TCSUH SPECIAL SEMINAR

Gun-Do Lee

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Tuesday, November 19, 2024

1:00 p.m. – 2:00 p.m. *Sandwiches provided.*

In Person: Houston Science Center (HSC), Room 102

Thermal Decoupling: A Mystery Solver in Unconventional High-T_c Layered Superconductors

ABSTRACT: Although many years have passed since the discovery of high-critical temperature (high-T_c) superconducting materials, the underlying mechanism is still unknown. In particular, the intricate interplay between non-ergodic bad metals and strange metals in high-T_c superconductors has remained enigmatic. Intriguingly, most of these unconventional high-T_c superconductors have layered structures. Using ab initio molecular dynamics (AIMD) simulations coupled with the temperature-dependent effective potential (TDEP) method, we successfully reproduce B1g phonon anomaly in YBCO, a representative material of unconventional high-T_c layered superconductors. We discovered an interlayer thermal decoupling which is driven by Ba atoms in YBCO. Surprisingly, we found that the thermal decoupling solves the linear-T resistivity in the strange metal phase, which has been a major mystery in unconventional high-T_c superconductors. It is revealed that the thermal decoupling can also explain the Uemura relation and superconducting dome rigorously and quantitatively. The strange metal and Uemura relation are tightly coupled by thermal decoupling. Thermal decoupling is also a key factor in understanding the relationship between the superconductivity and flat bands found in magic-angle twisted bilayer graphene. The relation between thermal decoupling and quantum geometry will be mentioned. Our discoveries will offer a revolutionary perspective on high-T_c superconductivity, suggesting the potential for a transformative shift in our comprehension.

BRIEF BIO: *Prof. Gun-Do Lee received his Ph.D. in Physics from Seoul National University, South Korea in 1996. He was a postdoctoral researcher at Iowa State University and the Ames Lab. He is a full research professor in Materials Science and Engineering at Seoul National University. Over the past 20 years, he has studied 2D materials using simulation methods such as ab initio calculations and tight-binding molecular dynamics simulations. He has published a total of 105 peer-reviewed journal articles, including Nano Letters (6), ACS Nano (15), Advanced Materials (3), Nature Communications (2), Science Advances (2), Physical Review Letters (3), and Nature Synthesis (1). Prof. Lee started his superconductivity research after the superconductivity in two-dimensional materials was reported. After discovering a new mechanism called thermal decoupling in high-Tc superconductivity, Prof. Lee became the director of the Center for High-Temperature Superconductors at Seoul National University in May this year, where he is leading a National Grand Challenge project titled "Identifying the mechanism of non-Fermi liquid through thermal decoupling and developing innovative superconductors".*

Host: Dr. Zhifeng Ren Persons requiring special accommodations to attend should call 713-498-9703.