Resolving Quantum Oscillations in Insulating YbB_{12}

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Strong magnetic fields have dramatic effects on electron motion. In metals, the result is a set of quantized electron orbits, or Landau levels. Above a critical field, only the lowest Landau level is occupied. The resulting quantum limit is highly degenerate and susceptible to instabilities yielding a rich variety of electronic phases including spin- and charge-density waves, fractional quantum Hall states, and excitonic insulators. Unfortunately, access to the quantum limit in the presence of strong electron correlations is typically impeded by the tendency of *d/f*-electrons to polarize in a strong magnetic field, weakening the interactions.

Here, users from **Los Alamos National Lab together with PARADIM** propose that the strongly correlated quantum limit can be approached in reverse, starting from an insulating state at zero magnetic field. The identified candidate material, ytterbium boride (YbB_{12}), was grown in single crystal form at PARADIM and studied in high magnetic fields at the NHMFL@LANL. The results not only provide access to a novel quantum phase of matter, but also provide a model that naturally explains how quantum oscillations arise in insulators.

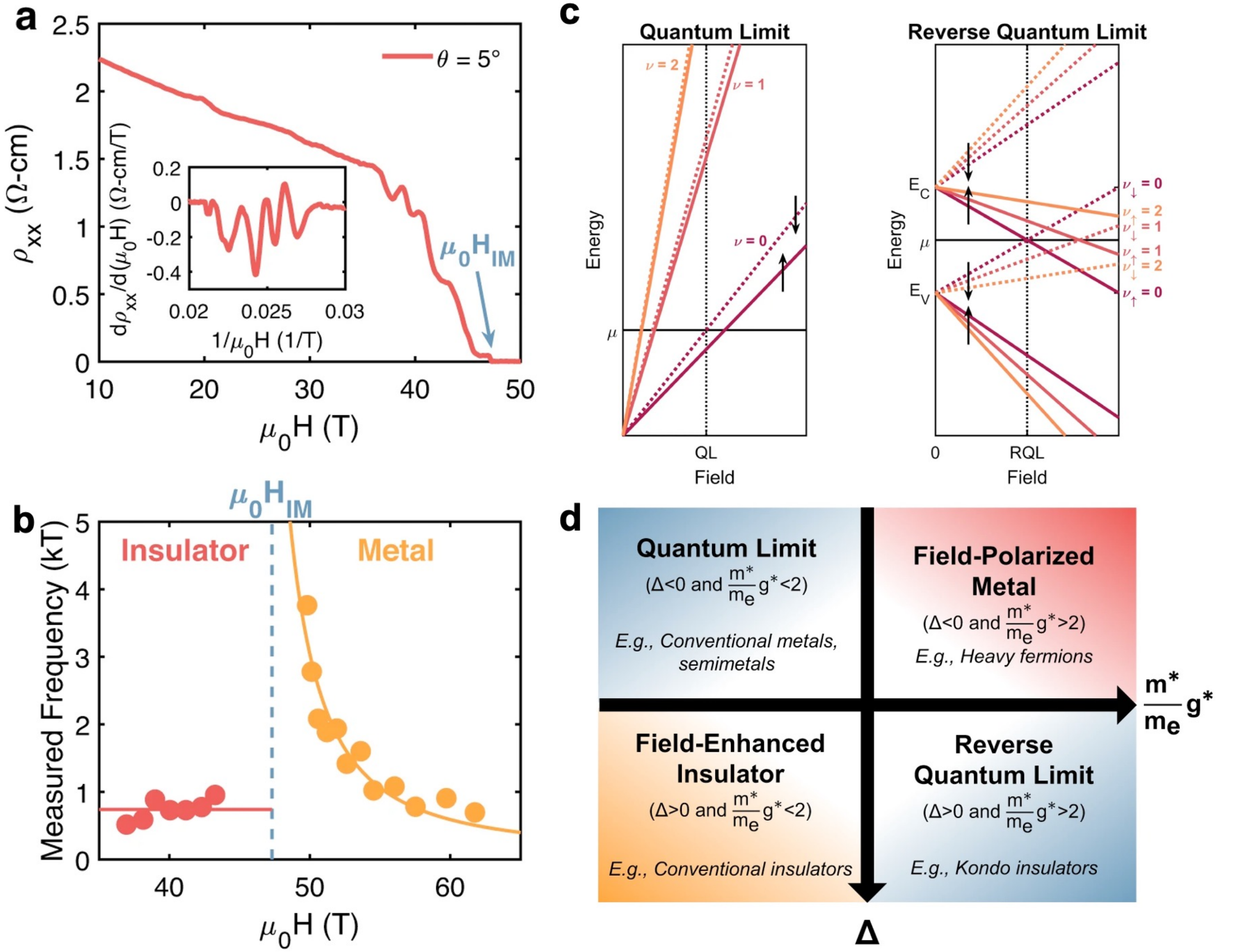

Figure: a) Magnetoresistance showing quantum oscillations in the insulating state and metallic state, respectively. Inset shows derivative. **b)** Insulating state quantum oscillations have a field-independent frequency of 740 ± 60 T and metallic state quantum oscillations have a field-dependent frequency (H ∥ [100]). Lines are guides for the eye. All measurements at ≈ 650 mK. **c)** Schematic of the formation of Landau levels and approaching the normal and reverse quantum limit. **d)** Categorization of possible high magnetic field behaviors as a function of gap and normalized g-factor.

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