Geometrical aspects of vibrational stabilization.

MARK LEVI*

* The Pennsylvania State University
University Park, PA 16802

Many mechanical systems exhibit a surprising stabilization effect when subjected to high frequency vibrations. The class of such systems includes, besides the well-known inverted pendulum [1], [2], more complex systems such as particles with vibrating constraints, including multiple pendula [3], and even fluids [4], e.g., molasses stabilized in a vibrating inverted cup [4]. On the formal level, stabilization is explained by averaging theory (normal form). It has been shown recently [5] that in a large class of vibrating systems any equilibrium of the unforced system becomes stable under vibrational forcing.

We describe a new geometrical explanation of the stabilization effect. This explanation shows a perhaps unexpected relationship between the above mentioned stabilization phenomena on the one hand and the temperature-induced deformations of materials on the other.

References

[1] P.L. Kapitsa , *Pendulum with a vibrating suspension.*, Collected Papers by P. L. Kapitsa, Volume II, Pergamon Press, London, pages 726-737, 1965.
[2] V. I. Arnold, *Ordinary Differential Equations.* Springer Verlag, 1992.
[3] D. J. Achson and T. Mullin. “Upside-down pendulums.” *Nature* **366**, pages 215-216, 1993.
[3] V. Lapuerta, F. J. Mancebo and J. M. Vega, “Control of Rayleigh-Taylor instability by vertical vibration in large aspect ratio containers.” *Pys. Rev. E* **64**, 016318, pages 1-17, 2001.
[4] M. M. Michaelis and T. Woodward, “An inverted liquid demonstration”. *American Journal of Physics* **59**(9) (September), pages 816-821, 1991.
[5] M. Levi, “Geometry and physics of averaging with applications”. *Physica D*, 132, pages 150-164, 1999.

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