Department of Physics
Condensed Matter Physics
Clarendon Laboratory, Parks Road, Oxford OX1 3PU

UNIVERSITY OF OXFORD

CONDENSED MATTER SEMINAR

Thursday 8th of February at 2.15pm

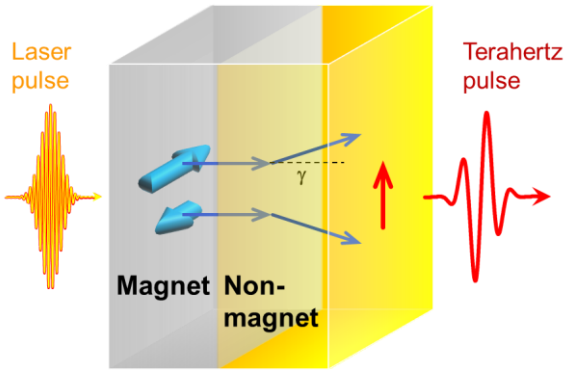
"Ultrafast spintronics with terahertz radiation"

Tobias Kampfrath
Freie Universität Berlin and Fritz Haber Institute of the Max Planck Society, Berlin, Germany

Sub-picosecond terahertz (THz) electromagnetic pulses are a powerful tool to probe and even control numerous low-energy modes of condensed matter. Here, we consider experiments showing that THz radiation is also a very useful and versatile tool to study spin transport and the only recently discovered spin Seebeck effects at extremely high (THz) frequencies.
First, we launch spin transport in spintronic bilayers such as Fe|Pt by means of a femtosecond laser pulse (see figure). Detection of the ultrafast spin current is facilitated by the inverse spin Hall effect that deflects spin-up and -down electrons in opposite directions, resulting in the emission of a THz pulse [1]. Sampling of the THz field allows us to monitor the spin transport and provides a quick and easy estimate of the strength of the spin Hall effect in a contact-free manner. Optimization of the spintronic thin-film structure has led to new, efficient and scalable emitters of THz pulses that fully cover the range from 1 to 30 THz without gap [2].
Second, this technique is applied to YIG/Pt heterostructures, thereby allowing us to test the ultimate speed limit of the spin Seebeck effect. By extracting the spin-current dynamics from the measured THz waveform [3], we find that the spin Seebeck effect is even operative at extremely high, that is, THz frequencies [4].

References

[1] T. Kampfrath, M. Battiato, P. Maldonado, G. Eilers, J. Nötzold, S. Mährlein, V. Zbarsky, F. Freimuth, Y. Mokrousov, S. Blügel, M. Wolf, I. Radu, P.M. Oppeneer, M. Münzenberg, Nature Nanotech. 8, 256 (2013)
[2] T. Seifert et al., Nature Photon. 10, 715 (2016)
[3] L. Braun et al., , Nature Comm. 7, Article number: 13259 (2016)
[4] T. Seifert et. al., https://arxiv.org/abs/1709.00768



Host: Prof Michael Johnston

Audrey Wood Seminar Room, Clarendon Laboratory