Geophysical Research Abstracts
Vol. 13, EGU2011-1406, 2011
EGU General Assembly 2011

Bidirectional and unidirectional waves in Hertzian chains

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Analysis of Hertzian chains is relevant to the dynamics of nonlinear compressional waves in granular media. The physical model is a line of elastic spheres in contact, with forces between each pair of spheres proportional to the 3/2 power of the deformation at the contact. From the coupled set of equations for discrete sphere deformations, one derives an effective medium description as a second order nonlinear wave equation in the long wavelength limit. The second order wave equation can be reduced to first order, describing a subset of unidirectional waves. The first order equation is amenable to similarity solution and solution by the method of characteristics. We compare solutions of the first and second order wave equations, and examine soliton- like behavior including the ability of waves to pass through each other.
Work supported by the U. S. Office of Naval Research.