Physics in ultra-high magnetic field: taking materials to the extreme

Philip Moll

Max-Planck-Institute for the Structure and Dynamics of Matter
Luruper Chaussee 149, Geb. 99 (CFEL), 22761 Hamburg, Germany

Magnetic fields are a fantastic, non-thermal tuning knob for quantum materials. They drive transitions between different magnetic ground states, they couple to quantum phases of mobile charge carriers, and they induce dynamics in coherent systems, such as vortices in superconductors.

However, they are a relativistic correction and tend to be very weak unlike their electric counterparts. As a result, the strongest static field in a facility-grade magnet (45 T) is only 40-times stronger than the field of a cheap Nd-Fe-B magnet. The ultimate strength of field is limited by the mechanical and thermal stress on the coils, pushing conductor technology to the limits of materials science. Pulsing the field is a natural way to push it beyond the yield strength of a coil, yet the dynamic nature comes at a price.

In this talk, I will review how advanced ultra-fast FPGA-based measurement methods can be used to perform guided experiments on ms-timescale pulses. In combination with more sensitive experimental technology, a reduction of sample volume can be a way forward into the exciting science beyond 100 T.