

# Spin wave modes of multilayered ferromagnetic films

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© 2019 American Physical Society. A study of ferromagnetic spin wave modes in multilayered films under general conditions is presented within a micromagnetic approximation. These modes, either in the magnetostatic or dipole-exchange approximation, have been studied in the past theoretically and experimentally by several authors. The novelty of the present study is that using a method based on the extinction-Green theorems it is possible to determine these modes with ease, under an arbitrary direction of an applied dc magnetic field, and for boundary conditions of diverse nature. The ferromagnetic films are coupled through dipolar interactions and eventually through exchange interactions. Due to an assumed in-plane translation invariance of the multilayers, the method allows us to determine the eigenfrequencies at a given in-plane wave vector as an algebraic eigenvalue problem of reasonable size: it is a  $6N \times 6N$  system of homogeneous equations if there are  $N$  distinct films in the structure