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Resonance clustering in wave turbulent regimes: Integrable dynamics

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Two fundamental facts of the modern wave turbulence theory are 1) existence of power energy spectra in k-space, and 2) existence of "gaps" in this spectra corresponding to the resonance clustering. Accordingly, three wave turbulent regimes are singled out: \emph {kinetic}, described by wave kinetic equations and power energy spectra; \emph{discrete}, characterized by resonance clustering; and \emph{mesoscopic}, where both types of wave field time evolution coexist. In this paper we study integrable dynamics of resonance clusters appearing in discrete and mesoscopic wave turbulent regimes. Using a novel method based on the notion of dynamical invariant we establish that some of the frequently met clusters are integrable in quadratures for arbitrary initial conditions and some others -- only for particular initial conditions. We also identify chaotic behaviour in some cases. Physical implications of the results obtained are discussed.

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