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A counterexample to the smoothness of the solution to an equation arising in fluid mechanics

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Abstract: We analyze the equation coming from the Eulerian-Lagrangian description of fluids. We discuss a couple of ways to extend this notion to viscous fluids. The main focus of this paper is to discuss the first way, due to Constantin. We show that this description can only work for short times, after which the “back to coordinates map” may have no smooth inverse. Then we briefly discuss a second way that uses Brownian motion. We use this to provide a plausibility argument for the global regularity for the Navier-Stokes equations.

Keywords: Navier-Stokes equations, Euler equations, regularity of systems of PDE's, Eulerian-Lagrangian description of viscous fluids

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