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Theory of inertial waves in rotating fluids

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The inertial waves emerge in the geophysical and astrophysical flows as a result of Earth rotation [1]. The linear theory of inertial waves is known well [2] while the influence of nonlinear effects of wave interactions are subject of many recent theoretical and experimental studies. The three-wave interactions which are allowed by inertial waves dispersion law (frequency is proportional to cosine of the angle between wave direction and axes of rotation) play an exceptional role. The recent studies on similar type of waves – internal waves, have demonstrated the possibility of formation of natural wave attractors in the ocean (see [3] and references herein). This wave focusing leads to the emergence of strong three-wave interactions and subsequent flows mixing. We believe that similar phenomena can take place for inertial waves in rotating flows. In this work we present theoretical study of three-wave and four-wave interactions for inertial waves. As the main theoretical tool we suggest the complete Hamiltonian formalism for inertial waves in rotating incompressible fluids [4]. We study three-wave decay instability and then present statistical description of inertial waves in the frame of Hamiltonian formalism. We obtain kinetic equation, anisotropic wave turbulence spectra and study the problem of parametric wave turbulence. These spectra were previously found in [5] by helicity decomposition method. Taking this into account we discuss the advantages of suggested Hamiltonian formalism and its future applications.

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