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Ultrafast resonant magnetic scattering at the soft X-ray free-electron laser FLASH. Christian Gutt. *DESY, Hamburg, Germany.*
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The quest for smaller and faster magnetic storage devices is a formidable challenge in modern magnetism. Ideally, one would like to probe elementary magnetization dynamics such as spin-flip processes and their coupling to the electronic system on their intrinsic time scales in the femtosecond (fs) regime. At the same time nanometer spatial resolution and element-specific information is required in order to account for the complex composition of technologically relevant magnetic media and devices. Simultaneous fulfilment of these requirements mandates ultrafast magnetic scattering experiments using flashes of resonantly tuned soft X-rays, in particular for the technologically relevant transition metals Cr, Mn, Fe, Co, and Ni with 2p electron binding energies between approximately 550 and 900 eV. Such experiments can be anticipated in the near future given the current construction of X-ray free-electron lasers (FEL) in the USA, Japan, and Germany. At present the world's most powerful FEL - FLASH in Hamburg, Germany - provides uniquely intense coherent short pulses in the extreme ultraviolet (EUV) energy range with the shortest fundamental wavelength of 6.5 nm.
Here we report on the first ultrafast resonant magnetic scattering experiments using the free electron laser facility FLASH at DESY in Hamburg. The experiments have been performed at the Co L3 edge with FLASH lasing at the fifth harmonic and at the Co M edge using the fundamental wavelength at 20.9 nm. We show that a magnetic small angle scattering signal from a Co/Pt multilayer can be recorded with a single FEL pulse of 30 femtosecond duration. Damage thresholds and FEL induced changes in the magnetic properties of the samples as evident in the SAXS signal will be discussed. First experimental results on pump-probe experiment using 120 fs optical pump pulses and 30 fs long FEL probe pulses will be reported [1], [2].

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Keywords: Magnetism, Free-Electron Laser, X-ray Diffraction

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Coulomb phase in the spin ices $Ho_2Ti_2O_7$ and $Dy_2Ti_2O_7$. Tom Fennell[a], [d]. [a]*Institut Laue Langevin, Grenoble, France.* [b]*IFF, Jülich Centre for Neutron Science at ILL,Grenoble, France.* [c]*Clarendon Laboratory, Oxford, UK.* [d]*London Centre for Nanotechnology, UCL, London, UK.*
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Recent experiments on the spin ices $Ho_2Ti_2O_7$ and $Dy_2Ti_2O_7$ using polarized neutron scattering have revealed the pinch point scattering characteristic of dipolar, or ice rule, spin correlations [1]. Such scattering has not previously been observed in the zero field spin ice state, but is strongly anticipated in theories of spin ice. It is characteristic of a Coulomb phase, which supports emergent magnetic monopole excitations. The measured scattering compares well with simple ice rule models, but there are extra contributions implying a modification of the pure ice rule constraint. I will discuss this comparison and its implication for the projective equivalence of near neighbour and dipolar spin ice Hamiltonians. Finally the effects of ice rule defects are clearly visible in the data, I will illustrate how their behaviour supports the picture of magnetic monopoles in spin ice.

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The Magnetic Structure of $CeAgAs_2$. Thomas Doert[a], Astrid Schneidewind[b], Markus Hölzel[b], Dieter Rutzinger[a], Michael Ruck[a]. [a]*Department of Chemistry and Food Chemistry, TU Dresden, Germany.* [b]*Forschungsneutronenquelle Heinz Maier-Leibnitz, TU München, Germany.*
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The majority of rare earth metal – coinage metal – dipnictides $LnMX_2$ (Ln = La, Ce – Lu; M = Cu, Ag, Au; X = P, As, Sb) shows antiferromagnetic order at temperatures below $T_N \approx 20$ K [1, 2]. Simultaneously, characteristic upturns in the resistivity curves were observed for some of these compounds below T_N which are discussed as possible Kondo systems [1]. For none of the $LnMX_2$ compounds the magnetic structure has been reported yet.
Starting with $CeAgAs_2$ neutron diffraction experiments on powder samples were performed to elucidate its magnetic structure. $CeAgAs_2$ adopts a distorted $HfCuSi_2$-type crystal structure (space group *Pmca*, [3]) and orders antiferromagnetically at $T_N = 6$ K. In susceptibility measurements an additional metamagnetic transition at $T_m = 4.8$ K was observed as well as a field dependence of the susceptibility [2].
In our diffraction experiments in the temperature interval $3.5 \leq T \leq 295$ K no peak splitting or broadening indicating a nuclear phase transition were observed. In the neutron scattering studies the magnetic ordering can be monitored by superstructure reflections which appear at T_N and increase in intensity upon further cooling. Below 4 K no additional intensity gain of the magnetic reflections is observed which can be attributed to a completion of the ordering process. The diffraction pattern of the antiferromagnetic phase can best be fitted with a structure model in the magnetic space group *Pmca'*. The magnetic moments on the Ce positions, which are computed to $M \approx 1$ μB at $T = 4$ K, are oriented along [100]. The intensities of the magnetic reflections decrease when an external field is applied. The relative intensity of the magnetic 001 reflection at $T = 3.5$ K, e. g., is reduced from 53% for $H = 0$ T to 24% for $H = 3$ T, the experimental limit. In the interval $4 \leq T \leq 6$ K, however, a much smaller external field of $H \approx 0.3$ T, suffices to suppress the magnetic ordering completely. In both cases, the effect is fully reversible: After switching off the external field at any $T < T_N$ the magnetic reflections gain their original intensity within hours.

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G., Schnelle, W., Kuz'ma, Yu., Grin, Yu. *Z. Anorg. Allg. Chem.,* 2004, 630, 635.

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Mossbauer and neutron diffraction study of polycrystalline $GaFeO_3$.

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Gallium iron oxide ($GaFeO_3$) is a member of a multiferroic family which exhibits ferrimagnetic and piezoelectric properties below room temperature [1-2].This material has orthorhombic crystal structure with space group P c 2_1 n with four different cation sites labeled Ga1, Ga2 (mostly occupied by gallium) and Fe1, Fe2 (mostly occupied by iron) [3-5]. Polycrystalline $GaFeO_3$ materials have been prepared by a traditional solid state reaction (SR) and sol-gel (SG) methods. The Curie temperature (T_C) for $GaFeO_3$ (SR) is about 190K and increases or reaches room temperature when the temperature of preparation is decreased from 1400°C to 900°C. The dielectric constant and dielectric loss are temperature and frequency independent for both samples.
Mossbauer analysis shows that at least two different assignment of the EFG and IS for the main Fe1 and Fe2 sites are possible. Both assignments results in similar site occupancies. It follows from the neutron powder diffraction that $GaFeO_3$ exhibits a ferrimagnetic order with spins parallel to c-axis. Also Mossbauer indicates for higher temperature of magnetic order in SG sample, in agreement with magnetization and neutron data.

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Spin strucure in ultrathin fcc-Fe films on Cu(001).

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Using soft x-ray resonant magnetic reflectivity in combination with frst-principles calculations we present a new model of the magnetic structure in fcc-Fe grown on Cu(001). Magneto Optic Kerr Effect (MOKE) experiments indicate an inverse spin reorientation transition, where the easy magnetization axis changes from in-plane at 4 monolayers (ML) to out of plane at 8ML thickness, while at 6 ML a hysteresis loop is found for both, in and out of plane magnetization [1].
Three samples were prepared consisting of 4, 6 and 8 ML on Cu(001) capped by 3nm Au. For each atomic layer both, the magnitude and the direction of the magnetization is fitted. While at 4ML the sample is ferromagnetic, for the anti-ferromagnetic structures in the coverage range between 6 and 8 ML we find blocks with robust magnetic structure, while the relative directions between the blocks vary involving a non-collinearity within the spin structure [2]. Experimental results are supported by parameter-free calculations within the framework of the density functional theory.

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