Acoustic metamaterials: the fascinanting dynamics of nonlinear resonators

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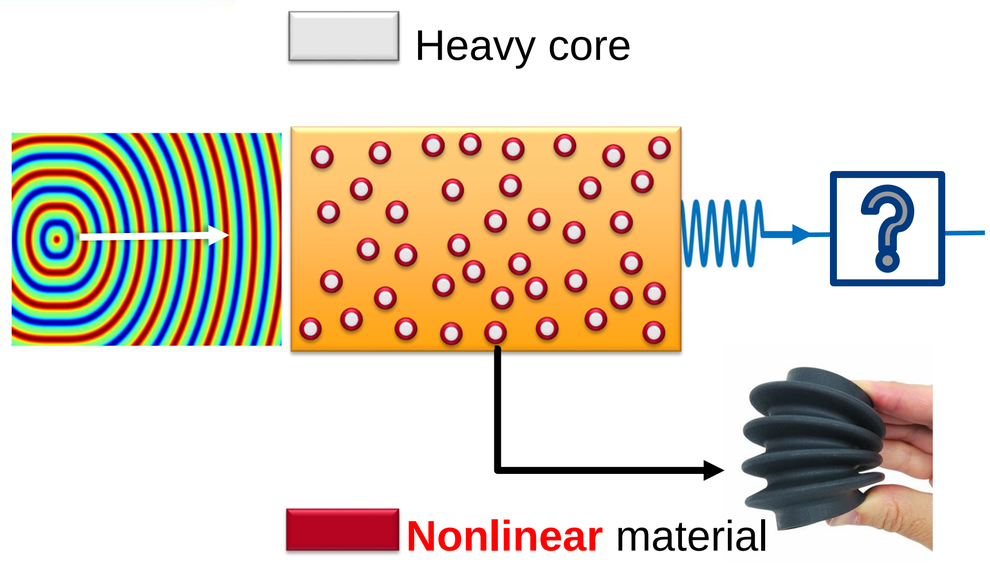
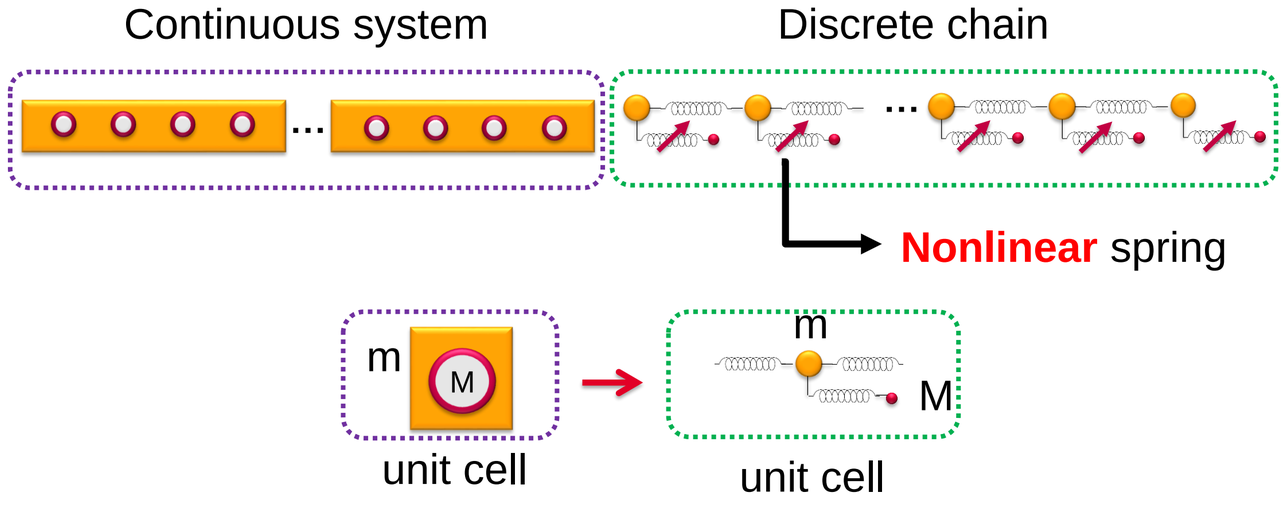
Introduction

Metamaterials are engineered structures in which the design of a meta-atom with specific dynamics gives rise to on-demand and unusual behavior of the artificial structure, making it possible to **manipulate waves**. Most of the works up to now in elastodynamics, however, have been limited to linear material models [1]. This work intends to show that **fascinating** and **unrevealed** phenomena is yet to be discovered when **nonlinearities** proper of many **real materials** are taken into account.



Model



Methodology

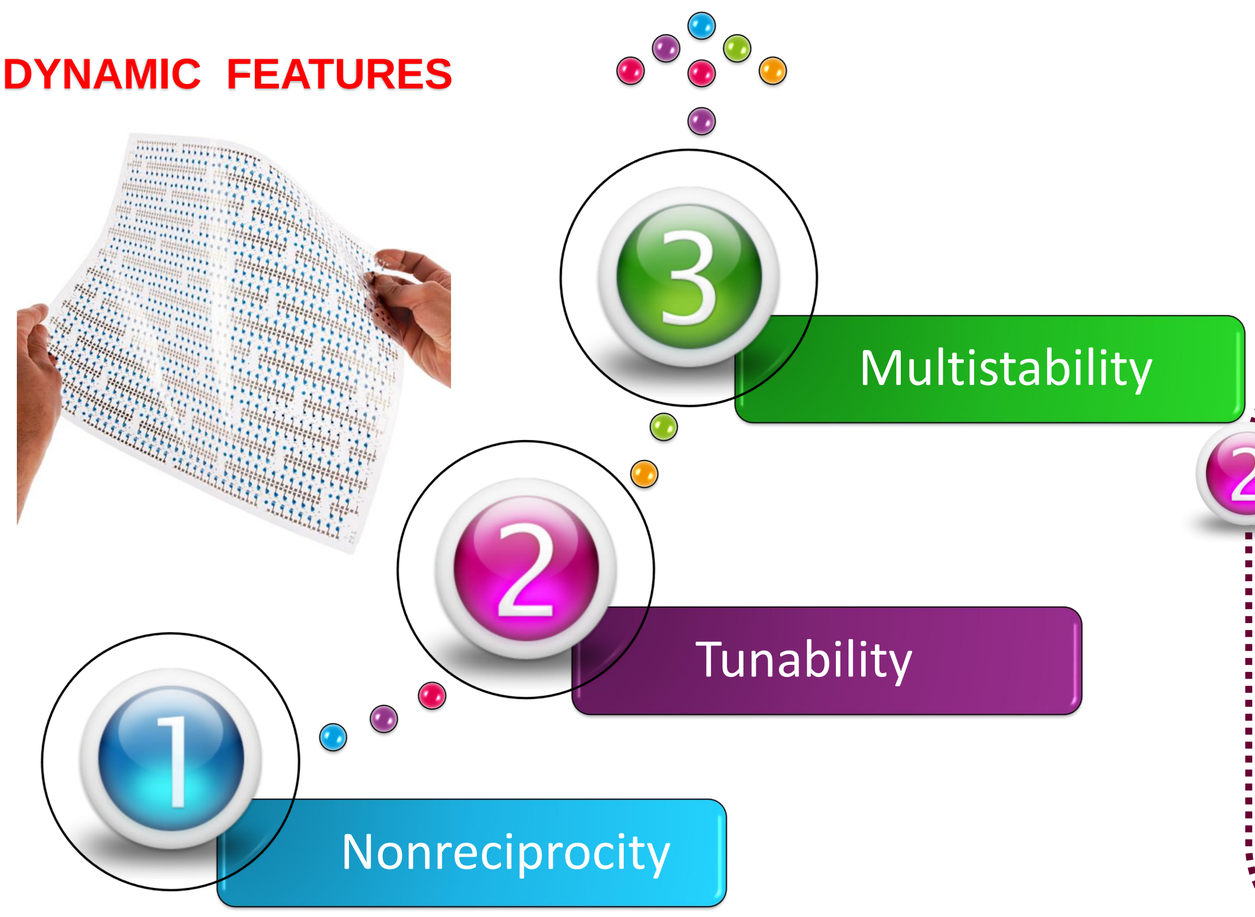
Approximating techniques were used to describe the oscillatory motion of the nonlinear periodic system:

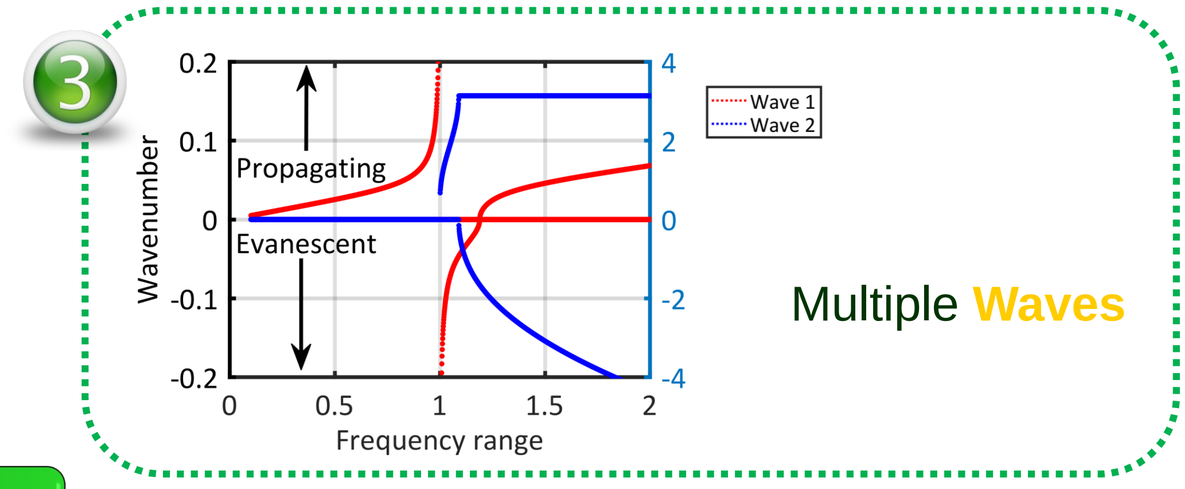
Harmonic Balance

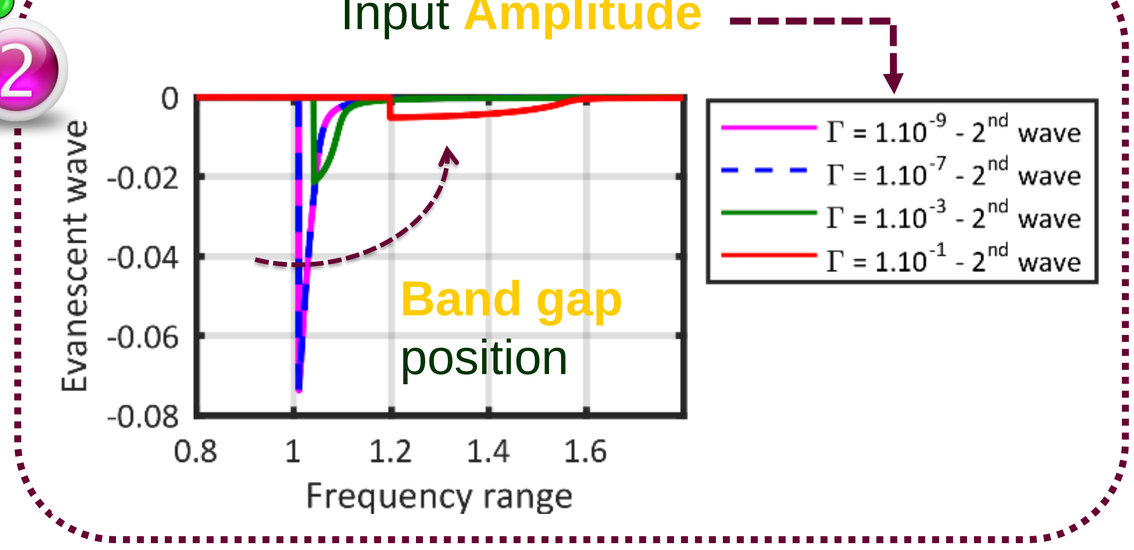
Multiple-Scale

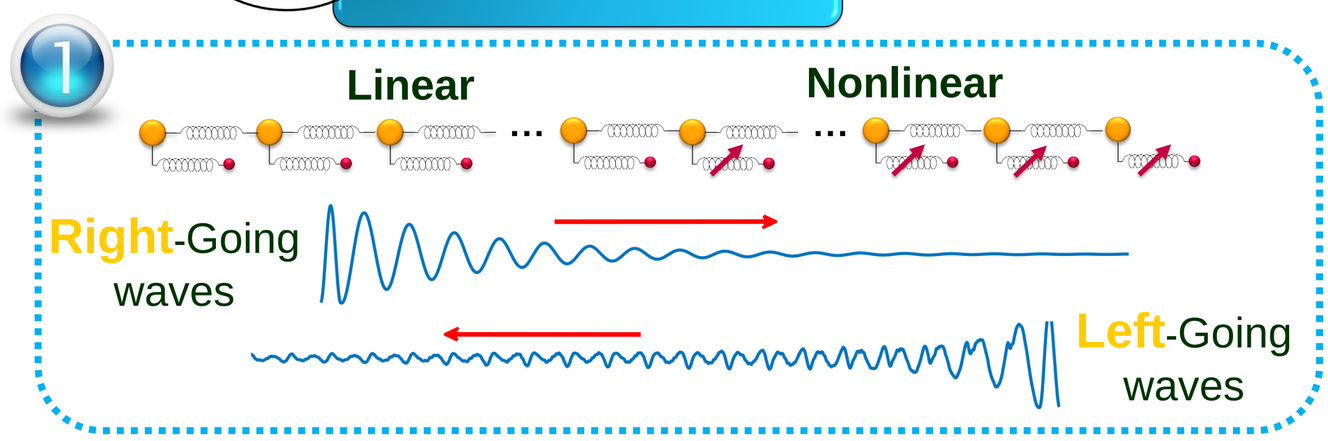
Direct numerical simulations were also performed in order to verify the approximating solutions.

Results









Conclusions and Future Prospects

It was shown that cubic metamaterials exhibit **multistability**, **tunability** and **nonreciprocity**. Such features make them promising for applications in **sensor technology**, **damage detection**, **imaging**, **energy harvesting**, among others. In the future, the effect of other nonlinear material models in the dynamic behavior of metamaterials will be investigated.

Reference

[1] J. Christensen, M. Kadic, M. Wegener and O. Kraft, *Vibrant times for mechanical metamaterials*, MRS Commun 5(3), 2015.