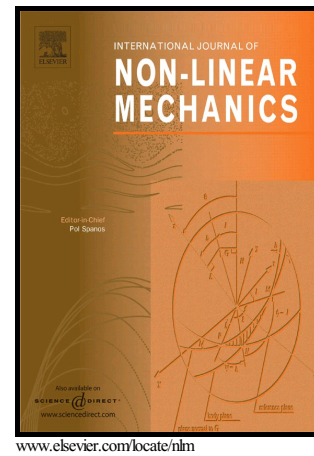


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Dynamics of noncontact rack-and-pinion device subject to thermal noise: Multiharmonic motion of the rack

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Abstract

We study miniaturized *noncontact* rack and pinion composed of a corrugated plate and a corrugated cylinder intermeshed via the lateral Casimir force. We assume that the rack position versus time is a periodic multi-harmonic signal. The axle of the pinion is subject to Casimir torque, frictional torque, load torque, and random Gaussian torque. A Fokker-Planck rather than Langevin description of the pinion dynamics allows us to explore a huge parameter space in a reasonable computational time. We show that even at the room temperature, the device acts as a mechanical rectifier: The pinion rotates with a nonzero average velocity and lifts up an external load. For typical values of parameters, we find that the pinion rotates with an average angular velocity $\sim 1 - 30$ Hz. The thermal noise may even facilitate the device operation.

Keywords: Nanomachine, Lateral Casimir force, Thermal noise, Fokker-Planck equation

2010 MSC: 00-01, 99-00

1. Introduction

Microelectromechanical systems (MEMS) is a rapidly growing technology dealing with the design and fabrication of tiny machines [1, 2]. With the ongoing

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