Title: Phase Transitions in Artificially Inhomogeneous Magnetic Materials

Abstract: The precise fabrication of magnetic heterostructures can lead to novel physical properties when well known materials are confined in one or more dimensions, or are placed in proximity to dissimilar materials. An excellent example of this is the 2007 Nobel Prize winning phenomenon of giant magnetoresistance, which is displayed by precisely engineered magnetic multilayers. My laboratory employs the tools of nanoscience to investigate magnetism in nanoscale materials, with particular attention to magnetic phase transitions. We grow structures to investigate magnetic phase transitions and related phenomena, such as the magnetocaloric effect-a thermodynamic phenomenon being explored for refrigeration technologies. To explore such phenomena in detail, we create and measure thin magnetic alloy films comprised of well controlled gradients of exchange energies, and measure them with conventional magnetometry, and magnetic depth profiling with polarized neutron beams [1, 2]. These "artificially inhomogeneous" structures enable us exciting control over the magnetic structure, including the ability to continuously tune the magnetic depth profile with both field and temperature. Our recent work shows that compositionally graded magnetic films (e.g., $Ni_{x(z)}Cu_{1-x(z)}$, where z is depth into the film) exhibit ferromagnetic phase transitions similar to what one would expect from a continuum of uncoupled ferromagnetic layers with distinct Curie temperatures. We demonstrate continuous control of the displacement of a quasi-phase boundary between weakly and strongly magnetically ordered regions in a thin film, with field control of the magnetization on both sides of the boundary.

[1] "Spatial Evolution of the Ferromagnetic Phase Transition in an Exchange Graded Film," B. J. Kirby, H. F. Belliveau, D. D. Belyea, P. A. Kienzle, A. J. Grutter, P. Riego, A. Berger, and Casey W. Miller, Phys. Rev. Lett. **116**, 047203 (2016).

[2] "Magnetic properties of epitaxial CoCr films with depth-dependent exchange-coupling profiles," L. Fallarino, B. J. Kirby, M. Pancaldi, P. Riego, A. L. Balk, Casey W. Miller, P.Vavassori, and A. Berger, Phys Rev. B **95** 134445 (2017).

Biography

Casey W. Miller is Associate Dean for Research and Faculty Affairs in the College of Science at the Rochester Institute of Technology. He is an experimental physicist focusing on nanoscale magnetic materials and related devices. He served as Director of the University of South Florida's APS Bridge Site, which was created by the American Physical Society in 2013. He graduated *summa cum laude* from Wittenberg University in 1999 with University and Physics Departmental Honors, where he was also elected to ΦBK. He earned his PhD from the University of Texas at Austin in 2003, earning the Department's Best Dissertation Award for work combining Magnetic Resonance Imaging with Scanning Probe Microscopy. His post-doctoral work at the University of California, San Diego, focused on quantum tunneling of electrons between magnetic films. He is recipient of the NSF-CAREER and AFOSR-Young Investigator Awards.