



Walther-Meißner-Seminar

Walther-Meißner-Institute, Seminar Room 143

Date: Friday, 03 July 2026, 11:15 h

Speaker: Lukáš Nádvorník

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Title: Terahertz spin-wave pulses of antiferromagnetic hematite

Abstract:

Magnonics offers a promising pathway toward ultra-low energy information processing by utilizing magnon spin-waves instead of moving electrical charges, yet conventional ferromagnetic materials limit device operation to gigahertz frequencies [1]. To overcome this speed bottleneck, the focus has recently shifted toward antiferromagnetic and emerging altermagnetic systems, which operate in the terahertz (THz) regime and offer linear dispersion profiles resembling photons [2]. However, while uniform ($k = 0$) spin resonance is routinely studied, exciting and tracking non-zero k propagating magnon packets coherently has remained an elusive challenge due to the lack of sufficiently broad, coherent excitation mechanisms.

This seminar will demonstrate how this limitation can be overcome by using THz field-induced spin-orbit torques in the altermagnetic insulator hematite (α -Fe₂O₃) [2]. We will show that by utilizing THz Spin-Hall magnetoresistance [3,4] to monitor ultrafast Néel vector dynamics, it is possible to generate and detect extremely compressed, 11 nm wide magnon wavepackets. The talk will highlight how these massless spin-waves propagate purely ballistically at exchange velocities of 23.5 km/s over distances exceeding 100 nm without any pulse broadening, opening new horizons for THz wave-based computing and analog simulators of relativistic quantum mechanics.

References

- [1] A. V. Chumak et al., [Nature Physics 11, 453–461 \(2015\)](#).
- [2] L. Šmejkal, J. Sinova, and T. Jungwirth, [Phys. Rev. X 12, 040501 \(2022\)](#).
- [3] M. Althammer et al., [Phys. Rev. B 87, 224401 \(2013\)](#).
- [4] P. Kubaščík et al., [arXiv:2507.02498 \(2025\)](#).