European XFEL Science Seminar

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Campus Schenefeld, XHQ, room E1.173

Christine Boeglin

Ultrafast Demagnetization Dynamics by Time Resolved XMCD

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Ultrafast processes involving electrons and spins are important issues for both fundamental science and for the potential applications in spintronics. Application of ultrashort Infra-Red laser pulses allows ultimately the manipulation of the local magnetization in magnetic films. In order to understand the change of the initial magnetic or structural state, induced by IR laser pulses, it is essential to describe the individual and fundamental processes taking place during the first hundred femtoseconds. Since the first observation of laser induced spin dynamics [1], the mechanisms responsible for the femtosecond demagnetization have been widely debated, but no consensus could be found until today. Time-resolved X-ray Magnetic Circular Dichroism (XMCD) using synchrotron facilities and X-ray free electron sources have provided femtosecond time resolution and thus new information concerning ultrafast demagnetization dynamics. At soft X-ray energies it is now possible to measure the dynamics of the spin and orbital magnetic moments with temporal resolution of ~100 fs [2-7]. Using the potential of the XMCD technique, we have shown that right after the IR laser excitation, interatomic transfer of angular moment takes place at the femtosecond scale, whereas the global demagnetization proceeds, illustrating one of the most efficient way of conservation of angular moment, during the loss of magnetization in the system [5]. As an alternative to direct laser excitations, laser induced hot-electron currents produce different characteristic times in rare earth and transition metal in 4f-3d alloys [7]. Our results can be related to propagation times and velocities of the hot-electron pulses as well as thermal effects.

[1] E. Beaurepaire, J.C. Merle, A. Daunois, and J.-Y. Bigot, Phys. Rev. Lett. 76, 4250 (1996).
[2] C. Boeglin, E. Beaurepaire, V. Halté, V. Lopez-Flores, C. Stamm, N. Pontius, H. A. Dürr, and J.-Y. Bigot, Nature 465, 458 (2010).
[3] M. Wietstruk, A. Melnikov, C. Stamm, T. Kachel, N. Pontius, M. Sultan, C. Gahl, M. Weinelt, H. A. Dürr, and U. Bovensiepen, Phys. Rev. Lett. 106, 127401 (2011).
[4] V. López-Flores, N. Bergeard, V. Halté, C Stamm, N. Pontius, M. Hehn, E. Otero, E. Beaurepaire, C. Boeglin , Phys. Rev. B 87, 214412 (2013)
[5] N. Bergeard, V. López-Flores, V. Halté, C Stamm, N. Pontius, M. Hehn, E. Beaurepaire and C. Boeglin, Nature Com. 5, 3466 (2014).
[6] T. Ferté, N. Bergeard, L. Le Guyader, M. Hehn, G. Malinowski, E. Terrier, E. Otero, K. Holldack, N. Pontius, and C. Boeglin Phys. Rev. B 96,134303 (2017)
[7] T. Ferté, N. Bergeard, G. Malinowski, R. Abrudan, T. Kachel, K. Holldack, M. Hehn, and C. Boeglin, Phys. Rev. B 96, 14427 (2017)

Host: Robert Carley

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