Vesna F Mitrovic, Struct Chem Crystallogr Commun, 3:2
DOI: 10.21767/2470-9905-C1-002

Novel magnetism and local symmetry breaking in a mott insulator with strong spin orbit interactions

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Study of the combined effects of strong electronic correlations with spin-orbit coupling (SOC) represents a central issue in quantum materials research. Predicting emergent properties represents a huge theoretical problem since the presence of SOC implies that the spin is not a good quantum number. Existing theories propose the emergence of a multitude of exotic quantum phases, distinguishable by either local point symmetry breaking or local spin expectation values, even in materials with simple cubic crystal structure such as Ba_2NaOsO_6. Experimental tests of these theories by local probes are highly sought for. Our local measurements designed to concurrently probe spin and orbital/lattice degrees of freedom of Ba_2NaOsO_6 provide such tests. We show that a canted ferromagnetic phase which is preceded by local point symmetry breaking is stabilized at low temperatures as predicted by quantum theories involving multipolar spin interactions. Specifically, we find that the ferromagnetic state is in fact a type of canted ferromagnet with two sub-lattice magnetizations and that cubic symmetry breaking occurs at a temperature above the Néel temperature and it involves deformation of oxygen octahedra presumably reflecting a complicated pattern of staggered orbital order. Our findings are in startlingly good agreement with theoretical predictions based on quantum models. Thus, our results, to be presented, establish that such quantum models represent an appropriate theoretical framework for predicting emergent properties in materials with both strong correlations and SOC, in general.

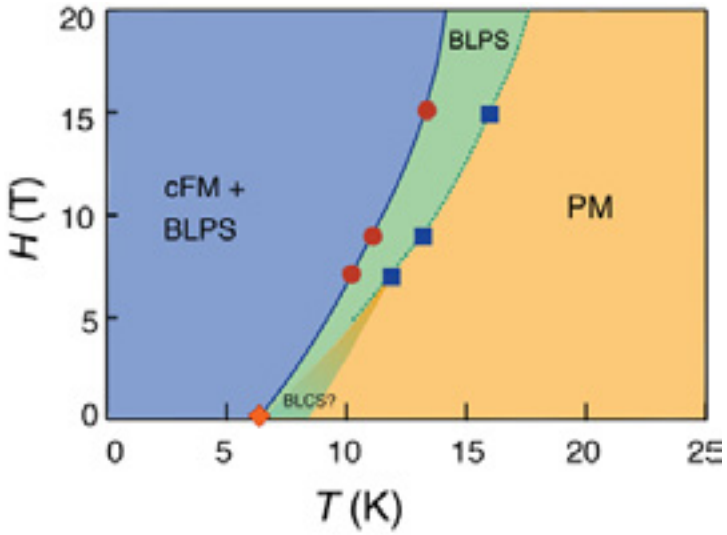

Figure 1: Phase diagram based on nuclear magnetic resonance measurements. The square symbols data indicate onset temperature for the local cubic symmetry breaking. Circles denote transition temperature into canted ferromagnetic (cFM) phase. The solid line indicates phase transition into the cFM state. The dashed line denotes cross-over to the broken local point symmetry (BLPS) phase.

Biography

Vesna F Mitrovic has her expertise in study of microscopic properties of materials using magnetic resonance techniques. She is a graduate of Illinois Institute of Technology and received her PhD from Northwestern University in 2001. Her thesis work was on magnetic resonance studies of high temperature superconductor. In 2003, she joined the Brown Physics Department and she was named Alfred P. Sloan Fellow in 2007 and Fellow of American. Physical Society in 2015 for her pioneering contributions to NMR study of low energy excitations in emergent quantum phases.

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