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Nonlinear Acoustic Waves in Solids with Dislocations

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The propagation of a longitudinal acoustic wave in a nonlinear dislocated solid is studied. We establish that the presence of dislocations leads to the formation of solitons. The soliton width is determined by the effective mass of dislocations and the sound–dislocation interaction coefficient. The influence of damping on the structure of wave processes is studied.

We show that a nonlinear stationary acoustic wave can be formed in a solid with dislocations. Such a wave is periodic and moves faster than the acoustic signals in a linear medium. A sawtooth wave has a wavelength increasing with its amplitude.

We consider the propagation of ultrasonic waves in a nonlinear quasi-harmonic solid medium with dislocations. We show that the presence of dislocations leads to the modulation instability of quasi-harmonics and the formation of stationary wave envelopes (wave packets), while their amplitude and width are determined by the effective mass dislocation and the acoustic–dislocation interaction coefficient.

We show that during the propagation of a longitudinal acoustic wave in a solid with dislocations, a quadratic nonlinearity becomes apparent that leads to the possibility of generation of a wave with a double frequency. The interaction between the first and the second harmonics is nonsymmetric; i.e. the first harmonic generates the second one, but the latter affects the first one only if signal of the first harmonic exists. We obtain the characteristic length at which energy transfer of the main wave into the energy of the second harmonic is expected. We analyze the dependence of this length on the main wave frequency, the dislocation mass, and the acoustic–dislocation interaction coefficient.