

Accepted Manuscript

Comparisons between the pendulum with varying length and the pendulum with oscillating support

James A. Wright, Michele Bartuccelli, Guido Gentile

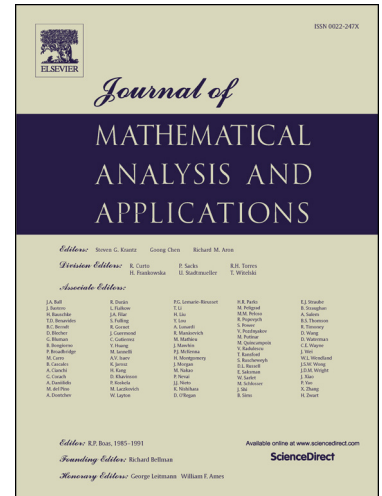
PII: S0022-247X(17)30001-X
DOI: <http://dx.doi.org/10.1016/j.jmaa.2016.12.076>
Reference: YJMAA 21016

To appear in: *Journal of Mathematical Analysis and Applications*

Received date: 16 August 2015

Please cite this article in press as: J.A. Wright et al., Comparisons between the pendulum with varying length and the pendulum with oscillating support, *J. Math. Anal. Appl.* (2017), <http://dx.doi.org/10.1016/j.jmaa.2016.12.076>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.



Comparisons between the pendulum with varying length and the pendulum with oscillating support

James A. Wright^a, Michele Bartuccelli^{a,*}, Guido Gentile^b

^a*Department of Mathematics, University of Surrey, Guildford, GU2 7XH, UK*

^b*Dipartimento di Matematica e Fisica, Università di Roma Tre, 00146 Roma, Italy*

Abstract

We consider two forced dissipative pendulum systems, the pendulum with vertically oscillating support and the pendulum with periodically varying length, with a view to draw comparisons between their behaviour. We study the two systems for values of the parameters for which the dynamics are non-chaotic. We focus our investigation on the persisting attractive periodic orbits and their basins of attraction, utilising both analytical and numerical techniques. Although in some respect the two systems have similar behaviour, we find that even within the perturbation regime they may exhibit different dynamics. In particular, for the same value of the amplitude of the forcing, the pendulum with varying length turns out to be perturbed to a greater extent. Furthermore the periodic attractors persist under larger values of the damping coefficient in the pendulum with varying length. Finally, unlike the pendulum with oscillating support, the pendulum with varying length cannot be stabilised around the upward position for any values of the parameters.

1. Introduction

Perturbations of the simple pendulum exhibit an extremely rich variety of dynamics whilst still allowing a complete control over the unperturbed system. For this reason perturbed pendula are often used as toy models to study new phenomena in dynamics — for instance in [3, 22, 50, 61, 60, 65] — or act as simplified models for more complex real world systems — see [47, 58, 63]. One of the most commonly studied perturbations is the pendulum with vertically oscillating support [6, 12, 13, 31, 65], often also referred to as the parametrically forced pendulum, see for example [22, 30, 33, 45, 67]. Another much studied perturbation of the simple pendulum is the pendulum with periodically varying length [8, 17, 59, 19, 57]. In [23, 54] it was noted that the pendulum with varying length is an example of a periodically forced system whose linearisation is different from Mathieu's equation, but no further analysis was completed. A brief comparison between the pendulum with oscillating support and the pendulum with varying length was made in [19], drawing the conclusions that the two systems are qualitatively different and further comparison of the two systems deserved a separate study. However there has not been further work focused on exploring the differences of the two systems. In fact, there are still instances, even as recent as 2014 [28], where the two systems are mistaken with one another — see also [36, 52, 53]. Therefore to avoid further confusion and misguidance it is important not only to highlight the differences between the two systems but also

*Corresponding author. Tel: +44(0)1483 682625 Fax: +44(0)1483 686071

Email addresses: j.wright@surrey.ac.uk (James A. Wright), m.bartuccelli@surrey.ac.uk (Michele Bartuccelli), gentile@mat.uniroma3.it (Guido Gentile)

Download English Version:

<https://daneshyari.com/en/article/5775240>

Download Persian Version:

<https://daneshyari.com/article/5775240>

[Daneshyari.com](https://daneshyari.com)