

Joint SSRL/ALS Workshop “Electron Dynamics in Spin Systems“

10.11.2006 SLAC Menlo Park, CA

Yves Acremann (SSRL), Peter Fischer (CXRO), and Andreas Scholl (ALS)

More than 20 participants attended the Joint SSRL/ALS workshop on “Electron Dynamics in Spin Systems” which was co-organized by Yves Acremann (SSRL), Peter Fischer (CXRO) and Andreas Scholl (ALS). The goal of this meeting was to bring together experts in the field of ultrafast spin dynamics to discuss and identify new scientific areas that can be addressed with next-generation ultrafast x-ray sources applying bunch compression, laser slicing, and free electron lasers.

T. Young (ALS) illustrated in his talk the experimental setup and the recent achievements with an X-ray streak camera system that has been developed and is currently operating at the ALS. It allows science to study ultrafast dynamics with a time resolution of better than 1 psec.

R. Schoenlein (LBNL) then introduced the new femtosecond slicing beamline 6.0 that is currently being commissioned at the ALS. He demonstrated the unique power of this ultrafast analytical tool by showing typical applications, e.g., to study the dynamics in correlated electron systems. During the discussion it became clear that a further upgrade, which would consist of an elliptically polarized undulator strongly enhances the capabilities at this facility to study unexplored phenomena of fsec dynamics in spin systems and was therefore strongly supported by the workshop participants.

An exciting overview on recent achievements to optically control magnetism with femtosecond time resolution was given by Frank Hansteen (U Nijmegen). He showed stunning results on ultrafast spin switching on a 40 fsec time scale in a magneto-optical system that was obtained very recently in his group which is led by Th. Rasing.

Fast dynamics of spin and orbital moments in Fe/Gd multilayered systems and halfmetallic Heusler alloys were studied by Alberto Comin (ALS) and coworkers with the streak camera system that is installed at the ALS. Very interestingly they found a synchronous dynamics in the demagnetization of the Fe and the Gd system and a slowing down of the dynamics in half-metallic Heusler alloys.

Joel Moore (UC Berkeley/LBNL) gave an extensive overview of a theorist’s view on electron spin transport in semiconductors, which opens exciting views into new and

fundamental aspects of solid state physics. He mentioned the lack of experimental evidence of the Spin Hall effect despite an enormous effort from the theoretical side.

Joe Orenstein (LBNL) described his research to investigate the spatial propagation of charge and spin in a two-dimensional electron gas. He characterized spin diffusion by the transient spin grating technique, which is based on the optical generation of spin-polarized electrons. The flow and decay of spin polarization is of particularly importance in spintronic applications.

Stuart Parkin (IBM Almaden) presented fundamental experiments on current-driven domain wall dynamics. He pointed out the exciting physics and unexpected behaviour of current-driven domain wall motion which has become a very active scientific area with great opportunities for revolutionary technological applications such as the so called Magnetic Race-Track device, which would extend non-volatile solid-state data storage into the third dimension.

Recent time resolved X-PEEM experiments tackling an optically excited spin-reorientation were reported by Thomas Eimüller (U Bochum). His findings indicate a relatively slow relaxation that cannot be explained by conventional spin-lattice coupling mechanisms and stimulated an intense discussion.

Jonathan Sun (IBM Yorktown Heights) gave an extensive introduction into spin-torque phenomena and he discussed the potential of switching nanomagnets by spin-polarized currents. He explained the associated dynamics and its thermal activation and he concluded that while the fundamental physics is understood the quest is still open to find the most suitable combination of materials and structures for data storage applications.

The workshop was concluded by a talk by John-Paul Strachan (U Stanford) on studies of spin transfer processed in nanopillars with time resolved-soft x-ray microscopy. His results revealed that the macrospin model is inadequate to describe the switching process in a spin transfer structure. Essential for his observation is the combination of spatial and temporal resolution that can nowadays be obtained by ultrafast soft x-ray microscopy.

Many interesting presentations and the lively discussions illustrated that spin dynamics on an ultrafast time scale is a growing field with ample opportunities for the application of short pulse x-ray sources and ultrafast detectors. The current lack of optimal sources will be partially closed by laser-slicing sources with polarization capabilities in combination with sub-picosecond detectors. There is, however, a need for sources with a time structure and pulse power compatible with high-power laser systems. Free electron laser sources in the soft

x-ray range would close this gap and open the door to ultrafast studies of spin dynamics and spin transport using x-rays.

