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Separation by diffusive irreversibility in a chaotic Stokes flow in a microchannel PAVITHRA SUNDARARAJAN, JOSEPH KIRTLAND, DONALD KOCH, ABRAHAM STROOCK, Cornell University — Taylor famously demonstrated that a fluid could be reversibly stirred and unstirred at low Reynolds numbers. Heller further suggested that stirring and unstirring of a mixture of diffusive solutes into a diluent could lead to partial purification of the mixture of solutes of low diffusivity. Finally, Jones and Aref showed in a numerical study that this separation process could be more efficient if the stirring flow was chaotic. This process, separation of particles by diffusive irreversibility (SDI), could be an extremely simple method of chemical separation that would not require external fields or membranes. We have investigated the reversibility of convection-diffusion in laminar chaotic flows in a microchannel patterned with staggered herring-bone shaped grooves. We will discuss a model that predicts the extent of reversibility of the flow and compare it with experimental and numerical results. We demonstrate the generality of the finding of Jones and Aref: chaotic flows allow for more efficient SDI by providing a clean separation of the time-scales of stirring and diffusive mixing. We will present the design of a micro-fluidic device that implements the principle of SDI effectively. The experiments and the model together could improve our understanding of the fundamental aspects of reversibility in chaotic Stokes flows.

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