unbounded initial vorticity. Thus, the blow-up found by *J. T. Stuart* [Nonlinear partial differential equations: Singularities and their solution. Symp. Honor C. C. Lin, World Scientific, D. J. Benney, F. H. Schu and C. Yuan (eds.) (1987)] in three dimensions using the stagnation-point form, also occurs in two. The singularity vanishes under a discrete, finite-dimensional 'point vortex' approximation, but is recovered as the number of vortices tends to infinity. We find that a small positive viscosity does not arrest the breakdown, but does strongly alter its form. Similar results are summarized for certain Boussinesq stratified flows.

MSC:

76B47	Vortex flows for incompressible inviscid fluids
35Q30	Navier-Stokes equations
76D05	Navier-Stokes equations for incompressible viscous fluids
76M99	Basic methods in fluid mechanics

Keywords:

classic, two-dimensional stagnation-point solution; Navier-Stokes equations; initial-value problem; Lagrangian coordinates; infinite domain; unbounded initial vorticity

Full Text: DOI

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