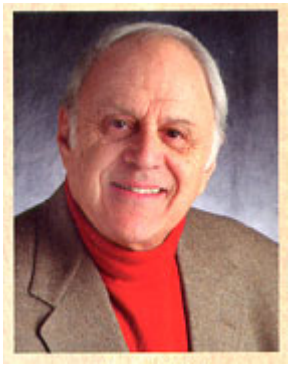
New Experiments in Condensed Matter Physics

Buffalo State College, July 9–14, 2017.

A five day set of experiments - one or two set-ups

Mentors



Jonathan F. Reichert is Emeritus Professor of Physics at SUNY at Buffalo, President and founder of Teachspin, Inc., and co-founder of the Advanced Laboratory Physics Association. His research career at Washington University, CWRU, and SUNY Buffalo has included many types of magnetic resonance experiments. At both CWRU and SUNY Buffalo, he developed and taught the advanced laboratory course. He's the designer of the cryostat system for this Immersion, and of the Specific Heat experiment.

David Van Baak is Professor Emeritus of Physics at Calvin College. His academic career included teaching and developing in the advanced-lab at Calvin College from 1980 through 2014; and since 2005 it has included collaborations with TeachSpin. Since 2014 he has been full time at Teachspin. He's the designer of the Magnetic-Susceptibility and Electrical-Transport Experiments in this Immersion.

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Condensed-matter physics is demographically and technologically at the center of the enterprise of physics, but for various reasons it has been under-represented in the advanced-laboratory curriculum. This Immersion aims at correcting that, by introducing participants to a laboratory package that enables users to conduct electrical, magnetic, and thermal experiments on solid-state samples. Participants will operate a cryostat system enabling temperature measurement and control in the 80 – 350 K region, in the process also acquiring skills in up-to-date vacuum technology. They will also perform first experiments in three physics areas:

1. Electrical transport, for resistivity and Hall-effect measurements in semiconductors;
2. Magnetic susceptibility, for inferring ‘spin content’ from Curie-Law paramagnetism (and its exceptions);
3. Specific Heat, for contrasting Debye with Dulong-Petit behavior, and/or detecting phase transitions.

Figure 1: Picture of the cryostat.

Because of the multiplicity of techniques and experiments covered, this Immersion will fill 5 working days (10-14 July, inclusive). Participants will assemble and operate a modern vacuum system; they'll learn safe handling of liquid nitrogen as a cryogen, and learn temperature servo-control in a cryostat. They will also learn how to mount, connect, test, and operate each of three classic condensed-matter experiments.

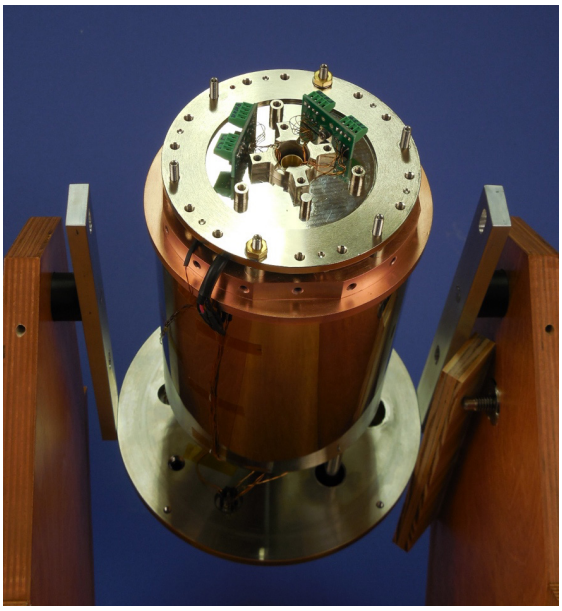

Figure 2: Interior of the cryostat. The dewar has been removed and the cryostat turned on its side.

Participants need only bring a favorite laptop or tablet. They'll be working on TeachSpin's new CMP package, which (in its entirety) costs about $36,000.

Please note that the Jonathan F. Reichert Foundation has established a grant program (ALPhA webpage; Foundation website) to help purchase apparatus used in Laboratory Immersions. Limitations and exclusions apply, but generally speaking the foundation may support up to 40% of the cost of the required equipment.
