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Hyperbolic waves and nonlinear geometrical acoustics. (English) Zbl 0668.76075

Applied mathematics and computing, Trans. 6th Army Conf., Boulder/Colo. 1988, ARO Rep. 89-1, 527-570 (1989).

[For the entire collection see Zbl 0664.00002.]

Nonlinear wave propagation is a unified scientific field largely because the basic phenomena are described by a relatively small number of canonical equations. These equations can be derived systematically from the primitive equations modelling the wave motion by means of formal asymptotic expansions. The aim of this paper is to summarise the canonical equations for weakly nonlinear hyperbolic waves, with or without the inclusion of small dissipative effects. We apply these results to the equations of motion of a compressible fluid, which gives a theory of nonlinear geometrical acoustics. We derive asymptotic equations for a single wave. The result is the kinematic wave equation for inviscid waves, and the generalized Burgers' equation for viscous waves. Next, we include diffraction. This gives the unsteady transonic small disturbance equation and the Kuznetsov equation. We consider wave-wave and wave-mean field interactions. Finally, these equations are specialized to the case of sound waves in a fluid.

MSC:

76N10	Existence, uniqueness, and regularity theory for compressible fluids and gas dynamics	Cited in **2** Documents
76D33	Waves for incompressible viscous fluids	
76Q05	Hydro- and aero-acoustics	
35Q99	Partial differential equations of mathematical physics and other areas of application	

Keywords:

formal asymptotic expansions; weakly nonlinear hyperbolic waves; motion of a compressible fluid; nonlinear geometrical acoustics; kinematic wave equation for inviscid waves; generalized Burgers' equation for viscous waves; diffraction; unsteady transonic small disturbance equation; Kuznetsov equation; wave-mean field interactions