
Modal self-tuning and mode-jumping of an oscillating variable-length rod

Francesco Dal Corso^{*†1}, Panagiotis Koutsogiannakis^{2,3}, Diego Misseroni², and Davide Bigoni¹

¹University of Trento [Trento] – Italy

²Università di Trento – Italy

³University of Colorado [Boulder] – United States

Abstract

An elastic rod, straight in its undeformed state, has a variable length because it is constrained at one end by a frictionless sliding sleeve. The constraint is arranged with the sliding direction parallel to a gravitational field, so that the rod can slide freely inside the sleeve when the latter is not moving. When the sliding sleeve is subjected to a harmonic transverse vibration, it is shown that the rod can oscillate around a finite height, appearing to be 'suspended', due to the configurational force developing at the sliding sleeve and acting in opposition to gravity. It is shown (experimentally, analytically and numerically) that by varying the oscillation amplitude and frequency of the sliding sleeve within certain ranges of values, the rod can oscillate under one or more modes of vibration and spontaneously adjust the sustained motion by self-tuning of the rod's external length. In addition, it is observed that the n th mode may become unstable as the frequency decreases, reaching a critical frequency at which the system may switch to the $(n-1)$ th mode depending on the amount of system dissipation. Acknowledgments: Funding from the European Research Council (ERC) under the European Union's Horizon Europe research and innovation programme, Grant agreement No. ERC-ADG-2021-101052956-BEYOND, is gratefully acknowledged.

*Speaker

†Corresponding author: francesco.dalcorso@unitn.it