A new Experimental Model-Flow? Double Cascade Turbulence and Richardson Dispersion due to Faraday Waves

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Atmospheric and oceanic flows can often be approximated by two-dimensional turbulence. Energy spectra of both flows have been found to obey $E_k \propto k^\gamma, \gamma \approx -3$, on some length scales, as expected for an enstrophy cascade. In the last years much effort has been put into the experimental exploration of two-dimensional turbulence in the laboratory in order to study its formation and its decay. We report the experimental observation of Richardson dispersion and a double cascade in a thin horizontal fluid flow induced by Faraday waves. The energy spectra and the mean spectral energy flux obtained from Particle Image Velocimetry data suggest an inverse energy cascade with Kolmogorov type scaling $E_k \propto k^\gamma, \gamma \approx -5/3$ and an $E_k \propto k^\gamma, \gamma \approx -3$ enstrophy cascade. Particle transport is studied analyzing absolute and relative dispersion as well as the Finite Size Lyapunov Exponent (FSLE) via the direct tracking of real particles and numerical advection of virtual particles. Richardson dispersion with $\langle R^2(t)\rangle \propto t^3$ is observed and is also reflected in the slopes of the FSLE ($\Lambda \propto \Delta R^{-2/3}$) for virtual and real particles.

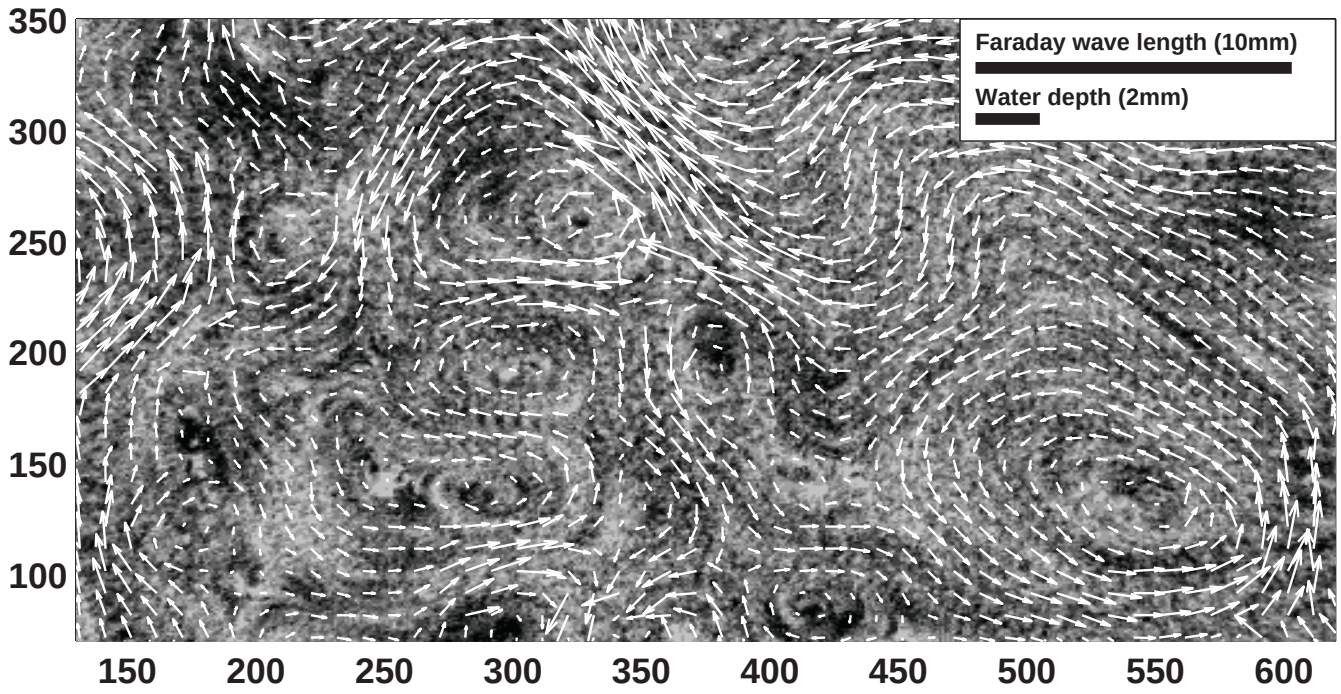

FIG. 1: The horizontal surface fluid flow induced by the Faraday waves at a forcing frequency of $\omega = 50$ Hz and acceleration $a = 1.5\, g_0$. Every second velocity arrow is shown. RMS velocity is $v_{rms} \approx 1.15$ cm/s. Reynolds number based on the Faraday wavelength and v_{rms} is $Re \approx 100$.

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