Topology and Geometry of Mixing of Fluids

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ABSTRACT

We obtained a complete mathematical approach for the three-dimensional mixing of two fluids, in high speed motion by enhancing the speed of stretching of the material lines of the flow. In this paper we investigate the possibilities of generation of topological chaos by using moving rods and wings with fractal geometric shapes. Topologically chaotic fluid advection is created by driving flow through these rods and wings whose kinematics is chosen to form a braided structure. In the studied cases, instead of using cylinders and tori, [3, 4], for the mixing process, we used the braid group on higher order homotopy/homology groups surfaces like N-tori and Mobius stripes. We also approached the problem of the topological entropy and its lower bounds, [6, 8]; for these flows and compared it with stirring simulations of Stokes flow to evaluate their sharpness, see for example [1, 6]. Extending the methods presented in [2-4] by using the theory of motion of surfaces, [5], we proved the existence of braids with positive topological entropy. The results are confirmed by experiments made in mixing of air-fuel for flames [2, 7].

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