CFA/VISHNO 2016

Strongly nonlinear propagation of rotational waves in a granular chain

A. Cebrecos-Ruiz[a], G. Theocharis[a], P. Béquin[a], L. Zheng[a], V. Andreev[b], V. Gusev[a] et V. Tournat[a]

[a]LAUM, UMR-CNRS 6613, Avenue Olivier Messiaen, Université du Maine, 72085 Le Mans, France

[b]Acoustics Department, Faculty of Physics, Moscow State University, 119991 Moscow, Communauté des États indépendants (ex-URSS)

vincent.tournat@univ-lemans.fr

CFA2016/349
Strongly nonlinear propagation of rotational waves in a granular chain

A. Cebrecos-Ruiz[a], G. Theocharis[a], P. Béquin[a], L. Zheng[a], V. Andreev[b], V. Gusev[a] et V. Tournat[a]
[a]LAUM, UMR-CNRS 6613, Avenue Olivier Messiaen, Université du Maine, 72085 Le Mans, France
[b]Acoustics Department, Faculty of Physics, Moscow State University, 119991 Moscow, Communauté des États indépendants (ex-URSS)
vincent.tournat@univ-lemans.fr

In Ref. [1], the first results on the purely nonlinear hysteretic propagation of rotational waves in a one-dimensional granular chain were presented. The basis of the theory describing the nonlinear pulse distortion by quadratic hysteretic torsional coupling at the contact was established. This description is in agreement with the experimental results obtained in a granular magnetic chain configuration and provided a quantitative estimate of the hysteretic nonlinear parameter. This " model " configuration is fairly well characterized and allows for the study of a wide variety of nonlinear effects in a purely hysteretic medium. Here we focus on the propagation of pulses with relatively larger amplitudes than previously, reaching a strongly nonlinear regime of propagation, out of the quadratic hysteretic approximation. The pulse amplitudes can lead to total torsional sliding at the contacts between beads and strong saturation effects are observed. Modeling of these strongly nonlinear hysteretic effects is in progress and will be presented together with experimental results. In particular, the role of the interplay between nonlinearity and dispersion will be discussed. These results could be of fundamental interest but also could help in the future design of wave devices based on nonlinear elastic metamaterials.
[1] J. Cabaret, P. Béquin, G. Theocharis, V. Andreev, V.E. Gusev, V. Tournat, Nonlinear hysteretic torsional waves, Phys. Rev. Lett. 115, 054301 (2015).