Memory effects in the advection of inertial particles

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Chaotic advection of finite-size particles (often called inertial particles) plays an important role in many environment-related phenomena ranging from meteorology to oceanography .The basic equations of motion for small spherical particles in a viscous fluid are given by the Maxey-Riley equation. Their precise form contains an integral, also called the history (or Basset) force, which describes the diffusion of vorticity around the particle during its full time history. This term renders the advection equation to be an integro-differential equation whose solution is much more demanding than that of an ordinary differential equation. Because of this difficulty, the integral term is neglected in nearly all applications.
This talk will present the results of a systematic investigation of this memory effect in a paradigmatic model flow of chaotic advection, the von Kármán flow. All investigated properties turn out to heavily depend on the presence of memory when compared to previous studies neglecting this force. A weaker tendency for accumulation and for caustics formation has been found. The Lyapunov exponent of transients becomes larger, the escape rates are strongly altered. Attractors are found to be suppressed by the history force,and periodic ones have a very slow t^(-1/2) type convergence towards the asymptotic form. The presented result will point out that the history force can have a strong influence on the advection of inertial particles.

[1] A. Daitche, T. Tel: Memory effects are relevant for chaotic advection of inertial particles, Phys. Rev. Lett. 107 , 2445001 (2011)