Dynamic Pathways in
Multidimensional Landscapes

Contribution ID : 15

Ultrafast dynamics in antiferromagnetic materials

Content :

Antiferromagnetic (AFM) materials have been predicted to show ultrafast magnetic dynamics since no macroscopic magnetization exists and dynamics might not be restricted by conservation of angular momentum. Out of recent studies investigating ferromagnetic materials like pure 4f elements (Gd,Tb,..) or a combination of 3d and 4f elements with (GdFeCo,..) it turned out that that the fast demagnetization time of the pure 4f elements Tb and Gd is around 750fs and in the combination with 3d's it is around 430fs. [1,2].

We addressed antiferromagnetic dynamics in the two 4f systems Ho and EuTe. Holmium is a helical antiferromagnetic metal while EuTe is a semiconductor with collinear antiferromagnetic order. Our optical pump, time-resolved resonant soft x-ray magnetic diffraction experiments have been performed at the FEMTOSPEX facility at BESSY II and at the SXR-beamline at LCLS, Stanford. The dynamics in Ho was mapped using the strong resonant x-ray scattering signal of the helical magnetic (00τ) superstructure reflection. It is generated by FM-planes whereby there is a turning angle of around 45° between each layer along the c-axis. The dynamics in EuTe are measured on the (½, ½, ½) superstructure reflection which comes from a doubled unit cell along the (111) as every Eu layer is antiferromagnetically ordered and spaced by a not magnetic Te layer.

We found, that independent of its individually magnetic moment Ho and EuTe can loose their magnetic order in a sub ps regime, 200fs for Ho and down to 450fs for EuTe. For both materials this is surprisingly fast but is in the first order directly explainable due to the fact that there is not net-orbital momentum which has to be transferred in contrast to the FM-materials.

By recording time resolved q-scans (mainly in EuTe) we find that the thin film magnetic profile is modified in a completely different way than for elevated temperatures in thermal equilibrium. This gives insight that also the structure itself is involved in the disordering process. We addressed this point with the measurements at the LCLS looking on a structural Bragg reflection of EuTe.

In summary we present ultrafast demagnetization dynamics in two antiferromagnets at low temperatures with surprising insights in this relatively new field looking on the delay and spatially resolved scans.

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Literature:

[1]M.Wietstruk etal,PRL106,127401(2011)

[2]I.Radu etal, Nature205,472(2011)

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