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Symmetry-plane models of 3D Euler fluid equations: Analytical solutions and finite-time blowup using infinitesimal Lie-symmetry methods[1] MIGUEL D. BUSTAMANTE, Complex and Adaptive Systems Laboratory, School of Mathematical Sciences, University College Dublin — We consider 3D Euler fluids endowed with a discrete symmetry whereby the velocity field is invariant under mirror reflections about a 2D surface known as the "symmetry plane." This type of flow is widely used in numerical simulations of classical/magnetic/quantum turbulence and vortex reconnection. On the 2D symmetry plane, the governing equations are best written in terms of two scalars: vorticity and stretching rate of vorticity. These determine the velocity field on the symmetry plane. However, the governing equations are not closed, because of the contribution of a single pressure term that depends on the full 3D velocity profile. By modelling this pressure term we propose a one-parameter family of sensible models for the flow along the 2D symmetry plane. We apply the method of infinitesimal Lie symmetries and solve the governing equations analytically for the two scalars as functions of time. We show how the value of the model's parameter determines if the analytical solution has a finite-time blowup and obtain explicit formulae for the blowup time. We validate the models by showing that a particular choice of the model's parameter corresponds to a well-known exact solution of 3D Euler equations [Gibbon et al., Physica D 132:497 (1999)]. We discuss practical applications.

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