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Report:

In this experiment the magnetism of oriented nanoscaled iron islands on W(110) was investigated. The island structure has been created by thermal evaporation under ultrahigh vacuum condition followed by a self-organization process when annealing the system to about 500°C. The 3D-islands are epitaxially ordered and exhibit a rectangular shape (width: 150-250nm; length: 150-800nm) with the long axis pointing along the W[001] direction. Before capping these islands with carbon or silver against oxidation the obtained geometric structure is anaylzed in-situ with an scanning tunneling microscope. Typical heights are about 5nm when starting from a coverage of 5ML. The length of the islands varies between 200nm and more than 2000nm depending on the details of the annealing process.

At the ESRF these capped oriented iron islands have been investigated using the technique of nuclear resonant forward scattering for various sample orientations and temperatures between 4.2K and 300K.

One of the questions of these measurements has been the influence of the capping material onto the magnetic behavior of the iron islands. Thus, we have prepared two nearly identical samples with iron islands in our laboratories and afterwards capped the samples with either a thin carbon or a silver layer. The results from of carbon-capped iron islands are partially shown in the ESRF-report SI-421 (ref. [1]). Here, we will only display the results for Fe islands on W(110) capped with silver, see fig. 1. The data clearly show pronounced quantum beat patterns, i.e., a magnetic ordering within the islands, that can be very well simulated by theory (solid line) [2].

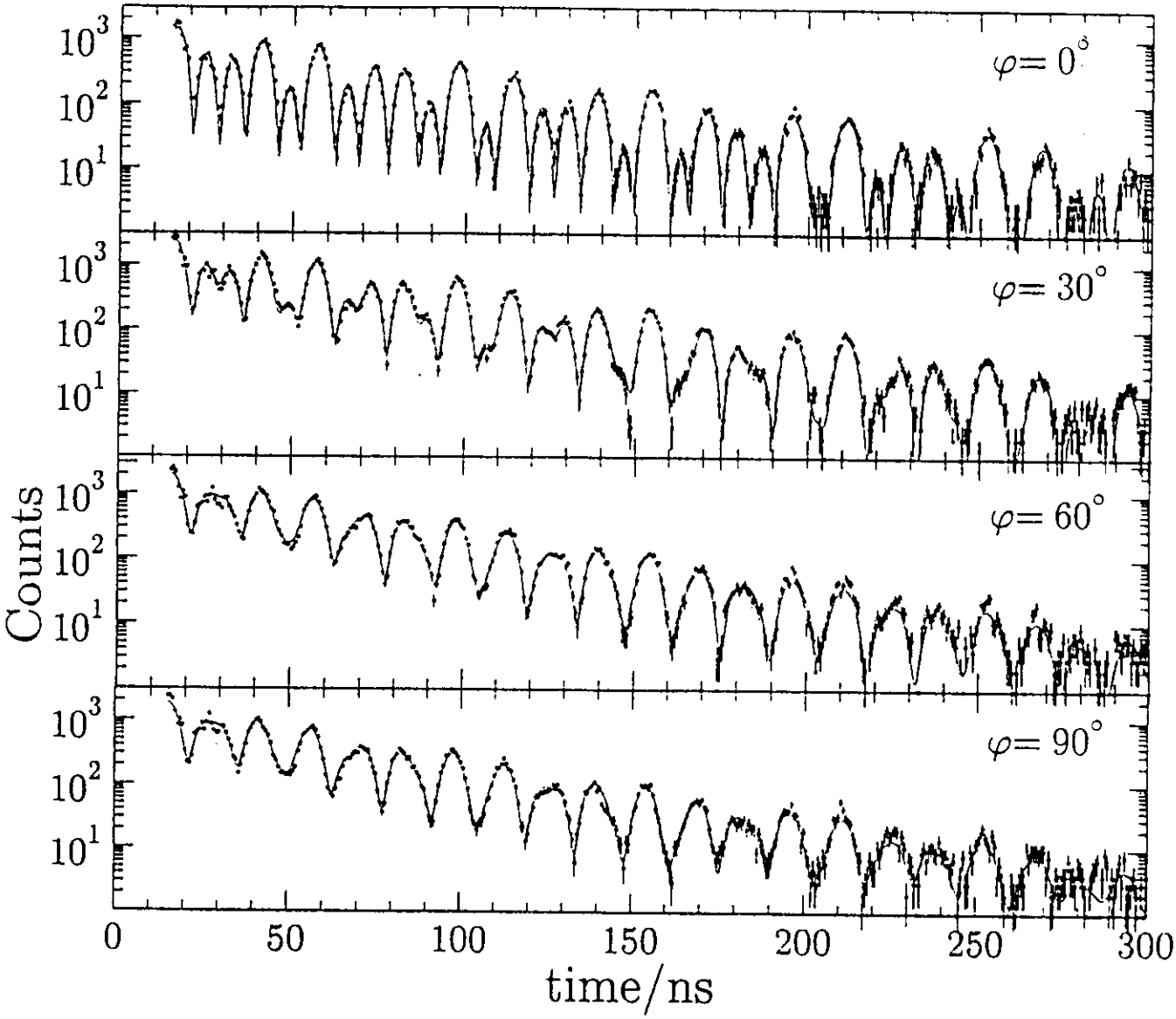

Fig. 1: Quantum beat spectra taken at room temperature from ^{57}Fe islands on W(110). For comparison with data from the SI-421 report, the angle 90° denotes the W[001] axis parallel to the incident radiation k_0. Solid lines are simulations according to the theory outlined in [2].

The time resolved quantum beat spectra shown in fig. 1 are nearly identical to the data observed from carbon-capped iron islands on W(110). Both sets of data clearly indicate that the magnetic moments are preferentially (i.e. 80%) aligned along the W[001] axis, i.e., along the orientation of the iron islands. However, there is an additional component of the magnetic moment lying also in plane by perpendicular to the prefered orientation axis (W[110], 20%). The occurence of this component is not fully understood, but it may arise from the fact that a certain part of the iron islands is quite small in lengths and thus does not exhibit a pronounced shape anisotropy. It should be furthermore mentioned that the hyperfine fields B_0 at low temperatures are close to the value known for bulk material. With increasing temperature, the hyperfine field B_0 decreases faster than that of the corresponding bulk material, pointing to a sligthly lower Curie-temperature of about 940K (bulk value 1043K).

[1] J. Bansmann et al., ESRF report SI-421 (1999).

[2] R. Röhlsberger, in: Nuclear Resonant Scattering of synchrotron radiation, eds. E. Gerdau and H. de Waard, Baltzer (1999).