Transport anomalies in time-independent two-dimensional viscous flows

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Abstract

Transport processes in continuous media are encountered everywhere from cosmological (galaxies), planetary (storms in the atmospheres of giant planets) and geophysical (ocean currents) scalesdown to micro- and nano-fluidics and functioning of the living cells; they are also important for innumerous technological applications. Anomalies in such processes are commonly viewed as ramifications of spatio-temporal disorder. Although this holds largely true, disorder is not a necessary precondition: as discussed in the talk, persistent anomalous dispersion of tracers can occur in our also for certain *regular, spatially periodic and time-independent* patterns of plane viscous flows, in the absence of either a Lagrangian chaos or a Brownian motion. The deterministic origin of unusual transport is the slowdown of motion near stagnation points and solid obstacles, responsible for singularities of the particle passage time. In this situation, anomalous transport is accompanied by presence of the long-range temporal autocorrelations for the Lagrangian observables. It will be shown that, by an appropriate choice of the flow geometry, both subdiffusive and superdiffusive transport of tracers can be achieved. Special attention will be paid to dynamics in vicinities of degenerate stagnation points of the flow pattern.

Keywords: anomalous transport, laminar flows

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