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Ultrafast spin-transfer torque driven by femtosecond pulsed-laser excitation.

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A hot topic in the field of ultrafast laser-induced manipulation of the magnetic state is that of the role and exploitation of laser-induced spin currents. Intense debate has been triggered by claims that such a spin-transfer, e.g. in the form of super-diffusive spin currents over tens of nanometers, might be a main contributor to the demagnetization process in ferromagnetic thin films after femtosecond laser excitation. In this presentation the underlying concepts will be introduced and recent developments reviewed. Particularly we demonstrate the possibility to apply a laser-induced *spin transfer torque* on a free magnetic layer, using a non-collinear multilayer configuration consisting of a free in-plane layer on top of a perpendicularly magnetized injection layer, as separated by a nonmagnetic spacer. Interestingly, this approach allows for a quantitative measurement of the amount of spin transfer. Moreover, it might provide access to novel device architectures in which the magnetic state is controlled by fs laser pulses. Careful analysis of the resulting precession of the free layer allows us to quantify the applied torque, and distinguish between driving mechanisms based on laser-induced transfer of hot electrons versus a spin Seebeck effect due to the large thermal gradients. Further engineering of the layered structures in order to gain fundamental understanding and optimize efficiencies will be reported. A simple model that treats local non-equilibrium magnetization dynamics to spin transport effects via a spin-dependent chemical potential will be introduced.