CSU PHYSICS COLLOQUIUM

"Quantum Magnetism and Spintronics "

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120 Engineering (Hammond Auditorium)

Abstract

Magnetism originates from electron spin, which is an example of quantum phenomena that, at single-electron level, do not have a classical limit. Nevertheless, common interpretations of collective magnetism and magnetoelectronic phenomena treat magnetization as a classical vector field.

The purpose of my talk is to highlight the phenomena that cannot be captured by the classical approximation. I will illustrate the dichotomy between classical and quantum aspects of magnetism using the example of spin transfer effect – the transfer of angular momentum between magnetic materials and spin currents – which allows unprecedented electronic control of magnetism for a variety of device applications. I will show that there is generally a non-classical contribution to this effect, which is typically small in ferromagnets [1-3], but can become dominant in antiferromagnets [4].

I will also discuss the importance of quantum-mechanical origins of magnetism itself. I will show that ordinary thin ferromagnetic films close to their Curie temperature exhibit "exotic" magnetic behaviors that cannot be explained by simple collective models of magnetism, but naturally emerge from the analysis of the quantum levels occupied by electrons and the quantum entanglement driven by electron-electron interaction. These phenomena can provide new "quantum tools" for the development of novel magnetic materials and devices on the way to the quantum revolution in magnetism.

Biography

Prof. Urazhdin received PhD in Physics from Michigan State University in 2002. His PhD work included the discovery of surface states in narrow gap semiconductors that later became known as topological insulators. After postdoctoral research in nanomagnetism at Johns Hopkins University, in 2005 he joined the Physics Department at West Virginia University, and in 2011 moved to Emory University, where he was promoted to a full professor in 2016, and was named Samuel Candler Dobbs Professor of Physics in 2020. Dr. Urazhdin received NSF CAREER Award in 2007, and Cottrell Scholar Award from the Research Corporation in 2008. His research has addressed non-equilibrium phenomena, mainly in the context of magnetism, and more recently quantum phenomena in condensed matter.