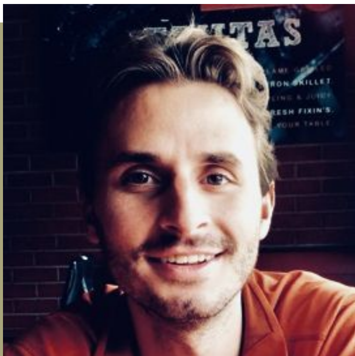
Physics Colloquium



Thursday

February 7

4:00 P.M.

Rm 118 NSH

Revealing and harnessing exotic emergent phenomena in entangled quantum matter

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Emergence and entanglement are two central concepts in the field of modern quantum condensed matter physics. Emergence was popularized nearly a half-century ago by P.W. Anderson: the collective low-energy behavior of an interacting many-body system can exhibit behavior profoundly different from that of the constituent degrees of freedom. Entanglement, while a more recent notion in the context of the many-body problem, is equally important: in essence, it quantifies the "quantumness" of the system of interest. In this talk, I will present recent work on two paradigmatic quantum condensed matter systems in which these two concepts play a defining role. First, I will discuss a spin model on the 2D kagome lattice relevant to a number of layered experimental compounds. Through large-scale entanglement-based numerical simulations and field-theoretic analysis, we find intriguing evidence for emergent fermions and an associated emergent gauge field arising at low energies in this system [1]. Next, I will turn to the half-filled Landau level and present two studies [2,3] in which we have employed large-scale numerical calculations to shed light on various recent theoretical and experimental quandaries of this classic albeit enigmatic problem. I will conclude by briefly mentioning one closely related example in which emergent quantum phenomena have enormous potential to be harnessed for technological gain, namely how "Majorana zero modes" can be used to build superior quantum computing hardware. Several directions of future research in these areas will be discussed.

[1] A. M-Aghaei, B. Bauer, K. Shtengel, and RVM, PRB 98, 054430 (2018)

[2] RVM and O. I. Motrunich, PRB 94, 081110(R) (2016)

[3] RVM, D. F. Mross, J. Alicea, and O. I. Motrunich, PRB 98, 081107(R) (2018)

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