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Time-reversal-symmetry breaking in turbulence[1] JENNIFER JUCHA, HAITAO XU, Max Planck Institute for Dynamics and Self-Organization (MPIDS), Goettingen, Germany, ALAIN PUMIR, Max Planck Institute for Dynamics and Self-Organization (MPIDS), Goettingen, Germany, and ENS-Lyon, Lyon, France, EBERHARD BODENSCHATZ, Max Planck Institute for Dynamics and Self-Organization (MPIDS), Goettingen, Germany — In three-dimensional turbulent flows, the flux of energy from large to small scales breaks time symmetry. We show here that this irreversibility can be quantified by following the relative motion of several Lagrangian tracers. We find by analytical calculation, numerical analysis and experimental observation that the existence of the energy flux implies that, at short times, two particles separate temporally slower forwards than backwards, and the difference between forward and backward dispersion grows as t^3. We also find the geometric deformation of material volumes, surrogated by four points spanning an initially regular tetrahedron, to show sensitivity to the time-reversal with an effect growing linearly in t. We associate this with the structure of the strain rate in the flow.

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