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Mixing in Multiconnected Planar Domains

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We study the stirring of two-dimensional fluids in multi-connected domains with moving boundaries using analytic and numerical tools. A time-periodic Euler flows with typical initial vorticity is not chaotic, but for constant initial vorticity there are stirring protocols which always yield chaotic time-periodic Euler flows. These protocols generate flow maps in pseudoAnosov isotopy classes as defined in the Thurston-Nielsen theory. PseudoAnosov stirring protocols with generic initial vorticity always yield non-periodic solutions for which the sup norm of the gradient of the vorticity grows exponentially. For Stoke's flow numerical and experimental results have shown that the flow maps under pseudoAnosov protocols are very efficient stirrers appearing to lack elliptic islands on visible scales. Our explanation of this phenomenon uses the connection between Helmholtz' variational characterization of Stoke's flow and the quasiconformal distortion of the flow map. Minimization of the latter, under the appropriate conditions, is known to imply global hyperbolicity.

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