ASU Department of Physics
Arizona State University

COLLOQUIUM

Thursday, February 15, 2024

Refreshments at 3:15pm in PSF 101
Colloquium from 3:30pm - 4:30pm outside PSF 101

Skyrmion Textures in Magnetic Materials

Professor Cristian Batista

University of Tennessee, Knoxville

Abstract:

Inspired by the work Herman Hemholtz, William Thompson proposed in 1867 that atoms could be vortices in aether. While later experiments put this proposal out of business, thinking of topological solitons as emerging building blocks or artificial atoms is very appealing. Indeed, more recent developments, that started around the 1960's, have demonstrated that nature has plenty of room for finding updated versions of aether. The aether of quantum magnets is the vector field of magnetic moments, whose topological solitons can be regarded as emergent mesoscale atoms. Like real atoms, these solitons form periodic arrays or crystals whose organizing principles are dictated by symmetry, anisotropy and competing microscopic interactions. These magnetic textures generate an effective magnetic field, coupled to the orbital degrees of freedom of conduction electrons, that can reach astronomical values. We will see how these topological magnetic structures emerge in real materials and how the quantum mechanical nature of spins can lead to richer skyrmion textures than the one that have been observed so far.

Biography:

Cristian D. Batista works in theoretical physics with emphasis in strongly interacting electron systems. His research combines analytical methods with numerical techniques for describing static and dynamical properties of many-body systems. He is particularly interested in novel quantum states of matter emerging from competing interactions. Quantum magnetism offers the simplest playground to study a multiplicity of exotic quantum states matter, ranging from multipolar orderings to spin liquids. A substantial body of his work is then devoted to frustrated magnets, which are prototypical systems to study the universe of complex quantum phenomena, such as fractionalization, anyonic statistics and topological solitons, that emerges in correlated materials. Over the last ten years, he has focused his research on the development of numerical and analytical techniques for studying the dynamical response of interacting quantum systems. These techniques range from classical and semi-classical approaches, adequate for vast classes of correlated materials, to techniques for solving the effective gauge theories that describe extreme quantum states, such as topologically ordered quantum spin liquids, of highly frustrated materials. This work is partly motivated by his joint affiliation with the Shull Wollan Center of the Oak Ridge National Laboratory (Biography). Cristian is also one of the founders of the Su(n)ny project (Biography), a numerical package for modelling inelastic neutron scattering data with classical and semi-classical methods. Another active area of interest is the study of skyrmion textures in magnetic materials, with particular emphasis on stabilization mechanisms and on the variety of topological solitons that can emerge in these materials under realistic conditions. Cristian is also particularly interested in the role of (kinetic energy) frustration on unconventional superconductivity.

Host: Prof. Onur Erten
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