TOR VERGATA
UNIVERSITÀ DEGLI STUDI DI ROMA

Dipartimento di Fisica

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Seminar

Tuesday, 28 November 2023 - h. 14:00

Fisica della Materia room (Department of Physics)

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"Mixing liquids of different viscosities"

Abstract

Mixing refers to the process that leads to the homogenisation of initially segregated miscible phases. It is a mechanism involving two phenomena, stirring and diffusion, and it is relevant in industrial applications (bacterial growth, pharmaceutical, materials) and natural phenomena (ocean climate, heat transfer, chemical reactions, and geophysical flows). In conventional mixing problems, the substance that diffuses (e.g. heat or dilute solute) does not alter the flow significantly. In other words, the flow is independent of the evolution of the mixing itself. But what happens if the substance contains viscosity heterogeneity?

In this seminar, I will tell how we approached the characterisation of this mixing problem and the (ongoing) results.

We experimentally characterise the deformation of a blob of viscosity η' subjected to a simple shear in a fully miscible bath of viscosity η. We show that increasing the viscosity ratio η'/η causes an abrupt transition from stretching to rolling, with dramatic consequences on the mixing time of the blob. For low viscosity ratios ($0 < \eta'/\eta \leq 2$), the blob stretches continuously and linearly into a thin lamella. In contrast, for high viscosity ratios ($\eta'/\eta > 4$), the blob essentially rotates, following periodic orbits with little elongation. For intermediate ratios, $\eta'/\eta \sim 4$, the blob follows a continuous sub-elongation regime and eventually destabilises by folding. From these qualitatively different kinematic regimes - in good agreement with analytical predictions based on Eshelby's elastic deformation theory - we will discuss how and to what extent the viscosity ratio affects the mixing of the blob.

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