MS15.02.05 HIGH ENERGY X-RAY MAGNETIC SCATTERING: A NEW TECHNIQUE. Th. Brückel, Hamburger Synchrotron-Strahlungslabor HASYLAB at Deutsches Elektronen-Synchrotron DESY, D-22603 Hamburg, Germany

Magnetic x-ray scattering owes some of it's success to the resonance enhancements observed at the L_{II},L_{III},-edges of Lanthanides and the M_{IV},M_V-edges of Actinides. For transition metal compounds at most very weak resonance phenomena are observed in the hard x-ray range and one is left with the small non-resonant magnetic scattering cross section. In this situation, the use of high energy x-rays with energies above 100 keV might provide a possible remedy. At these energies transition metal compounds become virtually transparent to x-rays. Penetrations depths amount to several millimetres. This leads to a volume enhancement of the signal, independent of the material under consideration. True bulk properties become accessible, which can be of importance in the study of magnetic disorder phenomena. In the limit of very high energies, x-rays become sensitive to the spin momentum only, which should allow a separation of spin and orbital angular momentum without polarisation analysis.

In the present contribution, the principles of the new technique are discussed and results of first experiments on simple magnetic model systems are presented.

MS15.02.06 STUDY OF ORBITAL AND SPIN MAGNETIZATION DENSITIES IN MAGNETIC MATERIALS. Gerhard Grübel, European Synchrotron Radiation Facility, 38043 Grenoble, France

The element specific determination of orbital and spin magnetization densities remains a challenging task which is adressed experimentally by both magnetic x-ray scattering (XMS) and x-ray magnetic circular dichroism (XCMD). XMS experiments performed at high brilliance synchrotron radiation sources allow a quantitative polarization analysis of the magnetic scattering cross-section in both the resonant and non-resonant regimes. This permits the determination of orbital- and spin magnetization densities either via the polarization dependence of the non-resonant cross-section or through the application of magneto-optical sum rules to the dipolar contributions of the resonant magnetic cross-section obtained at two absorption edges. The same sum rules allow to deduce element-specific orbital and spin magnetic moments from x-ray absorption spectroscopy (XAS) and its associated magnetic circular dichroism data.

PS15.02.07 THE FIRST MEASUREMENTS OF A PURE MAGNETIC POWDER REFLECTION WITH X-RAYS. R J Cernik, S P Collins, D Laundy and C C Tang, Synchrotron Department, Daresbury Laboratory, Warrington, Cheshire, WA4 4AD, UK

We report the first successful measurements of magnetic x-ray powder diffraction from an antiferromagnet, performed at the uranium M4 edge in UO_2. For some time, magnetic x-ray diffraction measurements on antiferromagnetic crystals have utilised the huge M-edge resonant enhancements to good effect, routinely providing intensities and resolution superior to those more traditionally associated with neutron scattering [1]. However, competition between the relatively weak Bragg intensities, and a combination of diffuse scattering and strong fluorescence signals has made powder measurements difficult.

Our experiment [2], carried out on SRS station 8.4, was configured for maximum count-rates and low background. The resulting (102) magnetic diffraction intensity was found to vanish above the magnetic ordering temperature and exhibit the anticipated resonance response. Moreover, the integrated intensity agreed remarkably well with a simple calculation of the magnetic cross-section.

We anticipate that measurements performed with high flux insertion devices on third-generation synchrotrons, such as the ESRF, should provide data of extremely high quality, and could be extended to less pronounced magnetic resonances, such as the L-edges of magnetic lanthanide compounds.

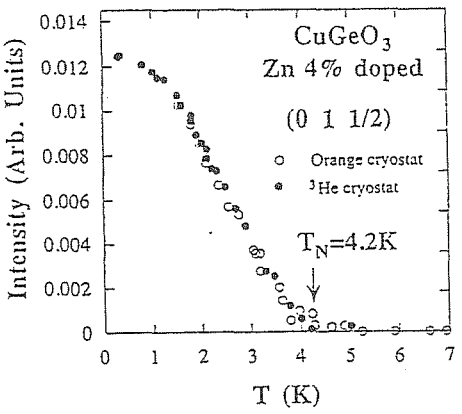
References

[1] McWhan D B, Vettier C, Isaacs E D, Ice G E, Siddons D P, Hastings J B, Peters C and Vogt O Phys.Rev.B 42 6007 (1990)

[2] Collins S P, Laundy D, Tang C C and Cernik R J J.Phys.:Condens Matter 7 L223 (1995)

PS15.02.08 CHARACTERISATION OF THE NÉEL STATE IN Zn AND Ni DOPED $CuGeO_3$ S. Coad[1], J.-G. Lussier[2], D. McK. Paul[1] and D. F. McMorrow[2] [1]Dept. of Physics, Univ. of Warwick, Coventry, CV4 7AL, UK [2]Dept. of Solid State Physics, Riso National Lab, DK-4000 Roskilde, Denmark.

Single crystal derivatives of the spin-Peierls (S-P) system, $CuGeO_3$, doped with concentrations of Zn (0.5% to 2.4%) and Ni (1.7% to 6%) have been studied using neutron scattering and SQUID magnetometry. Our study confirms that the presence of impurities generally suppresses the S-P state and leads to the onset of a Néel state at low temperatures. Although the effect of doping is fundamentally similar for Zn and Ni doped crystals, neutron scattering measurements of several magnetic reflections in the b*-c* plane reveal that the preferred spin orientation of the Cu^{2+} moments is along the c* axis for the Zn doped crystals and along the a* axis in the Ni doped material. In contrast to a recent report about the lack of saturation in the ordered moment in a Zn doped crystal, our measurements show the expected saturation of the magnetic intensity at low temperatures.



PS15.02.09 ANTIFERROMAGNETISM IN THE TERNARY CARBIDES $Tb_2Cr_2C_3$, $Ho_2Cr_2C_3$ and $Er_2Cr_2C_3$. By M. Reehuis, N. Stüßer, K. Zeppenfeld and W. Jeitschko, Hahn-Meitner-Institut, Berlin and Anorganisch-Chemisches Institut, Münster, Germany

The magnetic properties of the compounds $R_2Cr_2C_3$ (R = Y, Gd - Lu) with $Ho_2Cr_2C_3$ structure (C2/m) were determined with a SQUID magnetometer and by neutron powder diffraction. The chromium atoms do not carry a magnetic moment as is shown by the Pauli paramagnetism of the yttrium and lutetium compounds. The lanthanoid sublattices show antiferromagnetic order below the Néel temperatures T_N = 50 K ($Tb_2Cr_2C_3$), T_N = 14 K ($Ho_2Cr_2C_3$) and T_N = 7 K ($Er_2Cr_2C_3$) (K. Zeppenfeld, R. Pöttgen, M. Reehuis, W. Jeitschko and R. K. Behrens, J. Phys. Chem. Solids 54(1993)257). In the 2 K neutron powder patterns of $Tb_2Cr_2C_3$ and $Er_2Cr_2C_3$ the magnetic reflections could be indexed with the

primitive cell corresponding to the monoclinic C-centered nuclear cell with the propagation vector k = (1 0 0). The possible orientation of the moments of the four lanthanoid atoms in the unit cell (in the positions: (1) x, 0, z; (2) -x, 0, -z; (3) 1/2+x, 1/2, z; (4) 1/2-x, 1/2, -z) can be of the types F(++++), G(+-+-), C(++——) and A(+——+). For the terbium and the erbium compound the magnetic moments are aligned within the monoclinic ab-plane of the type $[A_x, 0, A_z]$ and $[A_x, 0, -A_z]$, respectively. The magnetic structure of the terbium compound is identical to that one found earlier for $Dy_2Cr_2C_3$ (T_N = 23 K) (Reehuis, K. Zeppenfeld, W. Jeitschko and E. Ressouche, J. Alloys Comp. 209(1994)217). For $Er_2Cr_2C_3$ a second set of magnetic reflections with the propagation vector k = (0 0 1/2) was found indicating that the magnetic cell is doubled along the *c*-axis. The moments in the unit cell are ordered of the type $[G_x, 0 -G_z]$ and are oriented nearly parallel to those of the structure with k = (1 0 0). For the carbide $Ho_2Cr_2C_3$ a magnetic structure with the propagation vector k = (1 0 -1/2) corresponding to the C-centered monoclinic cell was found. Within the unit cell the magnetic order of the holmium atoms is of the type $[A_x, 0, A_z]$. In these carbibes the moments are aligned in such a way, that they form an angle with the *c*-axis, which is practically the same as that one formed by the two neighbouring centrosymmetric lanthanoid atoms.

PS15.02.10 CRYSTALLOGRAPHIC ANALYSIS OF MAGNETIC STRUCTURES. A. Santoro and Q. Huang, Reactor Division, National Institute of Standards and Technology, Gaithersburg, MD 20899.

The nature of the spin ordering in a significant number of simple magnetic structures can be clarified by using the expression of the magnetic structure factor and by making use of simple crystallographic principles. The method used in our study of magnetic materials is based on a careful analysis of the diffraction patterns to determine the reflections with zero or near zero intensities. A judicious application of the procedure also allows one to find out if structural ambiguities are possible, i.e. to discover if two ore more spin orderings are consistent with the same distribution of powder or single crystal intensities, and to determine all the magnetic structures generating the ambiguity. This analysis does not make assumptions about the symmetry of the structure, which may be derived a posteriori. Applications to the derivation of the magnetic structures of HoNiBC, $YBa_2Fe_3O_8$ and other compounds will be illustrated in detail.

PS15.02.11 MAGNETIC ORDERING OF THE $UCu_{2-x}Ga_{2+y}$ SYSTEM DETERMINED BY NEUTRON DIFFRACTION. N. Stüßer, Z. Zolnierek*, Hahn-Meitner-Institut Berlin, FRG, *W.Trzebiatowski Institute, Wroclaw, PL

In the last few years there has been a great interest in studying the $(RE,An)T_2(Si,Ge)_2$ ternaries which exhibit a variety of magnetic structures. These compounds, where RE stands for the rare earth, An for actinide and T for transition metal atom crystallize in the space group I4/mmm. We have examined by neutron powder diffraction the ternaries $UCu_{2-x}Ga_{2+y}$ which are structural analogues to the $ThCr_2Si_2$ compound often referred to as the 1:2:2 compounds.

Two types of magnetic ordering were established. For $UCu_{1.16}Ga_{2.66}$ and $UCu_{1.33}Ga_{2.66}$ a simple AF-I-type structure was found. In the AF-I phase the uranium atoms at (0 0 0) have a spin parallel to the c-axis whereas those at (1/2 1/2 1/2) are antiparallel. This type of magnetic ordering is very common in the UT_2X_2-series.

For the copper ternaries $UCu_{2-x}Ga_{2.5}$ with x=0.75, 0.66, and 0.5 a new type of magnetic ordering was detected which has not been observed so far for any of the known 1:2:2 type intermetallics. The new magnetic unit cell is orthorhombic with lattice parameters $A=2^{1/2}a$, $B=2^{3/2}a$, and C=c, where a and c specify the tetragonal unit cell of the chemical structure. The magnetic structure can be described by a propagation vector k=(0 1 0) corresponding to (1/4 1/4 0) for the chemical unit cell. In this new type of magnetic structure the moments are canted from the c-axis. The c-components still exhibit the AF-I structure and the perpendicular components point along the B-direction forming an antiferromagnetic lattice as well.

Scattering Phenomena Inelastic, Anistropic Resonant Magnetic, Etc.

PS15.03.01 NEUTRON INELASTIC SCATTERING ON ULTRASONIC EXCITATIONS IN SILICON AND GRAPHITE. E. Iolin[1], B. Farago[2], F. Mezei[3], and E.Raitman[1], [1]Institute of Physical Energetic, Riga, Latvia; [2]Institute Laue-Langevin, Grenoble, France; [3]Hahn-Meitner Institute, Berlin, Germany

The effects of the bulk ultrasonic acoustic waves (AW) on the neutron scattering in single crystals have been studied for a long time. The energy of the AW is small (~10(-7) eV at f=25 MHz). Therefore the energy spectrum of the diffracted beam could not be studied by now. We had applied the neutron spin-echo technique and directly observed for the first time inelastic scattering on longitudinal and transversal AW. The measurements were carried out with perfect and deformed Si single crystals and on a pyrolitic graphite (PG) plate. The symmetric Bragg reflections (111) and (002) were studied (L=0.54nm, beam collimated to 0.5ang.deg.). The intermediate scattering function S(Q,t) was measured and analyzed as a sum of elastic I(0) and one, two and three phonon processes. i) Perfect Si. Clear harmonic time oscillations S(t) were observed (LAW, f=209 MHz), I(0) was almost independent from the AW amplitude W (the AW induced transitions between branches of the dispersion surfaces far away from the Lorentz point). ii) Deformed Si. Small amplitude TAW (f=49 MHz) decreases I(0) by up to 30%. This decrease is not fully compensated by the inelastic scattering, so that the total intensity I(t) of the diffracted beam decreases by up to 18%. These results are corresponded to the prediction of theory, one-phonon satellites are presented mainly in the forward scattered beam. iii) Strong excited LAW in Si (f =33 MHz). We observed S(t)=exp(-t/tr), tr~3ns instead of harmonic oscillations. It may be explained by the nonlinear effects and by many-phonon neutron scattering. iiii) Graphite. The effect of LAW (f=30.5 MHz) on the total intensity was absent, but inelastic scattering was strong. It was interpreted as a neutron scattering in each mosaic bloc vibrating as a whole in the LAW. Our approach may be applied for the studies of the artificial excitations in crystals and glasses.