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Dynamics of a parametrically excited simple pendulum

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The dynamics of a parametric simple pendulum submitted to an arbitrary angle of excitation ϕ was investigated experimentally by simulations and analytically. Analytical calculations for the loci of saddle-node bifurcations corresponding to the creation of resonant orbits were performed by applying Melnikov's method. However, this powerful perturbative method cannot be used to predict the existence of odd resonances for a vertical excitation within first order corrections. Yet, we showed that period-3 resonances indeed exist in such a configuration. Two degenerate attractors of different phases, associated with the same loci of saddle-node bifurcations in parameter space, are reported. For tilted excitation, the degeneracy is broken due to an extra torque, which was confirmed by the calculation of two distinct loci of saddle-node bifurcations for each attractor. This behavior persists up to $\phi \approx 7\pi/180$, and for inclinations larger than this, only one attractor is observed. Bifurcation diagrams were constructed experimentally for $\phi = \pi/8$ to demonstrate the existence of self-excited resonances (periods smaller than three) and hidden oscillations (for periods greater than three).

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REFERENCES

1. J. C. Sartorelli, Phys. Rev. B **45**, 10779–10872 (1992).



-
2. J. C. Sartorelli, S. Isotani, J. A. Ochi, W. Sano, and A. Piccini, Chem. Phys. Lett. **57**, 608–610 (1978).
[https://doi.org/10.1016/0009-2614\(78\)85331-7](https://doi.org/10.1016/0009-2614(78)85331-7), [Google Scholar](#),
[Crossref](#)
-
3. A. A. Galkin, A. Yu. Kozhukhar', and G. A. Tsintsadze, Zh. Eksp. Teor. Fiz. **70**, 248–254 (1976). [Google Scholar](#)
-
4. T. N. Nogueira, J. C. Sartorelli, M. P. Pato, and C. Ellegaard, Phys. Rev. E **78**, 055201(R) (2008). <https://doi.org/10.1103/PhysRevE.78.055201>,
[Google Scholar](#), [Crossref](#)
-
5. P. L. Kapitza, Sov. Phys. JETP **21**, 588–592 (1951) [Google Scholar](#)
P. L. Kapitza, [Usp. Fiz. Nauk **44**, 7–15 (1951)]. [Google Scholar](#), [Crossref](#)
-
6. J. C. Sartorelli and W. Lacarbonara, Nonlinear Dyn. **69**, 1679–1692 (2012). <https://doi.org/10.1007/s11071-012-0378-2>, [Google Scholar](#),
[Crossref](#)
-
7. G. Depetri, J. C. Sartorelli, B. Marin, and M. S. Baptista, Phys. Rev. E **94**, 012202 (2016). <https://doi.org/10.1103/PhysRevE.94.012202>,
[Google Scholar](#), [Crossref](#)
-
8. B. P. Koch and R. W. Leven, Physica D **16**, 1 (1985).
[https://doi.org/10.1016/0167-2789\(85\)90082-X](https://doi.org/10.1016/0167-2789(85)90082-X), [Google Scholar](#),
[Crossref](#)
-



[https://doi.org/10.1016/S0960-0779\(97\)00181-1](https://doi.org/10.1016/S0960-0779(97)00181-1), [Google Scholar](#),
[Crossref](#)

10. A. Belyakov and A. P. Seyranian, *Nonlinear Dyn.* **77**, 1617 (2014).
<https://doi.org/10.1007/s11071-014-1404-3>, [Google Scholar](#), [Crossref](#)

11. K.-H. Kwek and J. Li, *Int. J. Nonlinear Mech.* **31**, 277 (1996).
[https://doi.org/10.1016/0020-7462\(95\)00068-2](https://doi.org/10.1016/0020-7462(95)00068-2), [Google Scholar](#),
[Crossref](#)

12. M. J. Clifford and S. R. Bishop, *J. Aust. Math. Soc. B* **37**, 309 (1996).
<https://doi.org/10.1017/S0334270000010687>, [Google Scholar](#),
[Crossref](#)

13. P. F. Byrd and M. D. Friedman, *Handbook of Elliptic Integrals for Engineers and Physicists*, 1st ed. (Springer, Berlin, 1954).
[Google Scholar](#), [Crossref](#)

14. Y. Kuznetsov, *Elements of Applied Bifurcation Theory*, 2nd ed. (Springer-Verlag, New York, 1998). [Google Scholar](#)

15. E. J. Doedel, “ AUTO: A program for the automatic bifurcation analysis of autonomous systems,” *Congr. Numerantium* **30**, 265 (1981).
[Google Scholar](#)

16. G. A. Leonov, N. V. Kuznetsov, and V. I. Vagaitsev, *Physica D* **241**, 1482–1486 (2012). <https://doi.org/10.1016/j.physd.2012.05.016>,



17. E. J. Doedel and B. E. Oldeman, “ Auto-07p: Continuation and bifurcation software for ordinary differential equations,” Technical Report, Concordia University, Canada (2017). [Google Scholar](#)

18. J. Guckenheimer and P. Holmes, *Nonlinear Oscillations, Dynamical Systems, and Bifurcations of Vector Fields*, 1st ed. (Springer-Verlag, New York, 1983). [Google Scholar](#), [Crossref](#)

19. S. Wiggins, *Introduction to Applied Nonlinear Dynamical Systems and Chaos*, 2nd ed. (Springer-Verlag, New York, 2003).
[Google Scholar](#)

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