



Universiteit
Leiden
The Netherlands

Mechanical metamaterials: nonlinear beams and excess zero modes

Lubbers, L.A.

Citation

Lubbers, L. A. (2018, September 13). *Mechanical metamaterials: nonlinear beams and excess zero modes*. *Casimir PhD Series*. Retrieved from <https://hdl.handle.net/1887/65383>

Version: Not Applicable (or Unknown)

License: [Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

Downloaded from: <https://hdl.handle.net/1887/65383>

Note: To cite this publication please use the final published version (if applicable).

Cover Page



Universiteit Leiden



The handle <http://hdl.handle.net/1887/65383> holds various files of this Leiden University dissertation.

Author: Lubbers, L.A.

Title: Mechanical metamaterials: nonlinear beams and excess zero modes

Issue Date: 2018-09-13

Propositions

accompanying the thesis

Mechanical Metamaterials: Nonlinear Beams and Excess Zero Modes

- I.** The rescaled postbuckling stiffness as function of beam width cannot exceed Euler's limit.
Chapter 2 of this thesis.
- II.** A wide metabeam can mimic a slender plain beam, by balancing the nonlinearities of the rubber and the metastructure.
Chapter 2 of this thesis.
- III.** The maximum number of anomalous excess zero modes in diluted rotating square mechanisms is achieved when the number of 3×3 clusters is maximal.
Chapter 3 of this thesis.
- IV.** Excess zero modes occur in collections of symmetric elements featuring mechanisms that disappear under small geometric perturbations.
Chapter 4 of this thesis.
- V.** *Linearly* elastic beam-models that encompass extensibility are ill-defined.
Magnusson et al., Int. J. Solids. Struct. **38**, 8441-8457 (2001).
Humer, Acta Mech. **224**, 1493-1525 (2013).
- VI.** Surprisingly, mechanical instabilities are widely leveraged in metamaterials, but metamaterials are barely leveraged to tune instabilities.
Reis, J. Appl. Mech. **82**, 111001 (2015).
- VII.** Multibranch mechanisms are widespread in systems with symmetries.
Waitukaitis et al., Phys. Rev. Lett. **114**, 055503 (2015).
- VIII.** Finite correlation length-scales limit the practical design of metamaterials.
Coulais et al., Nat. Phys. **14**, 40-44 (2018).
- IX.** Finite element simulations should be treated as numerical experiments.

Luuk Lubbers
Leiden, 13 September, 2018
