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Probing spin-phonon coupling in magnetic materials using magneto-Raman spectroscopy[1]

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Combining spectroscopy with one or more external parameters such as low temperature, high pressure, and high magnetic fields, allows us to continuously tune correlations to probe properties of materials across their phase diagram. Recently, we employed magneto-Raman spectroscopy on two different kinds of magnetic materials. The first compound is $SrCu_2(BO_3)_2$. It is a quasi-2D orthogonal spin dimer system with a spin singlet ground state and is a typical example for the Shastry-Sutherland model. It exhibits a sequence of magnetization plateau at magnetic fields higher than 20 T. The unique behavior results from interplay between geometrical frustration and quantum fluctuations. I will discuss the origin of the strong spin-lattice coupling in $SrCu_2(BO_3)_2$ revealed by Raman studies at high magnetic fields up to 45T. The second compound is the multiferroic metal organic framework $[(CH_3)_2NH_2]Co(HCOO)_3$ belonging to the family of MOFs comprised of methylammonium (A= $(CH_3)_2NH_2$) and metal (B=Co, Cu, Fe, Mn, Ni) cations with a formate (X=$HCOO_3$) anion. Several efforts have been made to understand the exchange interactions in these functional materials including magnetization at high magnetic fields up to 60 T and infrared spectroscopy at magnetic fields up to 35 T. In the infrared studies under applied magnetic fields, it was concluded that Co complex adopts a different mechanism for facilitating saturation of magnetic states by involving formate stretching distortions unlike other complexes in the family that use the formate bending mode. In this talk, I will discuss our Raman spectroscopy on $[(CH_3)_2NH_2]Co(HCOO)_3$ at magnetic fields up to 31T to probe the magneto-elastic coupling. This work has been performed at the user facilities in the National High Magnetic Field Laboratory (NHMFL), Tallahassee. The NHMFL is supported by the National Science Foundation through NSF/DMR-1644779 and the state of Florida. The project is also funded by DoN HBCU/MI program award # N000141713061.

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