University of Crete
Department of Physics

Physics Colloquium

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Magnetic Skyrmions for Quantum Operations

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ABSTRACT

Half a century after its proposal in particle physics, the concept of a Skyrmion as a topological quasi-particle, has now found a highly suitable application in the form of whirl-like nano-objects observed in helimagnetic materials. Magnetic skyrmions are attractive candidates for magnetic storage of classical information, due to their appealing physical properties, including their nanoscale size, topological stability, lifetime, and tunable energetics. The discovery of stable nanometer-scale skyrmions at low temperatures has sparked interest in their quantum properties for information processing, while improved quantum sensors and novel skyrmion-hosting materials enable their experimental exploration.

I will discuss a new class of primitive building blocks for realizing quantum logic elements based on nanoskyrmions. Although quantum computers hold great promise, their realization poses challenges, making the research of new qubit technologies an activity pursued intensely across different solid-state platforms. In a skyrmion qubit, information is stored in the quantum degree of helicity, and the logical states can be adjusted by electric and magnetic fields, offering a rich operation regime with high anharmonicity. Scalability, qubit parameter tunability, and readout by nonvolatile techniques converge to make the skyrmion qubit highly attractive as a logical element of a quantum processor. I will review the parameter space for the experimental realization of quantum phenomena and discuss how to engineer noise sources to optimize decoherence rates. Using skyrmions in the quantum regime merges two areas of research and opens up new opportunities in the field of quantum magnetism.

ZOOM link: https://uoc-gr.zoom.us/j/89436794256?pwd=SGprc2JPd3ZvZVNiNk9sZkhKVHhEQT09