On-line SPICE-SPIN+X Seminars

Wednesday, 9th June 2021, 15:00 (German Time)

The seminar will be via Zoom (Meeting ID: 813 1531 0236) and live streamed in the SPICE YouTube Channel.

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Ultrafast coupled charge, spin and nuclear dynamics: ab-initio description.

Laser induced ultrafast dynamics is a burgeoning field of condensed matter physics promising the ultimate short time control of light over matter. From the outset of research into femtomagnetism, the field in which spins are manipulated by light on femtosecond or faster time scales, several questions have arisen and remain highly debated: How does the light interact with spin moments? How is the angular momentum conserved between the nuclei, spin, and angular momentum degrees of freedom during this interaction? What causes the ultrafast optical switching of magnetic structures from anti-ferromagnetic to ferromagnetic and back again? What is the ultimate time limit on the speed of spin manipulation? What is the impact of nuclear dynamics on the light-spin interaction?

In my talk I will advocate a parameter free ab-initio approach to treating ultrafast light-matter interactions, and discuss how this approach has led both to new answers to these old questions but also to the uncovering of novel and hitherto unsuspected early time spin dynamics phenomena. In particular I will demonstrate OISTR (optical inter-site spin transfer)[1,2] to be one of the fastest means of spin manipulation via light [4,7,8,9], with changes in magnetic structure occurring on attosecond time scales [8]. I will also discuss the impact of nuclear dynamics on laser induced spin dynamics and demonstrate how selective phonon modes can be used to enhance the OISTR effect.

The ability to measure and calculate the same physical quantity forms the cornerstone of the vital collaboration between theory and experiment, and I will discuss recent work where we have ab-initio calculated the real time response functions of L-edge and M-edge semi-core states during spin dynamics, demonstrating both good quantitative agreement with experiment [5,6] but also showing how theory can actually predict new phenomena and guide new experiments.

[1] Dewhurst et al. Nano Lett. 18, 1842, (2018)
[2] Elliott et al. Scientific Reports 6, 38911 (2016)
[3] Shokeen et al. Phys. Rev. Lett. 119, 107203 (2017)
[4] Chen et al. Phys. Rev. Lett. 122, 067202 (2019)
[5] Willems et al. Nat. Comm. 11, 1 (2020)
[6] Dewhurst et al. Phys. Rev. Lett. 124, 077203 (2020)
[7] Hofherr et al. Sci. Advs. 6, eaay8717 (2020)
[8] Siegrist et al. Nature 571, 240 (2019)
[9] Golias et al. Phys. Rev. Lett. 126, 107202 (2021)