Abstract Submitted
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Symmetry-plane model of 3D Euler flows: Mapping to regular systems and numerical solutions of blowup[1] RACHEL M. MULUNGYE, DAN LUCAS, MIGUEL D. BUSTAMANTE, Complex and Adaptive Systems Laboratory, School of Mathematical Sciences, University College Dublin — We introduce a family of 2D models describing the dynamics on the so-called symmetry plane of the full 3D Euler fluid equations. These models depend on a free real parameter and can be solved analytically. For selected representative values of the free parameter, we apply the method introduced in [M.D. Bustamante, Physica D: Nonlinear Phenomena, 240:1092-1099 (2011)] to map the fluid equations bijectively to globally regular systems. By comparing the analytical solutions with the results of numerical simulations, we establish that the numerical simulations of the mapped regular systems are far more accurate than the numerical simulations of the original systems, at the same spatial resolution and CPU time. In particular, the numerical integrations of the mapped regular systems produce robust estimates for the growth exponent and singularity time of the main blowup quantity (vorticity stretching rate), converging well to the analytically-predicted values even beyond the time at which the flow becomes under-resolved (i.e. the reliability time). In contrast, direct numerical integrations of the original systems develop unstable oscillations near the reliability time. We discuss the reasons for this improvement in accuracy, and explain how to extend the analysis to the full 3D case.

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Rachel M. Mulungye
Complex and Adaptive Systems Laboratory,
School of Mathematical Sciences, University College Dublin

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