# THE DYNAMICS OF JUMPING POPPERS

—MMSC CASE STUDY PROJECT—

Proposed by Marc Suñé

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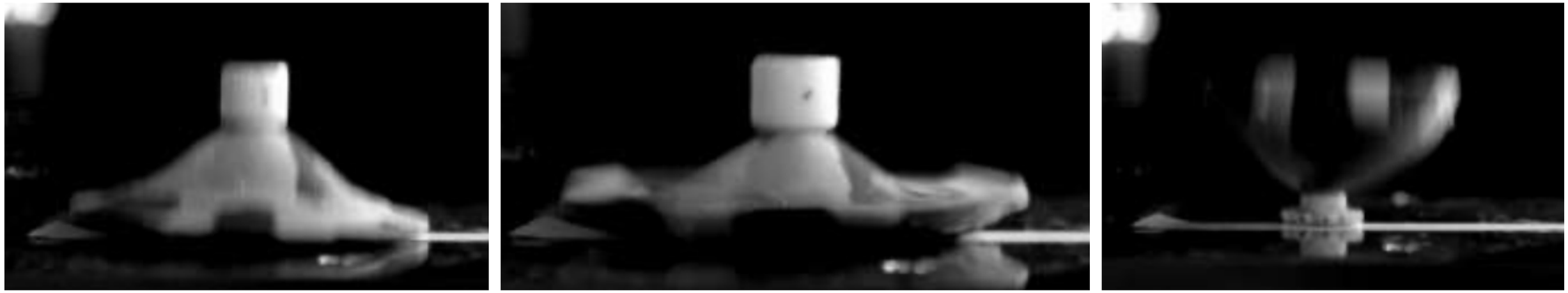

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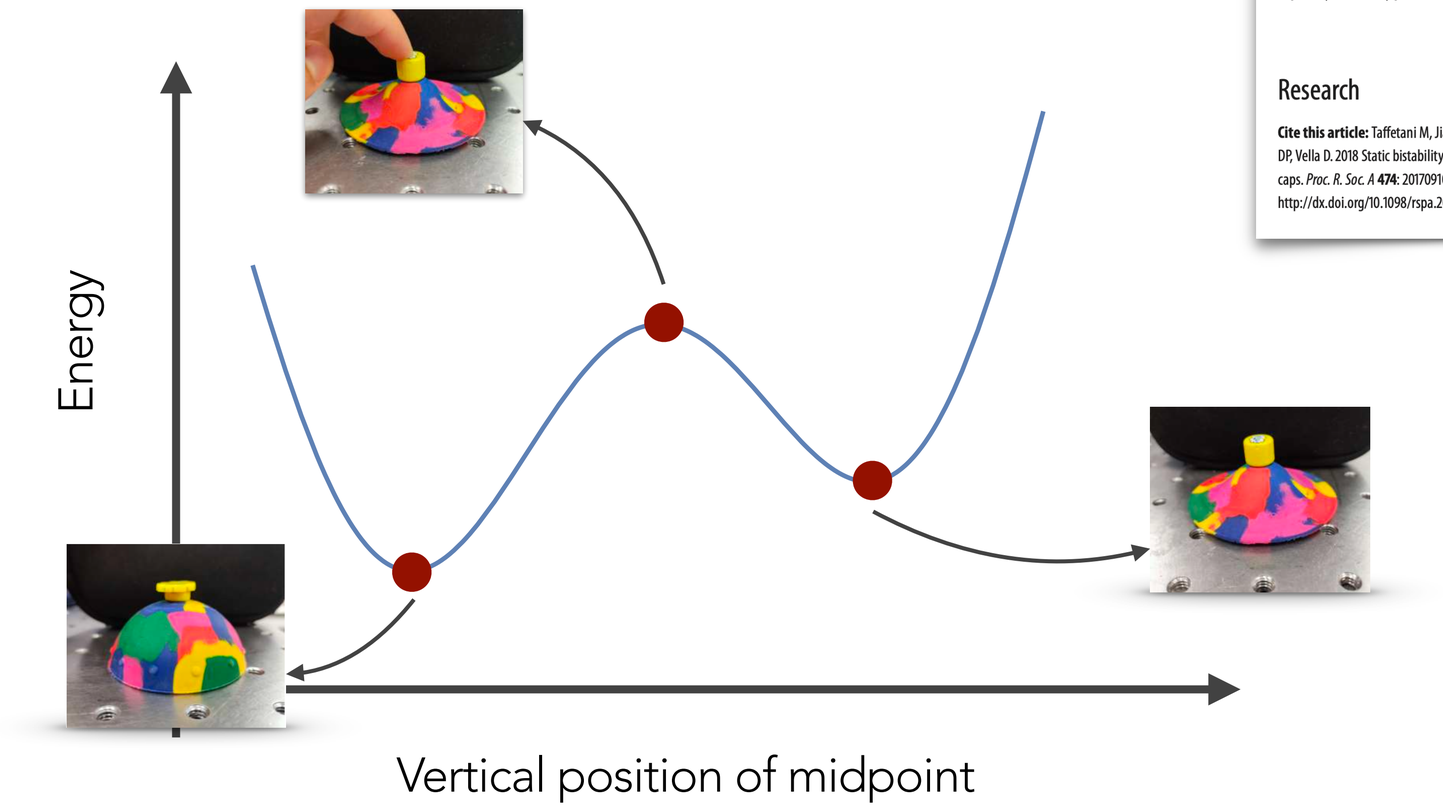
# HEURISTICS—STATICS

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Research

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## Static bistability of spherical caps

Matteo Taffetani[1], Xin Jiang[2], Douglas P. Holmes[2] and Dominic Vella[1]

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[2]Department of Mechanical Engineering, Boston University, Boston, MA 02215, USA

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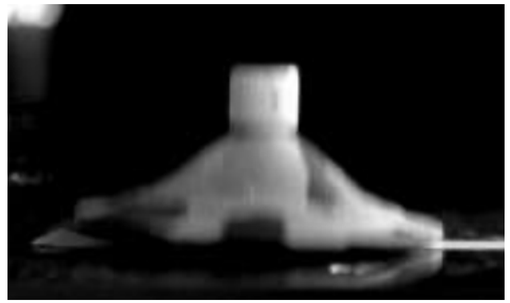
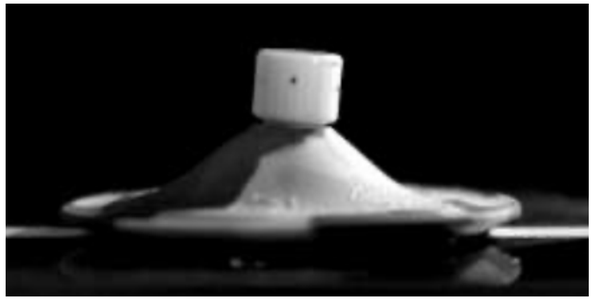
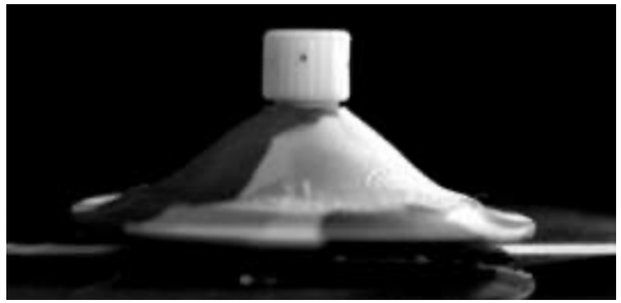
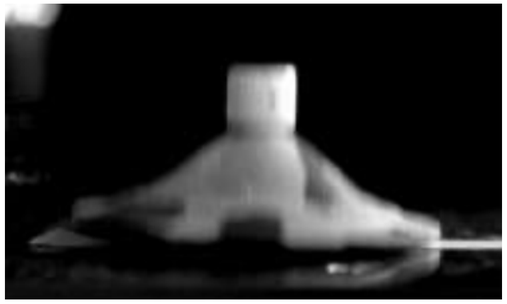
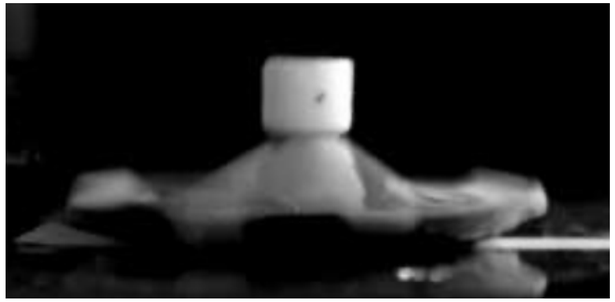
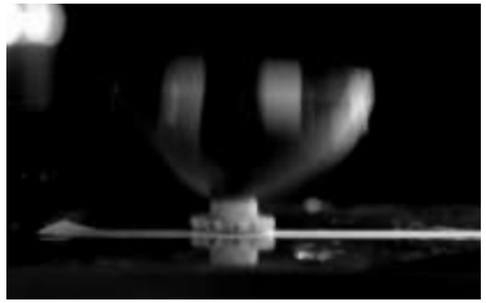
# HEURISTICS—DYNAMICS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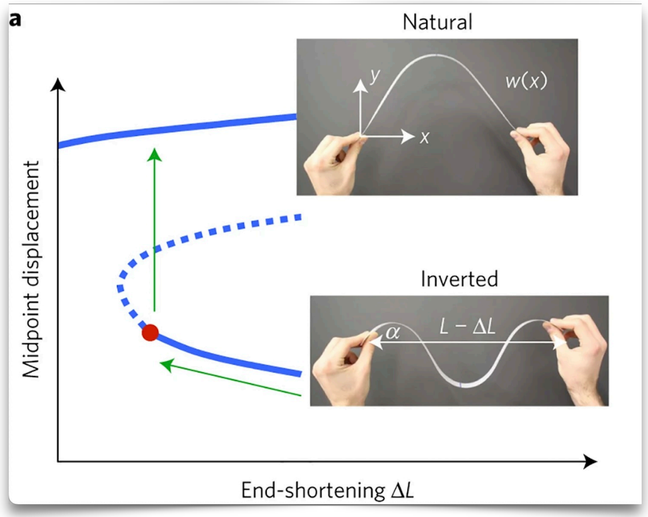
**Critical slowing down in purely elastic 'snap-through' instabilities**

Michael Gomez, Derek E. Moulton and Dominic Vella*

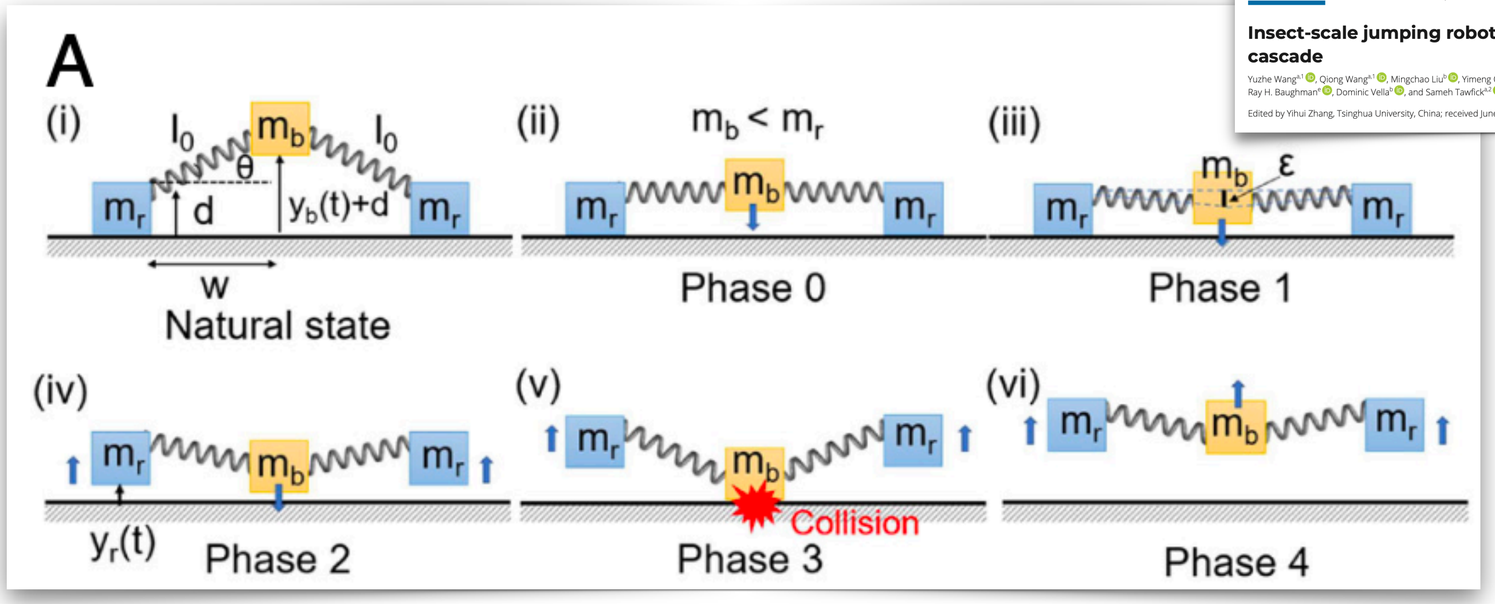


# MODEL

TRUSS MODEL (2D&3D):

- MASSES
- SPRINGS
- TORSION SPRINGS (TO BREAK UP-DOWN SYMMETRY)

→ ODEs





PNAS RESEARCH ARTICLE | ENGINEERING

**Insect-scale jumping robots enabled by a dynamic buckling cascade**

Yuzhe Wang[a,1], Qiong Wang[a,1], Mingchao Liu[b], Yimeng Qin[a], Liuyang Cheng[a], Ophelia Bolmin[a], Marianne Alleyne[c], Aimy Wissa[d], Ray H. Baughman[e], Dominic Vella[b], and Sameh Tawfick[a,2]

Edited by Yihui Zhang, Tsinghua University, China; received June 22, 2022; accepted December 12, 2022 by Editorial Board Member Yonggang Huang

# Proposal

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## Statics:

- Write down the continuum mechanics models for the mechanical equilibrium of shallow shells and elastic beams.
- Identify the relevant dimensionless parameters and the corresponding bifurcation behaviour.
- Tune the truss model so that it has the same bifurcation behaviour as these.

## Dynamics:

- Write down the ODEs of the truss model.
- Identify the different phases of the motion..
- Integrate the truss model
  - Analytically—with approximations
  - Numerically—matlab

# Scientific questions

- Can we find a law for the minimum height required for jumping?
- Can we tune the geometric parameters to optimise the jumping?
- … Experiments? Why not?!

# REFERENCES

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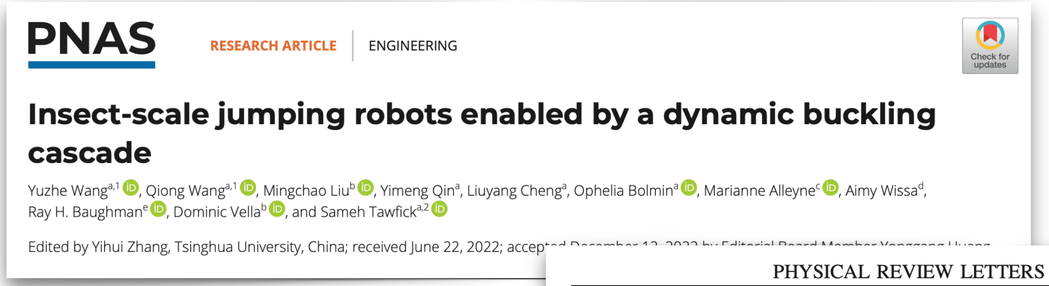

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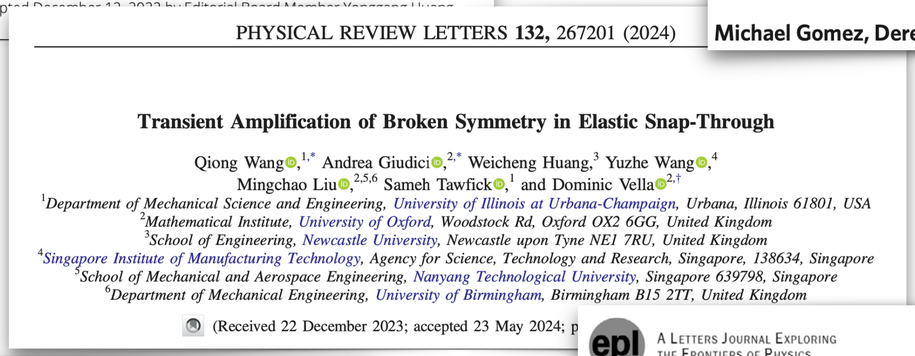

PHYSICAL REVIEW LETTERS 132, 267201 (2024)

**Transient Amplification of Broken Symmetry in Elastic Snap-Through**

Qiong Wang,[1,*] Andrea Giudici,[2,*] Weicheng Huang,[3] Yuzhe Wang,[4] Mingchao Liu,[2,5,6] Sameh Tawfick,[1] and Dominic Vella[2,†]

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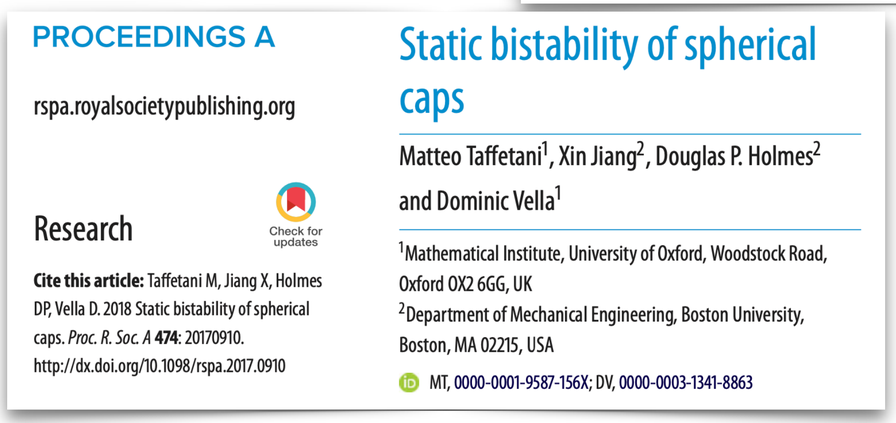

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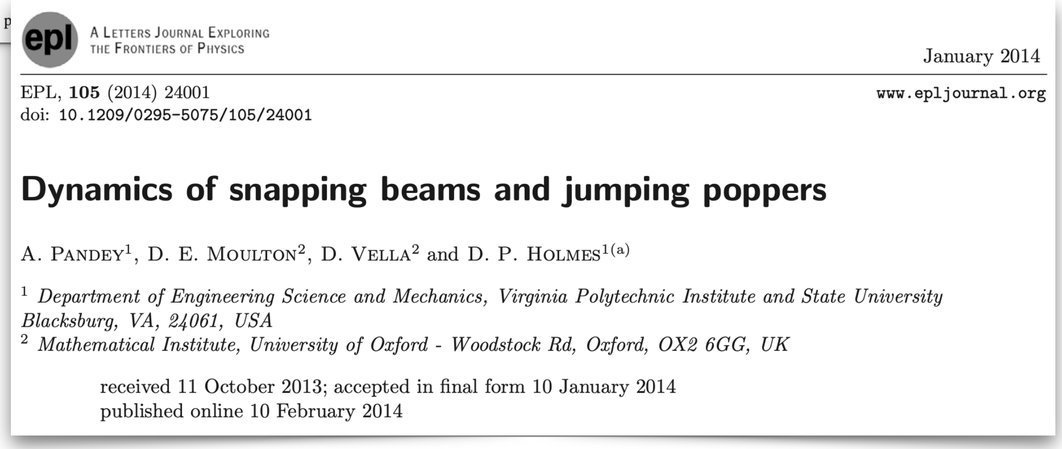

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doi: 10.1209/0295-5075/105/24001

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**Dynamics of snapping beams and jumping poppers**

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