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Shifts: 9	**Local contact(s):** Dr. H. Grünsteudel, Dr. J. Metge	*Received at ESRF:*

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Report:

1. We report on the first experiments with inelastic nuclear scattering (INS) under high pressure, here on α-Fe at 10 GPa in a diamond anvil cell (DAC). The INS technique uses the same setup as the coherent nuclear forward scattering (NFS), but is scanning the high-resolution monochromator (HRM) with a bandwidth of about 6 meV over the nuclear resonance [1,2] and monitoring the inelastically in 4π geometry scattered photons, which are connected with the creation or annihilation of phonons in the (inelastic) absorption process by the Mössbauer nuclei. In the case of Fe-57, one observes the reemitted 14.4 keV gammas and the Fe $K_{\alpha,\beta}$ x-rays of 6.4 and 7.1 keV (from the internal conversion process) in an intensity ratio of 1 : 8.9. The Fe $K_{\alpha,\beta}$ x-rays are, due to their low energy, completely absorbed in a normal high pressure cell. We used a specially developed DAC (see report HC-373), where the gasket material (epoxy) allows for the penetration of the x-ray perpendicular to the diamond axes and detection at a large solid angle by avalanche photo diodes. Even in this optimized case, the inelastic count rate is reduced at 10 GPa by a factor of 20. Fig. 1 shows the INS spectra of a-iron at ambient pressure and at 10 GPa, demonstrating the principal feasibility of the present setup for high-pressure studies. The data at ambient pressure were taken in 8 runs within 5 h, while the data at 10 GPa were taken in 20 runs within 24 h.

Unfortunately, it turned out that the accuracy of the INS data was limited due to mechanical instabilities; the energetical position of the HRM could not be determined reliable enough for a quantitave analysis of the data. A qualitative inspection of the present data shows, within the error bars, a small increase in the overall phonon energies and, from comparison of the elastic (central “zero-phonon-line”) to inelastic events (“wings”), also an increase in the f-factor (for details of such analyses, see [1,2]).

2. Using the last 3 shifts, we performed a few conventional high-pressure.NFS-experiments on magnetic Laves-phases. In continuation of our previous work (see reports HC-373 and HE-99) we studied YFe2 at 105 GPa, still in the same DAC as in HE-99, but now placed in a cryostat and studied down to 16 K; the NFS spectra indicate, as observed at 300 K, a nonmagnetic behaviour. This proves the suppression of Fe moment formation and magnetic order even at very low temperature at that high pressure.

We continued also our NFS studies on $GdFe_2$ at pressures up to of 105 GPa for comparison with YFe_2. Fig. lb shows high-pressure NFS spectra of $GdFe_2$ at 300 K with external polarizing field. The spectra demonstrate that $GdFe_2$ remains magnetically ordered even at 105 GPa. The different pressure dependencies of the (averaged) Fe-57 hyperfine fields in $GdFe_2$ and YFe_2 are shown in Fig. lc. This different behaviour is clearly caused by the magnetic Gd sublattice, since the structural properties and compressibilities of YFe_2 and $GdFe_2$ are very similar. From Fig. lc one may deduce that the magnetic strength of the Gd sublattice surpasses that of the Fe sublattice somewhere above 50 GPa, thereby taking over the leading role in the Fe moment formation. The different magnetic behaviour of Fe in YFe_2 and $GdFe_2$ is, to our opinion, of importance for a basic understanding of the Fe moment formation and stability in other Fe-rare earth intermetallics, for instance in hard magnets like $Nd_2Fe_{14}B$.

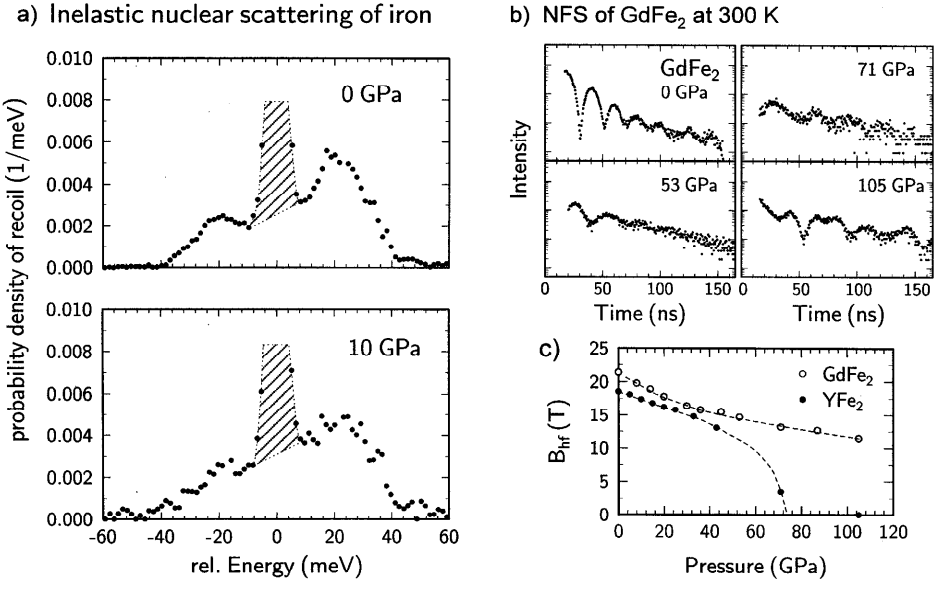

Fig. 1: a) Inelastic nuclear scattering of a-iron at ambient pressure and at 10 GPa.
b) NFS-spectra of $GdFe_2$ at various pressures, taken in an external field of 0.75 T.
c) Magnetic hyperfine fields for YFe_2 and $GdFe_2$.

References:

[l] W. Sturhahn et al., Phys. Rev. Lett. 74, 3832 (1995).

[2] A. Chumakov et al. , Phys. Rev. B 54, R9596 (1996).