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Phase transition in the quantum limit of the Weyl semimetal TaAs[1]

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Under extreme magnetic fields, electrons in a metal are confined to a single highly-degenerate quantum state−a regime known as the quantum limit. This state is unstable to the formation of new states of matter, such as the fractional quantum Hall effect in two dimensions. The fate of 3D metals in the quantum limit, on the other hand, has been relatively unexplored. The discovery of monopnictide Weyl semimetals has renewed interest in the high-field properties of 3D electrons, particularly those with linear dispersions. Several difficulties in determining the high-field properties have arisen, including the highly anisotropic nature of the magnetoresistance, and the presence of trivial (parabolic) Fermi pockets that cloud the underlying behaviour of Weyl pockets. We use magnetic fields up to 90 Tesla to put the Weyl semimetal TaAs into its extreme quantum limit, isolating its linear 0^{th} Landau level from the rest of the electronic spectrum. We find that a gap opens in the conductivity parallel to the magnetic field above 70 Tesla, and also find an abrupt reversal in the field-evolution of the sound velocity at the same magnetic field, suggesting a thermodynamic phase transition to a new state of matter.

[1]DOE BES "Science at 100 T"