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High field exploration beyond the quantum limit in three-dimensional metals ROSS MCDONALD, Los Alamos National Laboratory, BRAD RAMSHAW, Cornell University, ZENGWEI ZHU, Wuhan High Magnetic Field Lab, KIM PUTKONEN, Max-Planck-Institute for Chemical Physics of Solids, ARKADY SHEHTER, National High Magnetic Field Laboratory, NEIL HARRISON, FEDOR BALAKEREV, ERIC BAUER, FILIP RONNING, JON BETTS, Los Alamos National Laboratory, HIGH FIELD DREAM TEAM TEAM — Bandstructure topology is expected to have a profound influence upon the properties of metals at magnetic fields beyond the quantum limit, where all electrons occupy a single Landau level. In 2D electronic systems indexing Landau depopulation with field probes the Berry phase and provides the definitive identification of Dirac like dispersion. For multiband systems, in particular 3D metals, the connection between the Landau level depopulation and band topology is less trivial owing to mobility of charge between bands. Furthermore, in comparison to artificial 2D electron systems, very few 3D metals exist with sufficiently low carrier densities to access the quantum limit in even the highest available magnetic fields. Increased degeneracy at low Landau level occupation enhances the influence of electronic correlations – famously manifest as the occurrence of the Fractional Quantum Hall Effect in trivial 2D electron systems. In 3D semimetals the band topology dictates a subtle balance between these correlations and depopulation effects due to the absence (or occurrence) of a band crossing. This talk presents recent magneto transport studies of 3D low carrier density semimetals revealing novel phenomena at extreme magnetic fields. These include the valley polarizing effect of tilted magnetic fields in the quantum limit of Bismuth, the observation of field induced excitonic insulating phases in the quantum limit of Graphite and a novel field induced phase beyond the quantum limit of the Weyl semimetal TaAs.

Ross McDonald
Los Alamos National Laboratory

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