Large scale dynamics in three dimensional turbulence

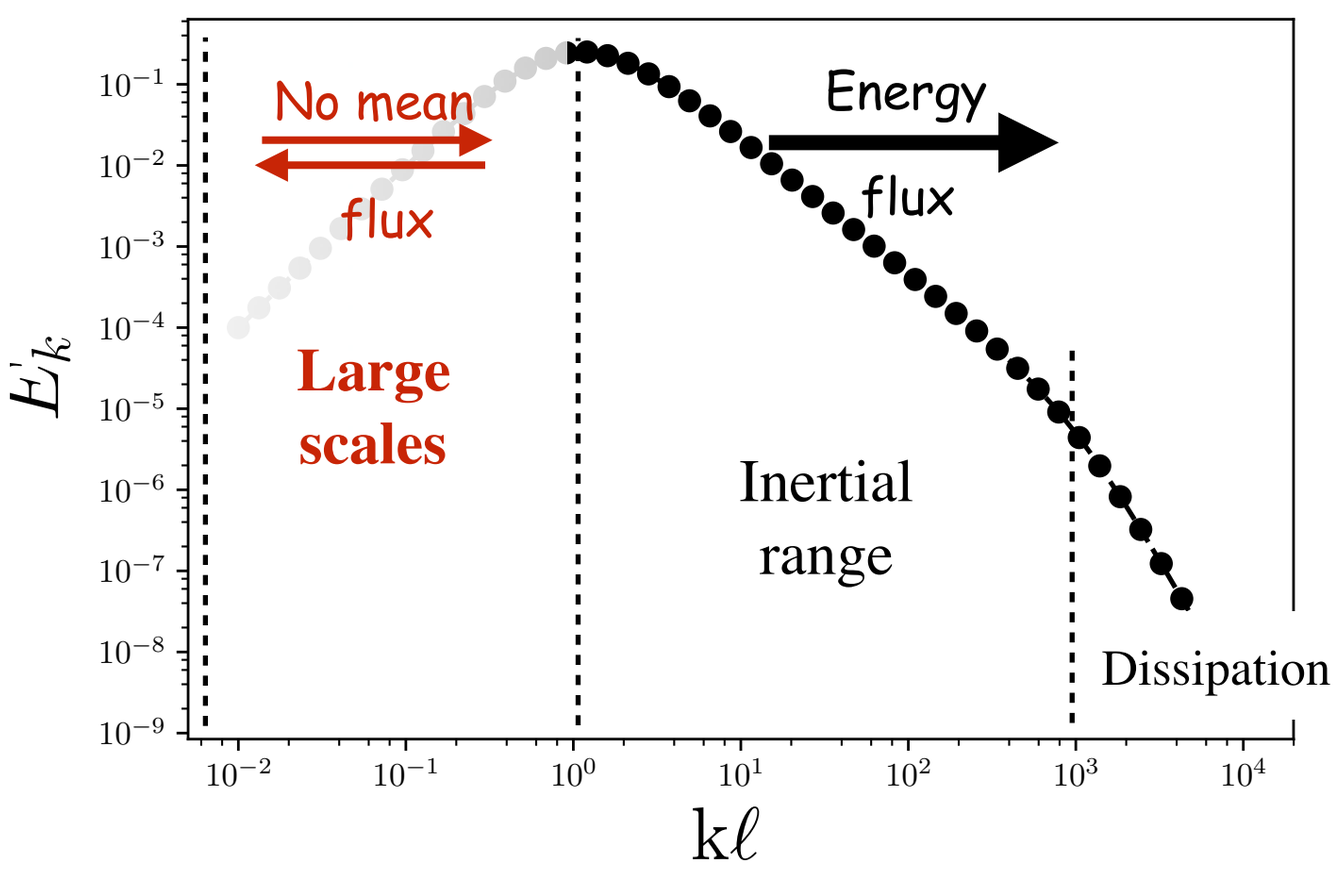
G. Prabhudesai[1], S. Perrard[1,2], F. Pétrélis[1], S. Fauve[1]

1 LPENS, département de Physique, Ecole Normale Supérieure, université PSL, France, EU

2 Laboratoire PMMH, Ecole Supérieure de Physique et Chimie Industrielle, université PSL, France, EU

In turbulent flows, how kinetic energy is distributed among large scales ?

System size >> Integral length scale >> Dissipative scale



No energy mean flux suggests that statistical Physics at equilibrium may apply

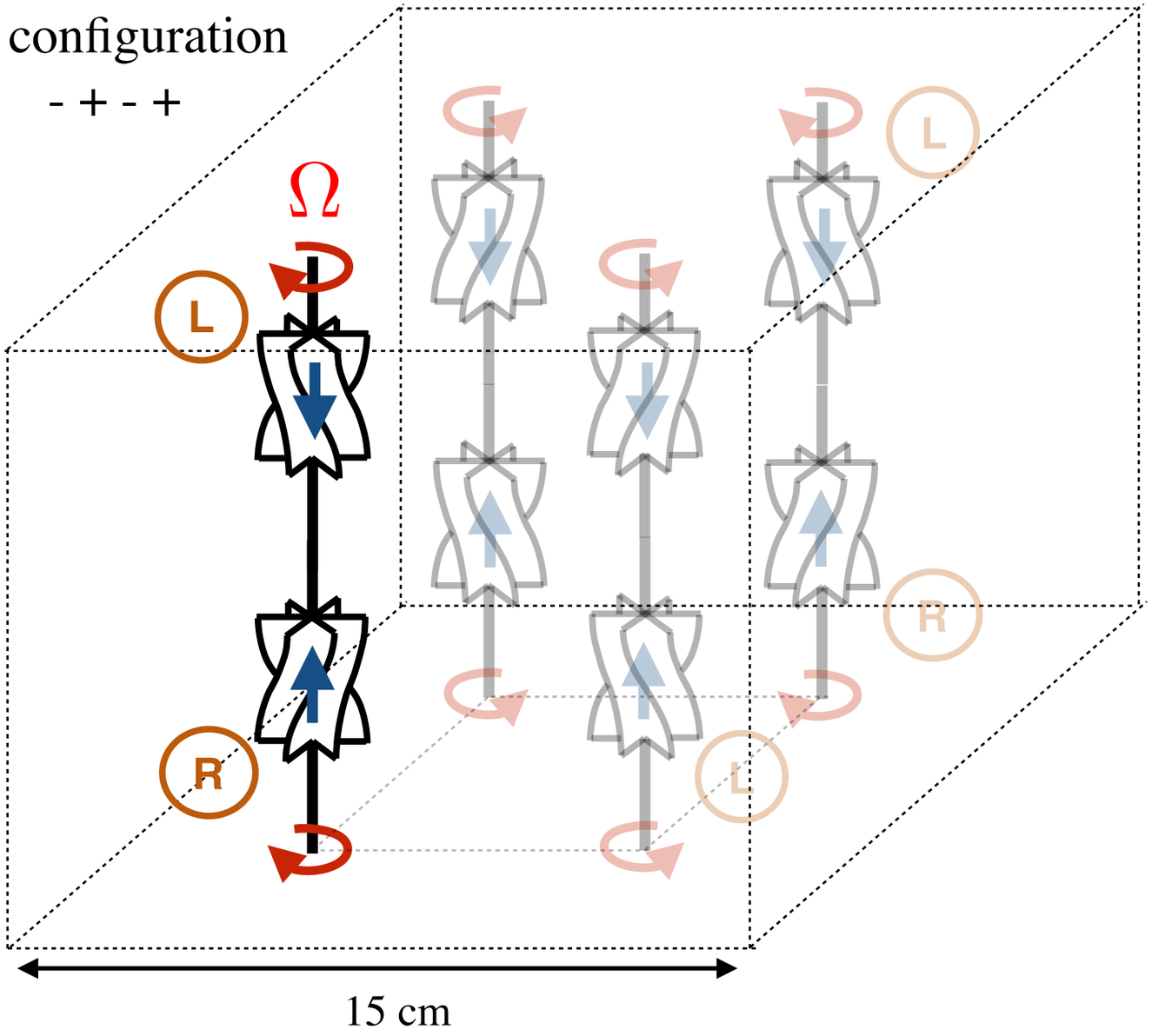
Power spectrum $$P_{ii}(\vec{k}) = \int \mathrm{d}\vec{d}\, C_{ii}(\vec{d}) e^{i\vec{k}\cdot\vec{d}}$$

Average over $\vec{k}$ directions: $E_{ii}(k) = \int \mathrm{d}\vec{\Omega}\ P_{ii}(\vec{k})$

Saffman prediction[1,2] : $E(k) \propto k^2$ for $k\ell \ll 1$

It would correspond to an equipartition of energy among large scale modes

Experimental set up : a 2x2 array of helices



3D2C velocity measurements
using laser scanning PIV

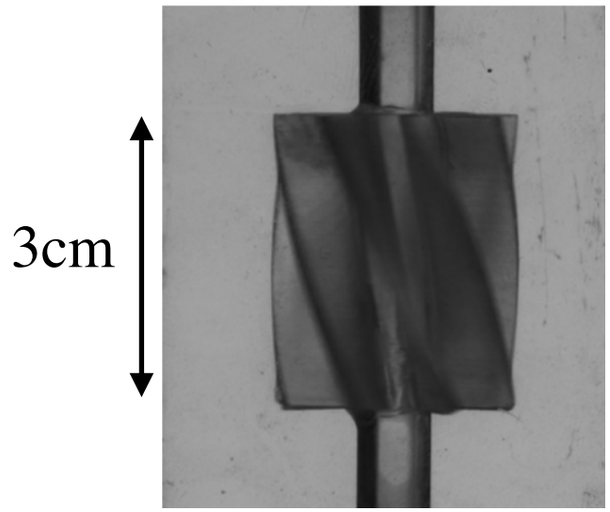
Helicity $\mathcal{H} = \int \mathbf{v} \cdot \omega \ \mathrm{d}^3\mathbf{x}$

Rotation $\mathcal{O} = \int \omega \ \mathrm{d}^3\mathbf{x}$

Alternating chirality

Alternating rotation direction

Chiral helix



Special Pastis mixture to match refractive index

If you want to learn more about the large scale behaviour, please come to see my poster !