Abstract View

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Kinematics of Turbulence Convected by a Random Wave Field

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ABSTRACT

Turbulent velocity spectra measured beneath wind waves show a large enhancement about the central wave frequency. A “5/3" frequency dependence can be seen both above and below the central peak, but with an apparent increase in spectral density at high Frequencies.

We show that these features can be understood via a generation of Taylor's hypothesis to the case in which frozen, isotropic, homogeneous turbulence is bodily convected past a fixed probe by a combination of drift and wave orbital motions. In a monochromatic wave field turbulent energy is aliased into harmonics of the wave frequency f_p. We show qualitatively how drift currents or a random wave field broaden these lines into a continuous spectrum, and present the results of direct calculations which demonstrate clearly the transition from “line-like” to a smooth “5/3" spectrum. We calculate the leading asymptotic behavior in the limit of large and small frequencies for an arbitrary wave-height spectrum. For wave orbital velocities larger than the mean drift (in the direction of wave propagation) we find when U denotes an rms velocity. This result provides a possible explanation for the observed increase in spectral densities for frequencies above the peak.