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Probing Giant Magnetic Anisotropies in Molecular Nanomagnets Using Very High-Field EPR[1]

STEPHEN HILL, NHMFL and Department of Physics, Florida State University, Tallahassee, FL32310

Most Electron Paramagnetic Resonance (EPR) research is performed at the X-Band frequency of 9.5 GHz. Specialized commercial instruments exist at K- (25 GHz), Q- (35 GHz) and W-Band (95 GHz), operating to magnetic fields of 6 T. The EPR facilities at the National High Magnetic Field Laboratory (MagLab) in Florida, offer scientists from all over the world opportunities to use several home-built, high-field/high-frequency EPR instruments with continuous coverage from 10 GHz to 1 THz [1]. Magnets are also available providing magnetic fields up to 45 T — roughly one million times the earth's magnetic field. EPR performed at these extremes offers tremendous advantages for problems spanning diverse research fields from condensed matter physics, to chemistry, to biology. After a brief overview of the MagLab EPR facility, the remainder of the talk will focus on molecular nanomagnets — molecules that contain either a single magnetic ion, or multiple exchange-coupled ions that possess a well-defined collective magnetic moment (or spin). These molecules are of interest in terms of their potential use as memory elements in both classical and quantum information processing devices [1]. Results obtained from EPR will be highlighted, emphasizing discoveries that have contributed to a shift away from the study of large clusters to simpler molecules containing highly anisotropic magnetic ions such as lanthanides or transition metals with unquenched orbital moments. In particular, certain transition metals residing in high-symmetry coordination environments can experience orbitally degenerate ground states and very strong first-order spin-orbit coupling. The resulting giant magnetic anisotropies associated with such species have been measured using very high-field (up to 35 T) EPR [2,3]. [1] Hill et al., Struct. Bond. **164**, 231-292 (2015). [2] Marriott et al., Chem. Sci. **6**, 6823-6828 (2015). [3] Ruamps et al., J. Am. Chem. Soc. **135**, 3017-3026 (2013).

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