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Quantum Magnetism and possible BEC in an organic Nickel compound

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I will review recent experimental and theoretical work on the S=1 quantum magnet, $NiCl_2$-4SC$(NH_2)_2$. [1] This compound exhibits field-induced XY antiferromagnetism for magnetic fields along the tetragonal c-axis between H_{c1} = 2.1 and H_{c2} = 12.6 T. The axial symmetry of the spin environment allows us to understand the quantum phase transitions at H_{c1} and H_{c2} in terms of Bose-Einstein condensation (BEC) of spin levels. Here the tuning parameter for BEC transition is the magnetic field and not the temperature. Specific heat, magnetocaloric effect, and magnetization data at low temperatures confirm the predicted behavior for a BEC: Hc-H_{c1} $\sim T^{\alpha}$ and M(H_{c1}) $\sim T^{\alpha}$ where $\alpha = 3/2$. I will also present magnetostriction data [2] taken at dilution refrigerator temperatures that show significant magnetoelastic coupling and magnetic-order-induced modifications of the lattice parameters in this soft organic compound. The data are well-described by Quantum Monte Carlo calculations, allowing us to make a quantitative determination of the magnetoelastic coupling, and also extract the spin-spin correlation function from the magnetostriction data.

[1] V. S. Zapf, D. Zocco, B. R. Hansen, M. Jaime, N. Harrison, C. D. Batista, M. Kenzelmann, C. Niedermayer, A. Lacerda, and A. Paduan-Filho, Phys. Rev. Lett. 96, 077204 (2006).
[2] V. S. Zapf, V. Correa, C. D. Batista, T. Murphy, E. D. Palm, M. Jaime, S. Tozer, A. Lacerda, A. Paduan-Filho, "Magnetostriction in the Bose-Einstein Condensate quantum magnet $NiCl_2$-4SC$(NH_2)_2$," cond-mat/0611229.