Condensed Matter Seminar

Prof. Vincent Sokalski

(Carnegie Mellon University)

"A New Kind of Magnetism- The Dzyaloshinskii-Moriya Interaction"

Monday, April 5,2021

4:00pm—5:00pm

Virtual Meeting

Zoom link: https://virginiatech.zoom.us/j/86100794777

Passcode: 737335

Magnetism has had a profound effect on our everyday lives from compass needles in ancient times to the modern hard disc drive in today's computers. The existence of magnetic materials is rooted in the Heisenberg exchange interaction energy, $E = -J(\vec{S}_1 \cdot \vec{S}_2)$, which favors parallel (or anti-parallel) alignment of neighboring spin vectors and their associated magnetic dipole moments as found, for example, in Fe, Ni, and Co. In the past decade, a different type of magnetic exchange came to the forefront of modern physics called the Dzyaloshinskii-Moriya Interaction (DMI) given by $E = -\vec{D} \cdot (\vec{S}_1 \times \vec{S}_2)$, which instead favors an orthogonal alignment. The combination of these two effects leads to unusual magnetic configurations characterized by a chiral winding texture of the internal magnetization; a type of order very different than that found in a conventional ferromagnet. In this presentation, I will introduce the most important concepts in chiral magnetism including topologically protected magnetic features like skyrmions and domain walls, which can be manipulated by electric current with unprecedented efficiency. I will present the magnetic imaging techniques (Kerr microscopy and Lorentz TEM) we use to characterize this interaction and discuss how ultrathin magnetic films can be engineered to enhance it with interfacial effects. I hope to convince you that the Dzyaloshinskii-Moriya Interaction presents rich new physics in magnetism and opens the door to the design of future, energy-efficient magnetic memory.

Bio

Professor Sokalski is an Associate Professor in the department of Materials Science & Engineering at Carnegie Mellon University. He obtained his B.S. in Materials Science & Engineering from the University of Pittsburgh in 2007 followed by M.S. and Ph.D degrees from Carnegie Mellon University in 2009 and 2011 also in Materials Science & Engineering. He spent two years as a postdoctoral fellow in the Electrical and Computer Engineering department at CMU working on spin devices for low-power memory and electronics. He joined the faculty at Carnegie Mellon University in September of 2013 where his research is focused on emerging phenomena in nanoscale magnetic and spintronic materials. He is currently chair of the Pittsburgh chapter of the IEEE magnetics society.

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