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PhD Job Offer

Single molecule magnets studied with unique µ-SQUID and combined µ-SQUID-EPR techniques.

Context: The single molecule magnets (SMM) offer interesting problems for Physicists and Chemists encompassing magnetic anisotropy at molecular level, slow relaxation and resonant quantum tunneling of magnetization (QTM) [1]. These systems are of growing interest for their numerous applications in molecular spintronics and quantum information processing. Recently, many interesting molecules, with special spin order like molecular spring magnets, single molecule toroic (SMT) etc., have emerged as candidates for molecular spintronics based technology. On the other hand, the hyperfine levels (from the interaction between electronic and nuclear spin), probed by M-H measurements in some special molecules [Fig.1(a)], open new possibilities of utilizing nuclear spin in quantum computation [2].

The µ-SQUID magnetometry technique stands as the most convenient tool (till date) to study the magnetic properties in a single crystal of such molecular magnets. A unique µ-SQUID [3] set up with a 3D vector magnet is used for angle resolved magnetometry of SMM down to 30 mK temperature inside a dilution fridge [Fig.1(b)].

Objective: Understanding and control of the electronic spin states in a single molecule magnet in view of application in molecular spintronics and nuclear spin-based quantum computation.

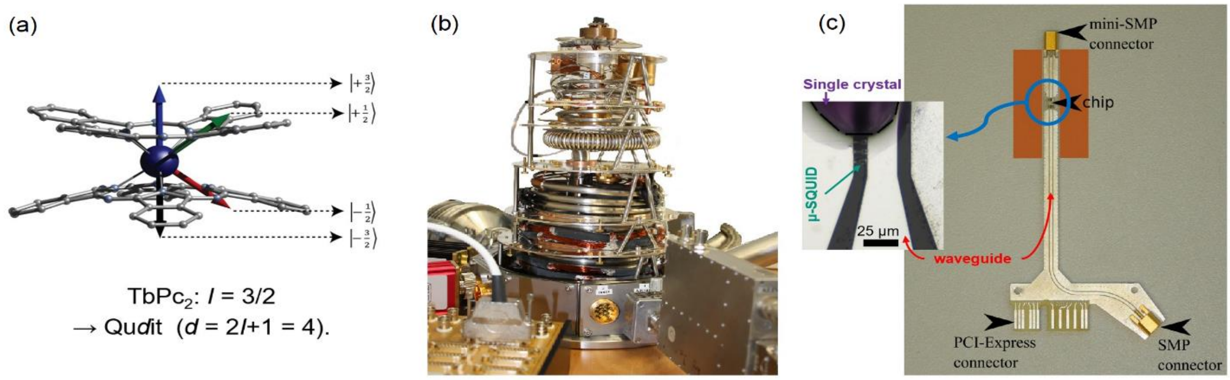

Fig.1: (a) Molecular structure of $TbPc_2$ SMM, a candidate for nuclear spin-based quantum computation. (b) The `sionludi' dilution fridge for µ-SQUID measurements. (c) Design of the sample holder chip for µ-SQUID-EPR study.

Work plan: Using the unique µ-SQUID set up, many different single crystals of molecular magnets, synthesized by various chemist groups, will be studied in search of special molecules as mentioned above. The work plan is as following: (1) low temperature magnetic measurements on single crystals of SMM, (2) theoretical understanding and simulation of the M-H data in terms of QTM, (3) improvement of a newly developed µ-SQUID-EPR (electron paramagnetic resonance) combined technique involving RF (or optical) excitation [Fig.1(c)] of the molecule, (4) using µ-SQUID-EPR on special molecules for more detailed understanding of different spin states in the SMM.

Reference:

[1] Measuring molecular magnets for quantum technologies,
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[2] Molecular spin qudits for quantum algorithms,
Eufemio Moreno-pineda et. al, Chem. Soc. Rev., **47**, 501, (2018).
[3] From micro- to nano-SQUIDs: applications to nanomagnetism,
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