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The role of resonance conditions in the dynamics of nonlinear waves

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The resonance conditions play the major role in the wave turbulence theory (WT). Statistical WT regards real solutions of the resonance conditions and yields wave kinetic equation while discrete WT deals with its integer solutions described by a few independent clusters of waves, with no energy flow among them. It was established in laboratory experiments with gravity waves (2006) that discrete effects are major and statistical WT predictions are never achieved while with increasing wave intensity the nonlinearity becomes strong before the system loses sensitivity to the vector space discreteness. It poses a novel problem of finding integer solutions of resonance conditions in arbitrary big spectral domain.

We present here both a sketch of a new fast computational method allowing to compute all integer solutions of the resonance conditions of 4-wave interactions among the gravity waves and the results of computation in spectral domain <1000. Our algorithm allows to study separately two classes of waves: (Class 1) those which transport the energy over the scales of the wave field, i.e. with all different wave lengths, and (Class 2) those which do not generate new wave lengths and transport the energy not over the scales but over the phases presenting circle structures in the spectral space, i.e. with pair-wise coinciding wave lenghs. In Class 1, solutions are distributed not uniformly along the wave spectrum but are rather grouped around some specific wave numbers and most waves take part only in one solution with number of vectors decreasing exponentially when vector multiplicity is grows (multiplicity describes how many times a given vector is a part of some solution). In Class 2, most solutions are constructed with the wave vectors parallel and close to either axe X or axe Y and there exists some initial interval of small multiplicities, from 1 to 10, with very small number of corresponding vectors. We discuss possible physical implications of these results.