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Hjøllum, Jari í; Lefmann, Kim; Niedermayer, Ch.; Kuhn, Luise Theil; Raittila, J.; Paturi, P.; Christensen, N.B.; Andersen, Niels Hessel; Lebech, Bente

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Investigations of the Antiferromagnetic Order Parameter in Nano-Sized YBCO Particles

By Jari í Hjøllum (1,2,3)
and
K. Lefmann(2), Ch. Niedermayer(3), L. Theil Kuhn(4), J. Raittila (5), P. Paturi(5), N. B. Christensen(3), N. H. Andersen(1), B. Lebech(1)
(1) Materials Research Department, Risø DTU.
(2) Niels Bohr Institute, Uni. of Copenhagen.
(3) Paul Scherrer Institute, Villigen, Switzerland.
(4) Fuel Cells and Solid State Chemistry Department, Risø DTU.
(5) Physics Department, Uni. of Turku, Finland.

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YBCO (YBa2Cu3O6+x) is maybe the best known high-temperature superconductor (HTSC), being the first superconductor with a TC above the boiling point of liquid N2. It is as the other cuprate HTSC antiferromagnetically ordered at low doping, and a superconductor at high doping. The superconductivity of YBCO is a two-dimensional phenomenon, existing even in materials only one unit cell high. However, it is well known that the dimensionality of the system affects the magnetic order in a material, with for instance a changed magnetization curve.
We have manufactured disc-shaped YBCO with a diameter of 30nm and a height of 3nm, and using neutron diffraction (ND) and muon spin rotation (μSR) we have measured the staggered magnetization in the YBCO particles versus doping and temperature.
The results show a significant lowering of both the Néel temperature and of the staggered magnetic order parameter compared to bulk. This shows that the magnetic order parameter in YBCO is a 3D phenomenon, in opposition to the superconducting order parameter.
Furthermore the μSR results show the reentry of the magnetic order parameter at low temperature, previously only reported in bulk-sized systems. This observation strongly supports the view that the reentry is an intrinsic property of the cuprate systems.