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Neutron spectroscopy of α-Fe2O3 nanorods: Direct detection of long-range spin wave excitations

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We present time-of-flight neutron spectroscopy data from PELICAN on α-Fe2O3 nanorods with an average length of 300 ± 100 nm and diameter of 60 ± 10 nm. A strong quasi-elastic neutron signal is associated with absorbed water on the nanoparticle powder, which can be removed through heat treatment. After suppressing the QENS signal, it is possible to observe weak spin wave excitations originating from the antiferromagnetic structure of the α-Fe2O3 nanocrystals. The excitations are directly compared with measurements conducted on larger microscale α-Fe2O3 particles at various temperatures to highlight differences in mode intensity and width. The interchanged spectral intensities in the nanorod are a consequence of a suppressed spin orientation, and this is also evident in the neutron diffraction which demonstates that the weak ferromagnetic phase survives to 1.5 K. The main magnon features are similar in bulk and nanoforms and can be explained using a model Hamiltonian considering interactions up to fourth nearest-neighbors. Complementary scanning transmission electron microscopy data is presented in order to clarify the atomic-scale structure and morphology of the rods. Finally, the implications are discussed for technological devices based on magnonic transmission at surfaces and through nanowires [2].

References

[1] D. L. Cortie et al. , submitted to Journal of Condensed Matter Physics (2018)

[2] A. V. Chumak et al., Magnon transistor for all-magnon data processing, Nature Communications 5 4700, (2014)

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