TWO-PARAMETER METHOD
FOR DESCRIBING THE NONLINEAR
EVOLUTION OF NARROW-BAND WAVE TRAINS

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S u m m a r y

We consider the evolution of narrow-band wave trains of finite amplitude in a nonlinear dispersive system which is described by the Klein–Gordon equation with arbitrary polynomial nonlinearity. We use a new perturbative technique which allows the original wave equation to be reduced to a model equation for the wave train envelope (high-order nonlinear Schrödinger equation). The time derivative is expanded into an asymptotic series in two independent parameters which characterize the smallness of amplitudes (ε) and the slowness of their spatial variations (μ). In contrast to other perturbative methods in which these two parameters are taken equal (e.g., the multiple scale method), the two-parameter method produces no secular terms. The results of this study can be applied to investigating the propagation of ultrashort (femtosecond) pulses in optical fibers, to studying the wave events on a fluid surface, and to describing the Langmuir waves in hot plasmas.