Title: High resolution neutron imaging

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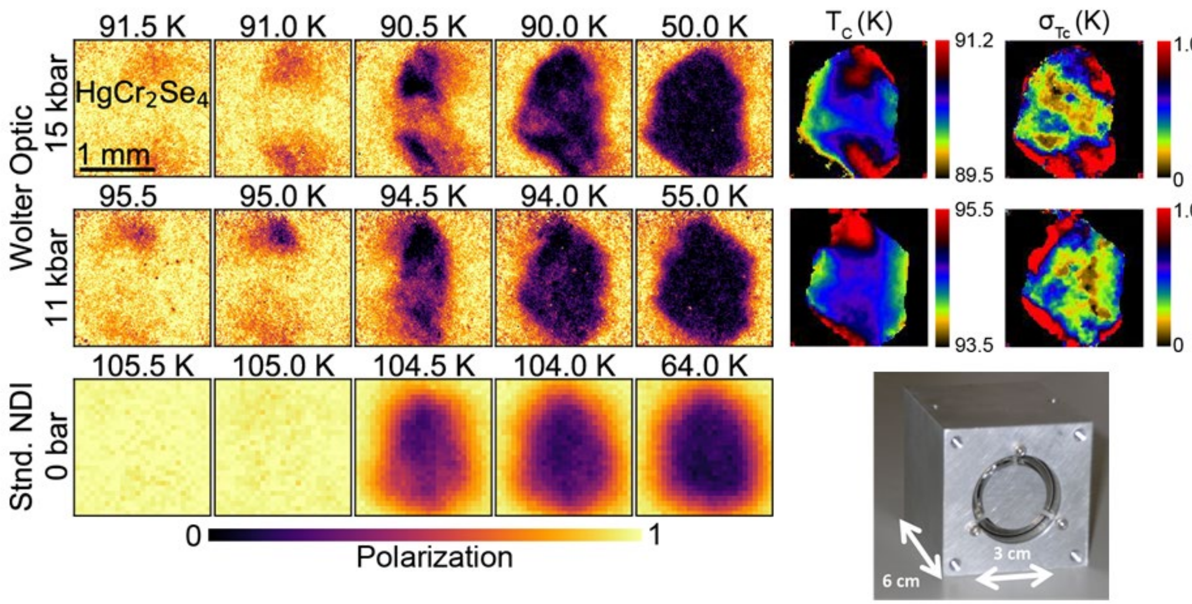
Abstract: The properties of the neutron – a massive particle, whose de Broglie wavelength is of atomic spacing for kinetic energies that are equivalent to room temperature, with net neutral charge, spin ½, and interaction with the nuclei of matter via the strong nuclear force – enable one to gain unique insights into materials science and the nature of the universe. Imaging with neutrons has seen strong development in the past two decades, driven by the rapid improvements in digital cameras and the ability to use the properties of the neutron to generate a variety of image contrasts. In this talk, I'll give an overview of the start of the NIST neutron imaging program and how we've augmented our measurements with a simultaneous X-ray source [1]. I'll discuss dark-field imaging using grating interferometers that enable one to obtain multi-scale images spanning length scales from the femtometer to decimeter [2]. The focus of the discussion will be on the current state of the art in neutron microscopy, and the outlook for the field with the nearly completed first neutron equivalent to Hooke's microscope with lens based on Wolter optics [3,4].



Neutron polarization iImages of a quantum magnet ($HgCr_2Se_4$) at various applied pressures and cryogenic temperatures through the ferromagnetic transition [3]. The top two rows were acquired with the prototype Wolter optic shown in the bottom right, while conventional pinhole neutron imaging was employed to capture the images in the bottom row. The images with the Wolter optic were acquired in half the time and had a spatial resolution that was a factor 5 finer than the conventional images.

References:

1. J. M. LaManna et al, Review of Scientific Instruments 88, 113702 (2017); doi: 10.1063/1.4989642
2. A.J. Brooks et al, Materials and Design 140, 420–430 (2018); doi: 10.1016/j.matdes.2017.12.001
3. P. Jorba et al, Journal of Magnetism and Magnetic Materials 475 176–183 (2019); doi: 10.1016/j.jmmm.2018.11.086
4. D.S. Hussey et al, NIMA 987 164813 (2021); doi: 10.1016/j.nima.2020.164813