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Turbulent diffusion in different spatial dimensions.

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The diffusion properties of a mixing layer in shear-free turbulence is studied numerically in two and three dimensional flows. In both cases, the system consists of two turbulent flows with different initial kinetic energies, E_1 and E_2, put alongside and separated by a finite gradient through a mixing layer of thickness $\Delta(t)$. The presented results focus on the differences in behavior of the system as a function of the dimensionality.

Previous studies on the problem, wether experimental [1] or numerical [2],[3] have shown that the velocity field was highly intermittent, which resulted in non Gaussian statistics characterized by high values of the skewness and kurtosis. Indeed, large scale eddies coming from the high energy region, penetrate intermittently into the low energy one through the mixing layer causing this latter to grow. At the beginning of the simulation, the typical thickness of the mixing layer is of the same order as the integral scale which is about 1/80 of the total domain.

Our results show that the thickness of the mixing layer evolves asymptotically in time as a power law, $\Delta(t) \propto t^{\alpha}$. The exponent α can thus be considered as a measure of the mixing velocity of the system. Figure 1, shows the evolution of $\Delta(t)$ as a function of time for the two dimensional (a) and the three dimensional (b) cases. The exponent α is found to be around two times higher in the first case ($\alpha \approx 0.7$ in 2D and $\alpha \approx 0.33$ in 3D), suggesting that the mixing process is faster in two dimensional turbulence.

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[2] Briggs, Ferziger, Koseff and Monismith, *J. Fluid Mech.* **310**, 215-241 (1996).
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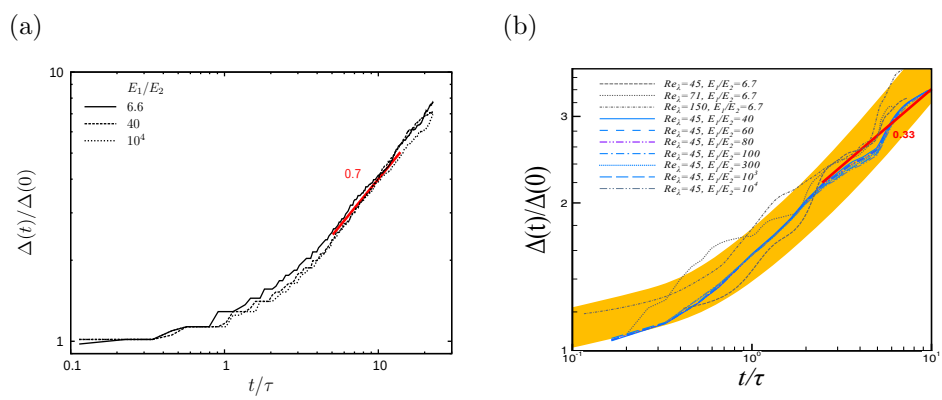

Figure 1: Mixing layer thickness as a function of time : (a) 2D case, (b) 3D case.