Plenary lecture (PL-1)

Magnetic Resonance in Molecular Nanomagnets: Quantum Tunneling of the Magnetization and Relevance to Quantum Computing

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It is well known that in nature macroscopic objects exhibit classical behavior whereas microscopic systems exhibit quantum properties. However, recently compounds have been synthesized wherein macroscopic properties exhibit quantum behavior. Examples are clusters of 12 Mn(III,IV) ions coupled by carboxylate ligands, commonly called Mn-12, and of 8 Fe ions, bonded through cyclic amino ligand, now known as Fe-8. Both of these compounds have 20 unpaired electrons on a subunit, which thus acts as a S =10 paramagnetic system. Their magnetic hysterisis loop, by definition a classical property, exhibits quantum jumps below a certain critical temperature, called the blocking temperature, T(b). This is indeed quite unexpected and currently not well understood. On the other hand, a detailed understanding of this behavior could have far-reaching implications, such as to memory storage at the molecular level and to the science and technology of quantum computing. Considerable effort is thus being currently devoted to systematic studies of both the chemistry and physics of these systems. An important factor is that because of the inherent strong electronic exchange interactions, these systems can best be investigated using very high field electron paramagnetic resonance (EPR) and nuclear magnetic resonance (NMR) techniques at helium and sub-helium temperatures. This talk will summarize the experimental techniques and some results obtained, in light of the recent progress in this field, taking examples mainly from the EPR and NMR work carried out at the National High Magnetic Field laboratory in Tallahassee, Florida.