RELAXATION OSCILLATIONS AND CHAOTIC MOTION IN A SYSTEM OF NONLINEAR COUPLED OSCILLATORS

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In the present work we study a strongly nonlinear system of 3 coupled oscillators

$$\begin{aligned}&\epsilon\ddot{y} + \epsilon\lambda(\dot{y} - \dot{x}_0) + C(y - x_0)^3 = 0,\\ &\ddot{x}_0 + d(x_0 - x_1) = \epsilon\lambda(\dot{y} - \dot{x}_0) + C(y - x_0)^3,\\ &\ddot{x}_1 + ax_1 + d(x_1 - x_0) = 0.\end{aligned} \tag{1}$$

With the use of transformations we reduce our system to the equation

$$w'' + \hat{\lambda}w' + \hat{C}w^3 = \hat{A}sin\hat{t} + \hat{B}sin\frac{\omega_2}{\omega_1}t + O(\epsilon). \tag{2}$$

We study the dynamics of our reduced system with the use of slow-fast partion of the dynamics. We derive the Slow Invariant Manifold(SIM) from which we prove that for a damping below a critical threshold there exists relaxation oscillations. These oscillations are associated with targeted energy transfer phenomena. From the numerical study of the Slow Flow on the SIM we see numerical evidence of the existence of the relaxation oscillations and also of probably chaotic motion.

References

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