Burgers-like wave turbulence in the surf zone

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Ocean wave fields are made of a large number of waves that are mutually interacting in a random way. It is an important example of *wave turbulence* (Nazarenko, 2011). Significant achievements for modelling wave turbulence in deep water have been made since the pioneer work of Hasselman (1962). Under the hypotheses of weak nonlinearities and strong dispersion Hasselman derived a kinetic equation for the wave action, which is the basis of current operational wave forecasting models. A remarkable property of Hasselmann kinetic equation is that it possesses a stationary analytical solution that corresponds to a constant flux of energy from high to small wave numbers (Zakharov and Filonenko, 1966). The solution corresponds, in the frequency wave spectrum, to a power law of the form of ω^{-4} (ω the pulsation), that is in agreement with field observations.

In shallow waters, the weak wave turbulence approach is no longer valid because, as the waves propagate shoreward, the nonlinearities increase and the dispersive effects decrease. In the inner surf zone, waves are strongly nonlinear and almost non-dispersive. The interacting random waves become phase-locked and generate sawtooth waves. These coherent structures result from the competition between nonlinear and dissipative processes.

During this talk, I will analysed wave dynamics in the inner surf zone. First, I will show that this dynamics has strong similarities with Burgers-like turbulence (Saffman 1968). Then I will present the derivation of a theoretical power spectral density law which describes wave energy from the inertial range to the dissipative range (see figure below). Finally, we will discuss about the implications of this work for predicting energy dissipation and turbulent eddy viscosity in the inner surf zone.

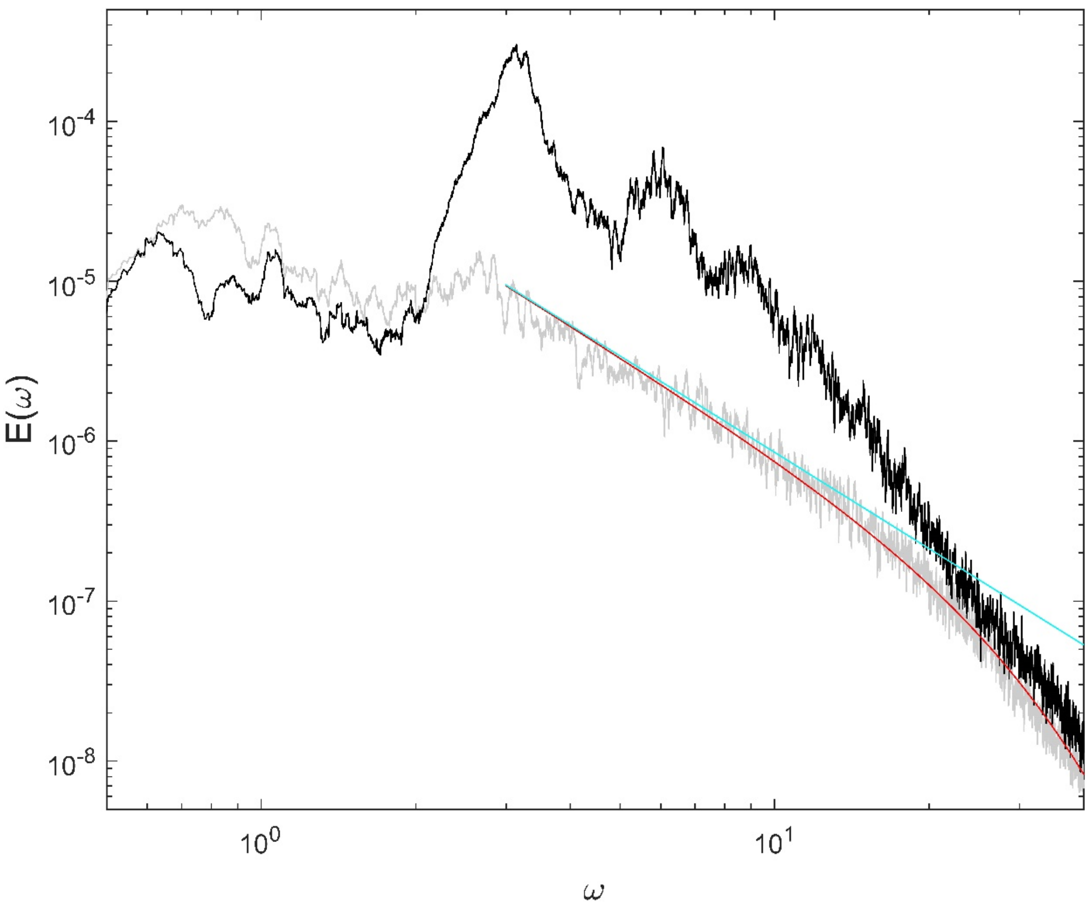

Figure 1: Power spectra. Comparison between laboratory measurements in the inner surf zone (grey line) and the theoretical model (red line). Cyan line, asymptotic ϖ^{-2} behaviour of the theoretical model for small values of ω; black line, measurements at the onset of breaking. Random wave data were collected by Van Noorloos (2003) in a TU Delft wave flume.