ESRF	**Experiment title:** Highly Temperature Resolved Investigation of the Spin Reorientation Transition in $^{57}Fe_3B0_6$ by Means of Nuclear Resonance Scattering of Synchrotron Radiation	**Experiment number:** HC-370
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Report:

Ferriborate (Fe_3BO_6), the sample studied in this experiment, has been investigated and described in many respects. So it is well known that it contains two non-equivalent iron sublattices which below the Néel temperature of 508 K are spontaneously antiferromagnetically ordered. At the temperature of 415 K, Fe_3BO_6 undergoes a spin reorientation phase transition, where the spins change their orientation from the [001] direction to the [100] direction of the crystal.

In the present experiment this spin reoricntation transition has been studied in detail by means of nuclear resonant forward scattering, both in the ordinary polarisation insensitive setup and with the sample between a crossed polarizer/analyzer, which allows one to detect optical activity.

The sample was heated in a furnace designed for high spatial homogenity **and** a defined slow drift of the sample temperature. .A temperature drift velocity down to 15 μKs^{-1} within a small interval1 around the phase transition temperature was achieved. Since each measured nuclear resonance scattering time spectrum was accumulated in only 300 s the derived temperature resolution per spectrum was about 5 mK.

The observed quantum heat pattern. which is due to hyperfine splitting of the nuclear states in a given environment, yields the desired information about magnitudes and directions of the local magnetic hyperfine fields, i.e. the orientations of the spins. The investigated $^{57}Fe_3BO_6$ single crystal was oriented in such a way that below the transition temperature the spins were oriented perpendicular to the incoming beam and to its polarization plane. Above the transition temperature the spins have moved to a direction parallel to the beam.

The spectra proved to be extremely dependent on the temperature within an interval of about 1 K at 415K. Fig. 1 displays spectra of the pure phases above and below the transition point and a spectrum taken at an intermediate temperature.

The analysis showed that the spectra, which exhibit intensity fluctuations of a factor of 10 within a few ns. are extremely sensitive to all hyperfine parameters.

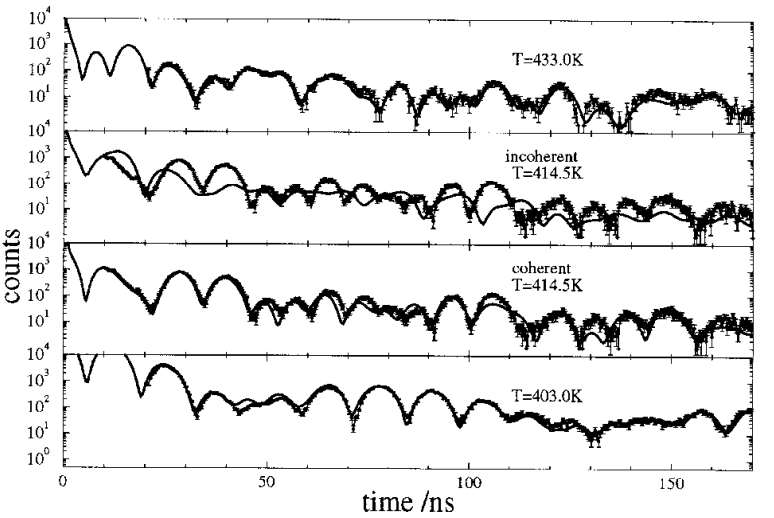

Fig. 1: Forward scattering of $^{57}Fe_3BO_6$ after excitation by synchrotron radiation pulses. a) above the transition point at 433.0 K; b) in the intermediate region at 414.5 K (incoherent superposition); c) as b) but coherent superposition; d) below the transition point at 403.0 K

The present result of the fitting is indicated by solid lines. Most remarkable is the result, for the intermediate region. It turns out to be a coherent superposition of the pure phases above and below the transition point. For comparison the result of an incoherent superposition is also shown. This clearly proves that the transition within a single domain proceeds by an abrupt jump and not via a continuous rotation or other intermediate orientations of the spins.

The coexistence of both phases can be seen from the mixing parameter which one gets from the a.nalysis of the t,ime spectra. Fig. 2a shows the result in terms of the partial weight of the low temperature phase. It is in accordance with the result of the experiment with crossed analyzer/polarizer (Fig. 2b). In our chosen setup optical activity is only present in the low temperature phase and thus the transmitted intensity downstream the analyzer decreases as function of temperature.

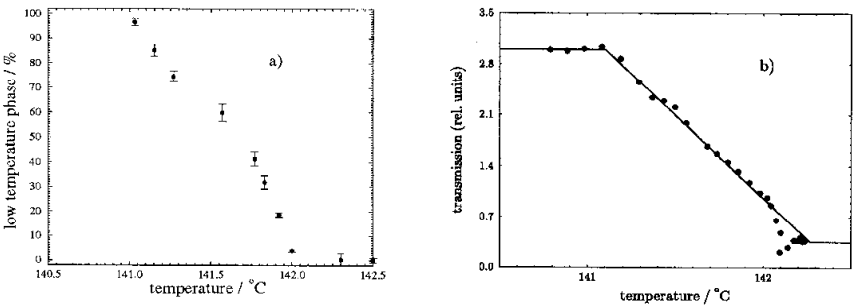

Fig. 2: a) Fraction of low temperature phase in the transition region derived from an analysis assuming coherent superposition. b) Temperature dependence of the transmission in the transition region with $^{57}Fe_3BO_6$ between crossed analyzer/polarizer.