13.X-5 NUCLEAR POLARIZATION AND NUCLEAR MAGNETIC STRUCTURE

M. Steiner
Hahn-Meitner-Institut, D-1000 Berlin 39 (FRG)

Nuclear polarization and nuclear magnetic structure were until recently fields, in which neutron scattering didn't make a large number of significant contributions, although it was known from the very beginning, that neutrons are sensitive to the nuclear polarization P_{nuc} through the term

$$P_{nuc}(b^+-b^-)$$

in the nuclear scattering length. In the last years we were able to perform a number of experiments measuring P_{nuc} and to investigate what areas could open up for neutron scattering by using $P_{nuc}(b^+-b^-)$. Necessary prerequisites are powerful dilution refrigerators in connection with a superconducting coil and polarized neutrons. Neutron scattering on "brute force" cooled samples can yield: nuclear temperature and nuclear spin lattice relaxation times, the determination of (b^+-b^-) and a contrast variation for structural studies, e.g. on alloys. An example for each of these applications will be discussed. If the nuclear spin system is cooled to sufficiently low T ($\sim 10^{-9}$K) one may eventually reach an ordered nuclear state, whose structure can be determined uniquely by neutron diffraction only. This case will be discussed by explaining the experiment on Cu, which is currently running. It should become clear from these examples, that the use of $P_{nuc}(b^+-b^-)$ opens up new and exciting fields for neutron scattering.

13.X-6 THE CORRECTION OF BRAGG INTENSITIES FOR TDS.

By BTM Willis, Chem. Cryst. Lab., University of Oxford, UK and Aere, Harwell, UK

In a diffraction experiment with X-rays, there is always a contribution from thermal diffuse scattering to the measured Bragg intensities. This contribution can easily amount to 20 or 30% of the total intensity, and, in order to correct for it, the elastic constants of the crystal must be known.

The correction is similar in neutron diffraction, provided that the velocity of the incident neutrons exceeds the velocity of sound in the crystal. However, for slower-than-sound neutrons the correction is smaller, and under certain conditions is zero. Pulsed neutron diffraction provides a rapid method of determining the elastic constants of a crystal for which a TDS correction is necessary.

13.1-1 NEUTRON AND X-RAY INTERFEROMETER WITH SEPARATED CRYSTALS.

By U. Bonse and H. Uebbing, Institute for Physics, University of Dortmund, Postfach 50 0500, 46 Dortmund 50, Fed. Republic of Germany and ILL, Grenoble, France.

We describe a perfect crystal interferometer which is operated simultaneously with neutrons and X-rays. The instrument consists of two separated crystals mounted about 1m apart in order to allow long empty sections in the interfering beams the distance of which is about 4.5cm. Stability problems are reduced by making the beam geometry skew-symmetric, i.e. with parallel beams between the two crystals. X-rays serve as reference for the neutron wavelength. The alignment is monitored with the X-ray angular interferometry fringe system which, with our geometry, has a period of less than 10^{-3} (10^{-2}) arc sec for a rotation about the Bragg angle axis (axis normal to the latter and normal to the diffraction vector), respectively. Furthermore, the combined use of X-rays with neutrons in interferometry opens up novel and interesting possibilities. Simultaneous measurement of neutron and X-ray interference fringes correlates atomic scattering factors f_0 and coherent scattering length b_c unambiguously. The phase relationship in the combined pattern can be exploited to determine dynamical diffraction parameters for the two different radiations. Effects on the neutron like sample velocity (Fizeau), gravity, magnetic and (possibly) electric fields, which are essentially different or even vanish for X-rays, may be determined more precisely.

13.1-2 THE POLARISED TARGET STATION AT THE 5 MW REACTOR OF THE GKSS RESEARCH CENTRE AT GEESTHACHT

By W. Knop, M. Krumpolc, K.H. Nierhaus, T.O. Niinikoski, V. Novotny, M. Rieubland, A. Rijllart, O. Schärpf, H.-J. Schink, H.B. Stuhrmann, R. Wagner, GKSS-WS D-2054 Geesthacht in collaboration with CERN Geneva, ILL Grenoble, MPI Berlin, Univ. Chicago, Univ. Mainz F.R. Germany

The last ten years have seen considerable progress in the performance of neutron polarisers (Schärpf, AIR Conf. Proc., 1980, 89 182) and dynamic polarised targets (Niinikoski, AIP Conf. Proc. (1976) 35 458). One of the polarised target stations of CERN is now operated at the GKSS Research Centre at Geesthacht (near Hamburg) using a thermal neutron beam of the 5 MW reactor FRG-1. The polarisation of the neutron beam is achieved by magnetic total reflection. For 5 Å neutrons these spin filters have an efficiency of .98. The alignment of proton spins of biological structures in the direction of an external magnetic field is best achieved by dynamic nuclear polarisation (DNP) in the presence of Cr(V) as paramagnetic radical. In a magnetic field of 2.5 T and at temperatures below 0.4 K the proton polarisation may reach 70 % after one hour microwave irradiation (Knop et al. 1986, Helv. Phys. Acta 39 741). The polarisation of the protons is measured by continuous NMR, calibrated by the measurement of the signal area in thermal equilibrium with the helium around 1 K. The high homogeneity ($\Delta H/H \leq 0.0005$) in the sample area between the poles of an electromagnet is needed to meet the resonance condition of DNP. The sample is cooled in a horizontal fast access dilution refrigerator. Sample exchange and cooling to 0.4 K takes about 5 hours only. The sample is given a special design to minimize the absorption of the neutrons by 3 He. A new cryostat with a 4 He-filled sample chamber thermally coupled to the mixing chamber is being prepared.