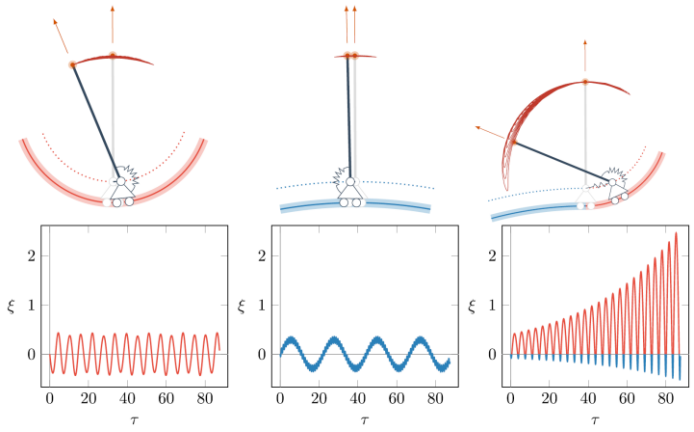
To flutter, or not to flutter, that is the question (for an elastic structure)

Davide Bigoni

Università di Trento
DICAM Via Mesiano 77, 38123 Trento

A compound elastic structure, displaying a dynamic instability, is shown to be designed as the union (or 'fusion') of two structures which are stable when separately analyzed. The compound elastic structure has two degrees of freedom and is made up of a rigid rod connected with two springs to a smooth support, which evidences a jump in the curvature at the equilibrium configuration [1]. Instability is proven in a linearized context and is related to the application of a non-conservative load of the follower type, so that the instability disappears under dead loads. In the fully nonlinear range, the instability is also confirmed through numerical simulations.

The obtained results may be useful in the design of new mechanical sensors, or devices for energy harvesting, or architected materials. In addition, our findings have conceptual implications on piecewise-linear theories of mechanics such as for instance plasticity or frictional contact.



Two stable smooth subsystems with positive and negative curvature of a sliding constraint (upper part: left and centre) and the fusion of these two structures, namely, a compound non-smooth structure displaying instability (upper part: right), although the two 'components' are stable. The tensile force acting at the free end of the rods is tangentially follower and the same for all three structures, lying well below the critical load for instability in the case of the two smooth 'component systems'.

Acknowledgements Financial support is gratefully acknowledged from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (Grant agreement No. ERC-ADG-2021-101052956-BEYOND).

References

[1] M. Rossi, A. Piccolroaz, D. Bigoni (2023) Fusion of two stable elastic structures resulting in an unstable system. J. Mech. Phys. Solids, 173, 105201.