Intermittency in turbulent emulsions

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We investigate the statistics of turbulence in emulsions of two-immiscible fluids of same density, see a render in Fig. 1(a). We compute for the first time velocity increments between points conditioned to be located in the same phase or in different phases and examine their probability density functions (p.d.f., see an example in Fig 1(b)) and the associated structure functions (SF). This enables us to demonstrate that the the presence of the interface reduces the skewness of the p.d.f. at scales below the Kolmogorov-Hinze scale and therefore the magnitude of the energy flux towards the dissipative scales, which is quantified by the third-order SF. The analysis of the higher order SFs shows that multiphase turbulence is more intermittent than single-phase turbulence. In particular, the local scaling exponents of the SFs display a saturation about the Kolmogorov-Hinze scale and below, which indicates the presence of large velocity gradients across the interface. Interestingly, the statistics approach of classic homogeneous isotropic turbulence when significantly increasing the viscosity of the dispersed phase.

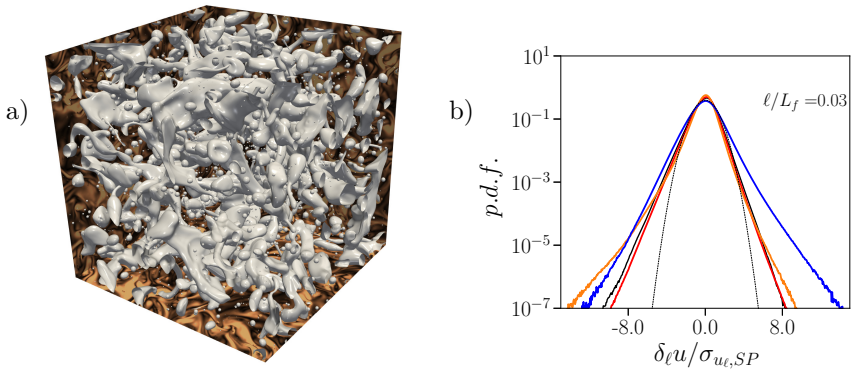

Figure 1: (a) Render of an emulsion at 10% volume fraction, Taylor-Reynolds number $Re_\lambda \approx 137$ and large-scale Weber number $We \approx 42.6$; background planes are colored with vorticity. (b) p.d.f. of longitudinal velocity increments for the same case. Statistics are conditioned to be inside (yellow curve) and outside (red curve) the dispersed phase or across the interface (blue curve). Black curve shows the statistics for the same scale in the correspondent single-phase case. Data are normalised using the single-phase standard deviation.

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