# Title

# Landau Quantization and hidden quantum phases in Insulators

## Abstract

Abstract: In 1930, the Shubnikov–de Haas effect and the de Haas–van Alphen effect were discovered in bismuth (a metal). In the same year Landau published his theory of Landau quantization that explains the experimental observations. By 1970s, these effects, known as quantum oscillations, were established as the standard quantum characteristics, as well as diagnostic tools, of almost all metals, but not insulators. The same underlying process of Landau quantization further gave rise to the discoveries of integer and fractional quantum Hall effects in 1980s in the high-mobility metallic two-dimensional electron gas (2DEG), which are the foundation of the nowaday field of topological quantum matter. In this talk, I will describe our recent experimental observations of Landau quantization in an insulator (monolayer $WTe_2$), a phenomenon that came as a complete surprise. Despite being a strong insulator, the observed resistance displays large quantum oscillations with many periods onsetting at a very low magnetic field, and displays discrete peaks, mimicking those observed in the high-mobility 2DEG. I will discuss both the experimental discovery and possible explanations, including a scenario based on the presence of fractionalized, charge-neutral fermions. The observations post a strong challenge to the established quantum theory of materials and call for understanding of a new type of insulators that may host hidden quantum excitations and phases.