

# Magnetic field influence on the frequency of a sound wave in cubic ferromagnets

I. Korniienko,<sup>1</sup> P. Nieves,<sup>2</sup> and D. Legut<sup>3,1</sup>

<sup>1</sup>*IT4Innovations, VŠB - Technical University of Ostrava,  
17. listopadu 2172/15, 70800 Ostrava-Poruba, Czech Republic*

<sup>2</sup>*Departamento de Física, Universidad de Oviedo,  
C. Leopoldo Calvo Sotelo, 18, 33007 Oviedo, Spain*

<sup>3</sup>*Department of Condensed Matter Physics,  
Faculty of Mathematics and Physics,  
Charles University, Ke Karlovu 3,  
121 16 Prague 2, Czech Republic*

Recently increased interest in the surface acoustic waves coupled with spin waves in ferromagnetic films renews the requirement for a better understanding of the external magnetic field effects on the sound wave propagation speed in a magnetically ordered crystals. Although these effects have been known for a long time, some aspects of it, such as the low-field regime, remained not fully understood. Based on the example of bcc Fe, we show that a significant role is played by dispersion effects [1]. Interestingly, they do not have a significant impact on the high-field regime and therefore are often neglected. In our work, we perform a detailed analysis of lattice vibrations to spin waves coupled effects both analytically and using numerical atomistic simulations based on the recently developed spin-lattice models [2].

We analyze the role of the direction of the magnetic field in the change of sound wave propagation speed within the cubic crystal [3]. For the case of bcc Fe we present full 3D image of group velocity according to the direction of wave propagation and analyze the effect of magnetic fields of different directions for three types of acoustic waves (one quasi-compressional wave and two quasi-shear).

## References:

- [1] I. Korniienko, P. Nieves, D. Legut, *Results in Physics*, 73 (2025) 108264
- [2] P. Nieves, J. Tranchida, S. Nikolov, A. Fraile, D. Legut, *Phys. Rev. B*, 105 (2022) 134430
- [3] P. Nieves, I. Korniienko, A. Fraile, J.M. Fernández-Díaz, R. Iglesias, D. Legut, *SoftwareX*, 33 (2026) 102472