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Highly Unquenched Orbital Moment In Fe Phthalocyanine[1]

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Metal-Phthalocyanine molecules (MPc) form a family of compounds with a wide range of commercial application such as catalysts or dyes, and more recently in thin film technology. In an early work we found that in the α-phase of FePc, where the FePc molecules are stacked in a herringbone structure, the Fe atoms are strongly magnetically coupled into ferromagnetic Ising chains with very weak antiferromagnetic interchain coupling. The chains achieve 3D long range ordering at T_N=10 K, and strong irreversibility (slow relaxation) below 5K. The Fe(II) is in a S=1 state and the hyperfine field in the ordered phase reaches a record value in Fe(II) of B_{hf}=66.2 T. This result is consistent with a large, unquenched orbital moment. It has been measured directly in a X-ray Magnetic Circular Dichroism (XMCD) spectroscopic study on FePc thin films deposited parallel on a Au surface predeposited on a Si substrate. The XMCD spectra at the L_3 and L_2 edges were measured as a function of incident angle γ. The orbital moment is $|m_L| = 0.53 \pm 0.04\mu_B$ and the isotropic spin component is $m_S = 0.64 \pm 0.05\mu_B$. The origin of this unusually high orbital moment is the incompletely filled e_g level lying close to the Fermi energy. The ferromagnetically coupled Fe moments show strong, in-plane anisotropy [1]. Angular dependent measurements at the Fe K-edge also show strong quadrupolar excitations associated to a strong orbital moment, confirming the above result of the existence of a large, unquenched orbital moment in this molecule. Submonolayer FePc thin films deposited on Au, recently studied my XAS and XMCD have shown that there is charge transfer from the substrate to the Fe atom, modifying the electronic structure and magnetic properties [2]

[1] J. Bartolomé et al., Phys. Rev. B 81, 195405 (2010)
[2] S. Stepanow et al., Phys. Rev. B 83, 220401(R) (2011).

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