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Nonlinear dynamics of NEMS resonators in temperature fields

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Abstract: Regular and chaotic dynamics of a curvilinear nanobeam governed by the first-order approximation kinematic model (Bernoulli-Euler) in a stationary field is studied. Geometrical nonlinearity follows the von Kármán model, whereas the influence of the temperature field obeys the Duhamel-Neumann theory. PDEs of motion of flexible beam are yielded by Hamilton's principle taking the account of the couple stress theory. The obtained PDEs with respect to displacements are reduced to the counterpart Cauchy problem by the FDM of the second-order approximation, and the obtained nonlinear ODEs are solved by the 4th order Runge-Kutta method. Realibility of the numerical results is quantified based on the Runge-Kutta principle. Both chaotic and regular nonlinear dynamics were investigated with respect to reliability (true results) by using qualitatively different methods of theories of dynamical systems and differential equations based on the Fourier and wavelet power spectra, phase portraits, and Poincaré sections. In order to get results reliable (convergent) with respect to chaotic regimes, the sign of the largest Lyapunov exponent is estimated, whereas the power of chaotic dynamics is measured by a spectrum of the Lyapunov exponents. The reliability of computation of the sign of the largest Lyapunov exponent is validated by the Wolf, Rosenstein, Kantz, and the modified neural network methods.

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