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FOR BASIC SCIENCES
Block JD, Sector III, Salt Lake, Kolkata 700 106

DEPARTMENTAL SEMINAR

Condensed Matter and Materials Physics

14th February,2023 **3.00 PM** **ONLINE/ FERMION**

SPEAKER

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TITLE OF THE TALK

A ROUTE TO ACCESS THE QUANTUM SPIN LIQUID STATE IN SPIN-ORBIT COUPLING ASSISTED MOTT INSULATORS

ABSTRACT

Quantum spin liquid state (QSL) is exotic phase of matter which is a superposition of states in which spins simultaneously points in different directions, with entanglement of spins even upto large separation. Long-range magnetic order, even close to 0 K, is not expected in this state despite having well-formed spins in the system. It is proposed to exhibit unconventional behavior such as fractional spin excitations, artificial gauge fields and superconductivity. One of the spin models which naturally hosts QSL state is honeycomb Kitaev model [1] where Ising-like bond dependent interactions brings frustration into the system. Ever since the proposal of Kitaev model, efforts have been made to explore real materials hosting Kitaev physics. In this direction, further progress is made after the seminal work of Jackeli and Khaliullin in 2009 [2] where they proposed that dominant Kitaev interaction can emerge in so called spin-orbit coupling (SOC) assisted Mott insulators in presence of strong SOC for a certain geometrical setup. This led to exploration of many 4d/5d transition metal based Kitaev QSL candidates such Iridates, RuCl 3. However, recently proposed 3d materials like cobaltates Na 2 Co 2 TeO 6 and Na 3 Co 2 SbO 6 remained unexplored in this context. In this talk, I will first show that similar to 4d/5d candidates, these 3d materials also suffer from appearance of some undesirable magnetic interactions, like isotropic Heisenberg coupling, reason behind long-range magnetic order and consequently, spontaneous symmetry breaking in these systems. I will then present my recent computational exploration to design an experimentally viable route for realization of QSL state in these materials [3, 4, 5]. By tuning electronic parameters, I will show that materials with large SOC and smaller Hund's exchange coupling may be a possible direction to look for new QSL candidate materials. The later parameter can purportedly be tuned experimentally through epitaxial strain and can be achieved by advance crystal growth techniques.

[1] A. Kitaev, Ann. Phys. 321, 2 (2006).
[2] G. Jackeli and G. Khaliullin, Phys. Rev. Lett. 102, 017205 (2009).
[3] Shishir Kumar Pandey and Ji Feng, Phys. Rev. B 106, 174411 (2022)
[4] Shishir Kumar Pandey, Q. Gu, Y. Lin, R. Tiwari and Ji Feng, arXiv:2207.05045v3 [Accepted in Phys. Rev. B (2023)].
[5] Q. Gu, Y. Lin, Shishir Kumar Pandey, Tuning electronic parameters to access QSL state in SOC assisted Mott insulators: A computation study, Unpublished

HOST FACULTY

Prof. Priya Mahadevan, Senior Professor

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