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Resonances and Mixing in Stokes Flows

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In the present paper we study chaotic advection and mixing in a stationary incompressible Stokes flow between two co-axial counter-rotating cylinders. The velocity field of the flow is a result of a small perturbation of an integrable velocity field. Under arbitrarily small perturbations of a certain kind a domain of chaotic advection within the gap between the cylinders arises. We show that this phenomenon is a consequence of quasi-random changes in the adiabatic invariant of the flow, which occur as a streamline crosses the two-dimensional resonance surface of the unperturbed flow. We derive an asymptotic formula for the change in the adiabatic invariant due to the passages through the resonance and describe the diffusion of the adiabatic invariant due to multiple passages through the resonance.

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