Multiscale Analysis of Nonlinear Waves in Elastic Materials

Carlo Cattani

University of Salerno (Italy),

Sunto   This lecture is devoted to the nonlinear analysis of waves in hyperelastic materials and deals with: 1) Nonlinear wave equations for plane waves in hyperelastic materials; 2) the harmonics generation by initially excited harmonic longitudinal wave; 3) New simple waves generation by initially excited simple longitudinal wave 4) Resonance phenomena. Especial attention is payed to simple waves and similarity between new harmonic and simple waves generation. Some peculiarities of using the wavelets analysis to revealed wave e®ects are also discussed.

It is shown that cubic nonlinearity and nonlinearities of higher order follow naturally from classical nonlinear acoustics approach and should be considered equally important compared with the quadratic nonlinearity.

Nonlinear deformations are realized within the classical theory of waves in material by using the Murnaghan elastic potential

$$W(\varepsilon_{ik}) = \frac{1}{2}\lambda(\varepsilon_{mm})^2 + \mu(\varepsilon_{ik})^2 + \frac{1}{3}A\varepsilon_{ik}\varepsilon_{im}\varepsilon_{km} + B(\varepsilon_{ik})^2\varepsilon_{mm} + \frac{1}{3}C(\varepsilon_{mm})^3:$$

Here $\lambda; \mu$ are Lame elastic constants, $A; B; C$ are Murnaghan elastic constants, $\varepsilon_{ik} = \frac{1}{2}(u_{i;k} + u_{k;i} + u_{m;i}u_{m;k})$ is the nonlinear Green strain tensor. The Murnaghan potential describes a broad class of materials, is basic in mechanics of materials and widely used. From this potential follows some nonlinear equations for the displacement. Some approximate solutions, with suitable initial conditions, will be studied within the framework of the harmonic wavelet analysis. With harmonic wavelets some e®ects depending on the scale of resolution will appear showing some complex features of the simple (plane) wave propagation.

DiFarma

University of Salerno,

Via Ponte Don Melillo, I-84084 Fisciano (SA)

E-mail address: ccattani@unisa.it