

The generation of internal waves by a translating and oscillating body: theory and experiment

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Interest in the generation of internal waves by bodies both translating and oscillating has recently been revived by experiments which showed that, for sufficiently high Reynolds and Froude numbers, lee waves generated by a body moving horizontally through a stratified fluid give way to “random” internal waves generated by its turbulent wake, and by theories which led to model the wake as a source of mass advancing at the same velocity as the body and pulsating at the Strouhal frequency of vortex shedding [1–4]. The present paper proposes a joint theoretical and experimental study of this model.

First the results of [5] are applied to a horizontally moving mass source of oscillatory strength. The structure of the wave field depends markedly on the ratio ω/N of the source frequency to the buoyancy frequency. For $\omega/N < 1$ three systems of waves are observed, each of which contained inside its own conical wavefront; parts of the fronts are caustics and extend only downstream, while other parts extend both upstream and downstream. For $\omega/N > 1$ only two systems remain, with no upstream propagation. Advances beyond the analysis of [5] are the calculation of both the phase and the amplitude of the waves; particular attention is paid to the shape of the surfaces of constant phase, the streamwise evolution of the wavelength, and the nature of the fronts.

These results are then compared with experiments involving the simplest practical realisation of the preceding source, i.e. a sphere translating horizontally and oscillating vertically. Values of ω/N both smaller and larger than 1 are considered ($\omega/N = 0.4, 0.6, 0.8, 1.01$ and 1.2), using the visualisation technique developed in [2–3]. Discrepancies between theory and experiment are noted, concerning in particular the shape of the fronts and the relative amplitudes of the different components of the wave field; explanations are proposed.

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