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The theory of waves in dispersive systems and its application to problems in physical oceanography

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The generation and propagation of waves in one-dimensional, linear, non-dissipative, homogeneous, dispersive systems are considered. Familiar results are obtained for an applied force in the form of a localised pulse, and for a localised disturbance with periodic time variation. The initial value problem for the periodic disturbance is then examined, the results of which exhibit two significant features not generally recognised elsewhere in the literature. It is found that the forced waves propagate with their group velocities, in the sense that each forced wave is observed in a region the boundary of which travels away from the disturbance with the group velocity. If the group velocity of a forced wave is zero, the amplitude at a fixed point increases with time, indicating a form of resonance. The physical interpretation of this behaviour is that energy does not then propagate away from the disturbance. The results are then generalised to the problem of a travelling oscillating disturbance (the most important particular case of which is a travelling steady disturbance). The forced waves again propagate with their group velocities, and a resonant response is found when the velocity of the disturbance equals the group velocity of a forced wave.

These general results are illustrated by application to three problems of oceanographic interest. In the classical problem of waves on the surface of a liquid, they provide a new physical understanding of results obtained by many writers, beginning with Lord Rayleigh and extending to the

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present time. The generation of 'double Kelvin' waves by various wind distributions is then considered, both for an abrupt step and a particular model of a more gradual change in depth. The final problem examined is the generation of Rossby waves propagating in one dimension; the possible implications of the results for two dimensional propagation are also discussed.