Celebrating Physics with a Good Excuse", Symposium at PSI
July 3 – 6, 2017, Paul Scherrer Institut

New Phases of Magnetic Quantum Matter

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Materials with arrays of quantum spins forming well-defined lattices serve as model systems to study the phases of correlated magnetic quantum matter. Neutron and X-ray scattering are unique tools for high-precision studies of such phases and of their correlations and excitations with high energy and momentum resolution. We investigate elementary quasi-particles and their stability under static multi-extreme conditions in temperature, magnetic field and pressure in frustrated and low-dimensional magnets. In one-dimensional ladder systems with and without frustration, we control and observe single- and multi-particle excitations and their decay using fundamental symmetries. In the two-dimensional frustrated Shastry-Sutherland lattice, pressure is used to control directly the frustration and stability of quasi-particles resulting in novel quantum phases near (deconfined) quantum critical points. The results will be discussed in the context of recent developments in computational physics and neutron instrumentation.