INSTITUTE COLLOQUIUM

20th November 2025, 4.00 pm at FERMION

* TITLE:: More is Different: The Emergent Physics of Correlated Clusters

ABSTRACT: **The paradigm of strong electronic correlations has long been dominated by the physics of individual magnetic ions. In this talk, we will discuss how this picture fundamentally changes when the relevant quantum unit is not a single atom, but a correlated cluster — a molecular entity such as a dimer or trimer embedded within a crystal. We will consider how such clusters can self-assemble through mechanisms like the orbital-induced Peierls effect [1,2], which forges distinct electronic bonds between neighboring sites. This molecular perspective naturally gives rise to orbital-selective phenomena, where electrons within a cluster partition into localized and itinerant factions across different orbitals [3]. The resulting many-body state can be a novel Cluster Mott insulator, where the Mott physics is governed by the entire cluster's molecular orbitals. This can result to a spin-liquid ground state like in LiZn2Mo3O8 [4]. Furthermore, the specific symmetries and spin structures of these clusters provide a fertile ground for emergent altermagnetism [5]. These collective phenomena demonstrate that "more" is not just different—it is a rich new frontier for discovering unconventional quantum phases in materials.**

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References:

[1] D. I. Khomskii and T. Mizokawa Phys. Rev. Lett. 94, 156402 (2005)
[2] D.I. Khomskii and S.V. Streltsov, Chemical Reviews 121, 2992 (2021)
[3] S.V. Streltsov and D.I. Khomskii, Proceedings of the National Academy of Science 113, 10491 (2016)
[4] S.A. Nikolaev, I.V. Solovyev, and S.V. Streltsov NPJ Quantum Materials 6, 25 (2021)
[5] S.V. Streltsov and S.-W. Cheong NPJ Quantum Materials 10, 102 (2025)

SPEAKER: **Prof. Sergey Streltsov graduated from Ural Federal University in 2003 and subsequently obtained his Ph.D. degree in 2005 and then his doctoral degree in condensed matter physics in 2015 at the Institute of Metal Physics, Ekaterinburg (Russia). In 2016 he was elected as a Professor and in 2019 as a Corresponding Member of the Russian Academy of Sciences. He is the head of the Theory of Low- dimensional Spin Systems laboratory at the Institute of Metal Physics. Professor Streltsov research interests encompass a range of topics in condensed matter physics, with an emphasis on theoretical study of the interplay among orbital, charge, spin, and lattice degrees of freedom and computational methods for application to solid-state physics. His research has resulted in over 150 journal publications.**

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