DynaHeat: Dynamic Heat transport measurements in novel quantum conditions

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In 1853, two German physicists, Gustav Wiedemann and Rudolf Franz, found that electric and thermal conductivity is directly proportional in metals. This relation is later named Wiedemann-Franz (WF) law after them and soon becomes one of the most important guiding principles in condensed matter physics research. However, the empirical application of WF law is challenged by the recent emergence of quantum materials, where quantum mechanics manifests its properties strongly, leading to exotic states of matter beyond the trivial band description. The central goal of the **DynaHeat** project is to justify the utilization regime of WF law and establish a more empirical link between heat and charge transfer among these novel quantum materials. These new demands come with new challenges, as the quantum manifestation of materials often occurs in conditions where quantum fluctuations become dominant. This typically means extremely low temperatures, high magnetic fields, and microscopic sizes. We plan to utilize a novel thermal conductivity measurement technique based on the higher harmonic electric response at heated conditions. The oscillating heat wave resulting from Joule heating of the AC electric current across the sample yields straightforward measurements of thermal and electric conductivities concurrently. This advanced technique relies significantly on the collaborative interplay between focused-ion-beam microstructuring, pulsed high-power thin film coating, and atomic layer deposition. This combination presents a promising opportunity to explore innovative heat and electricity conversion methods that arise from non-trivial band topology and/or strong electronic correlations.