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Radar backscattering due to nonlinear gravity-capillary waves. Laboratory study.

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Ka-band radar backscattering due to gravity-capillary waves (GCW) of finite amplitude has been studied in laboratory conditions.

First, radar scattering for the case of small-amplitude monochromatic GCW is modeled and direct experimental verification of the Bragg scattering mechanism is presented. Resonance dependencies of the intensity of backscattered signals on frequency and propagation direction of GCW are obtained. The width of the resonance curves is shown to be determined by the angular width of the radar diagram.

At the second stage the impact of nonlinearity of gravity-capillary waves on radar return is investigated. A double-peak resonance curve is obtained when studying radar backscattering due to steep periodic gravity-capillary waves with second-order harmonics satisfying the Bragg resonance condition. It is shown that both the second (bound) harmonic and free gravity-capillary waves at the double GCW frequency are excited. An indication of co-existence of the two types of waves is given in the form of spatial periodic modulation of the wave amplitude at the double GCW frequency. This modulation is detected in experiment and the relation between the amplitudes of the free and bound harmonics is estimated. A contribution from nonlinearity of radar scattering mechanism itself to the intensity of the radar signal is estimated theoretically. This contribution to the backscatter is estimated as a second order correction to the resonance (Bragg) scattering model, and is shown to be comparable to the Bragg backscattering due to the second harmonics of GCW. The work has been supported by RFBR (Projects 05-05-64137, 04-05-64763) and INTAS (Project 03-51-4987 “SIMP”).