Volume fraction profiles of transport structures in Rayleigh-Taylor turbulent mixing zone: evidence of enhanced diffusion processes

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Using (a) general mass conservation equations, (b) simple volume fraction and density profiles provided by experimental and numerical data, and (c) basic first-gradient constraints on mass flux and mass exchange closures, it is possible to deduce the normalized strength of the flux and exchange terms in a turbulent mixing zone (TMZ) for incompressible fluids and vanishing Atwood number. Some physical consistency properties are also obtained.

This approach shows that, in contrast to more common turbulent shear layers, the Rayleigh-Taylor TMZ must contain an *enhanced diffusion process*, which is *an order of magnitude higher* than $C_\mu k^2/\varepsilon$, the usual estimate of the turbulent diffusion coefficient. The relative weakness of the usual turbulent diffusion reflects the small integral length scales which were previously reported [Llor 2003]. However, the mass exchange rate between structures (akin to the relaxation rate of the variance of a passive scalar) is still correctly and consistently captured by the turbulence relaxation rate ε/k.

The findings support some recent and important evolutions of the 2SFK modelling concept [Llor & Bailly 2003] as presented in this conference [Llor, Bailly & Poujade 2004].

References

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