

## Postprint: Magnetoelastic Random Vibration of Microscale Current-Carrying Nanoplates in Magnetic Fields

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### Abstract

This study investigates the magnetoelastic random vibration of simply supported rectangular microplates under magnetic fields and random currents. Using nonlocal elasticity theory and plate-shell magnetoelastic theory, the equations of motion for current-carrying microplates in an external magnetic field are established, and the magnetoelastic random vibration equations for the microplate are derived. The modal analysis method is employed to analyze the displacement response, obtaining statistical characteristics such as the mean value and power spectral density function of the random displacement response when stationary and non-stationary random currents are applied. For a specific numerical example under stationary random current excitation, the power spectral density function of the displacement response is obtained, and the power spectral density diagram of the displacement response at the plate center point is plotted. The results demonstrate that the coupling term has a significant influence on the vibration response bandwidth. When the coupling term is considered, the vibration energy is primarily distributed within the 0–20 Hz bandwidth range, and as the random current and magnetic field intensity increase, the bandwidth of concentrated vibration energy distribution becomes narrower. Based on this property, the occurrence of vibration can be effectively reduced or its damage mitigated, providing a reference for structural detection and fault diagnosis in microstructure systems.

### Full Text

#### Preamble

The theoretical framework presented herein is built upon an extensive series of mathematical relationships that define the core methodology. The initial foundational equations establish the basic parameters of the model system. These

are supplemented by additional fundamental expressions that extend the theoretical framework through increasingly complex formulations.

The analytical development continues with intermediate derivations which further elaborate the mathematical structure. Specialized cases and computational methodologies are addressed in subsequent series of equations that incorporate advanced boundary conditions and technical specifications.

The final mathematical foundation is completed by sophisticated derivations and extensions. Collectively, these equations provide the comprehensive theoretical basis for the empirical investigations and computational analyses described in the remainder of this paper.

*Note: Figure translations are in progress. See original paper for figures.*

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