Surface waves propagating on a turbulent flow

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Resumen

We study the propagation of monochromatic surface waves on a turbulent flow of liquid metal, when the waves are much less energetic than the background flow. Electromagnetic forcing drives quasi-two-dimensional turbulence with strong vertical vorticity. To isolate the surface-wave field, we remove the surface deformation induced by the background turbulent flow using coherent-phase averaging at the wave frequency. We observe a significant increase in wavelength, when the latter is smaller than the forcing length scale. This phenomenon has not been reported before and can be explained by multiple random wave deflections induced by the turbulent velocity gradients. The shift in wavelength thus provides an estimate of the fluctuations in deflection angle. Local measurements of the wave frequency far from the wavemaker do not reveal such systematic behavior, although a small shift is visible. Finally, we quantify the damping enhancement induced by the turbulent flow and compare it to the existing theoretical predictions. Most of them suggest that the damping increases as the square of the Froude number, whereas our experimental data show a linear increase with the Froude number. We interpret this linear relationship as a balance between the time for a wave to cross a turbulent structure and the turbulent mixing time. The larger the ratio of these two times, the more energy is extracted from the wave. We conclude with possible mechanisms for energy exchange. (C) 2016 AIP Publishing LLC.

Palabras clave

KeyWords Plus: WATER-WAVES; UPPER OCEAN; DISCONTINUOUS VORTICITY; DISPERSION-RELATIONS; SCATTERING; ENERGY; SWELL; DECAY

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