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Non-Markovian signatures in ultrafast magnetism experiments

F. Hartmann,[a] V. Unikandanunni,[b,c] S. Bonetti,[b,d] and J. Anders[a,e]
a: University of Potsdam, Institute of Physics and Astronomy, Potsdam, Germany;
b: Department of Physics, Stockholm University, Stockholm, Sweden;
c: Institute of Applied Physics, University of Bern, Bern, Switzerland;
d: Department of Molecular Sciences and Nanosystems, Ca' Foscari University of Venice, Venice, Italy
e: Department of Physics and Astronomy, University of Exeter, Exeter, UK

For many decades the phenomenological Landau-Lifshitz-Gilbert (LLG) equation has been used to describe magnetism dynamics. At ultrashort timescales an inertial correction to the LLG equation has been predicted, which leads to an additional frequency contribution, known as nutation [1]. This nutation frequency has recently been measured in ultrafast magnetism experiments [2,3]. However, not only the nutation frequency has been observed but additional higher frequencies, leading to a complex nutation spectrum [4].

By employing the recently proposed memory-enhanced LLG equation [5], we show how such a complex nutation spectrum is obtained and can qualitatively and quantitatively describe the experimental data. In addition, we will compare the measured nutation spectrum at different temperatures with temperature-dependent simulations of the memory-enhanced LLG equation. This work outlines a way of understanding the role of non-Markovian and colored noise effects on short time scales in ultrafast magnetism experiments and beyond.

[1] M.-C. Ciornei et al., Phys. Rev. B 83 020410 (2011)
[2] K. Neeraj et al., Nat. Phys. 17 245–250 (2021)
[3] A. De et al., arXiv 2405.01334 (2024)
[4] V. Unikandanunni et. al., Phys. Rev. Lett. 129 237201 (2022)
[5] J. Anders et al., New J. Phys. 24 033020 (2022)