Karlsruher Institut für Technologie

Institut für Technische Mechanik
- Dynamik und Mechatronik -

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Bachelor/Master thesis

Analysis of the effect of nonlinear damping on the safe basins of a particle's escape from a potential well under harmonic excitation

Background

The escape phenomenon is a classic problem of engineering and natural sciences. The phenomenon occurs whenever a particle or a system of particles leaves a limited potential well and does not return in it. Escape is present at any scales of Physics, from atomic sizes, such as reaction of molecules up to the magnitudes of celestial mechanics, like the collapse of galaxies. Such everyday phenomena as the capsizing of vessels or dynamic buckling of beams are all related to escape dynamics.

At the Institute of Engineering Mechanics (ITM) we investigate several aspects of escape in cooperation with Prof. Gendelman's research group at Technion – Israel Institute of Technology. One of the simplest escape models consists of a 1DoF mechanical system (see Fig. 1), a particle in a limited potential well with additional damping excited with a sinusoidal force:

$$m\ddot{x} + F_d(x, \dot{x}) + V'(x) = F\sin(\Omega t).$$

For some choice of the parameters and initial conditions, the particle remains in the potential well (*safe basin*), for another set of parameters, however, the particle escapes. In case of a truncated quadratic potential and viscous damping ($F_d(\dot{x}) = c\dot{x}$), the location of the primary safe basin can be determined analytically (see Fig. 2). For other kinds of damping, however, the impact of the parameters on the safe basin's size and location is still an open question.

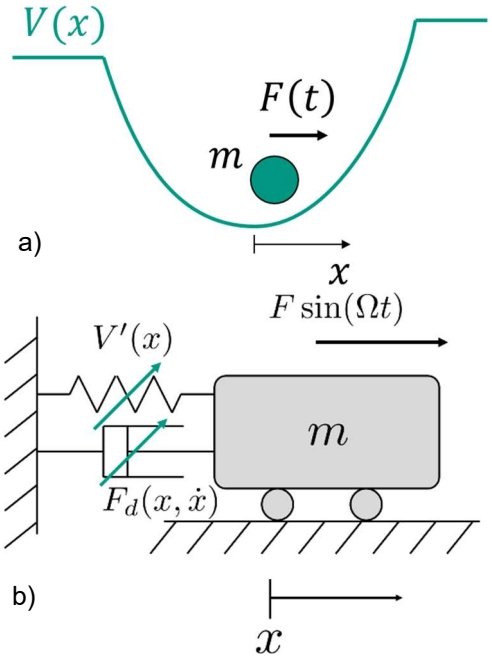

Figure 1a) – Truncated quadratic potential
Figure 1b) – Homologous mechanical model of the problem

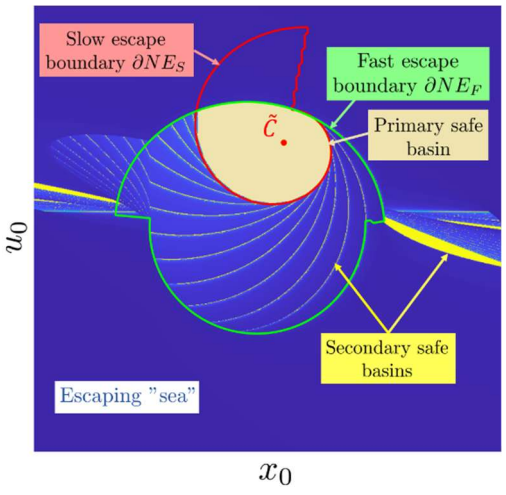

Figure 2 – The location of the primary safe basin can be determined analytically in case of viscous damping and a quadratic potential

Topic

The aim of the Bachelor/Master thesis is to investigate the impact of different kinds of nonlinear damping (Coulomb friction, air drag, etc.) on the size and location of the safe basins of escape.

Requirements

- Strong mathematical background
- Programming skills in MATLAB or in a similar programming language

Start: immediately

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