Physics Colloquium

Thursday, 1 April 2021 | 17:00 – 18:00, Online with BigBlueButton

From quantum field theory to experiment through development of materials' specific theory for superconductors

Dr. Alexandros Aperis

Department of Physics and Astronomy, Uppsala University, Sweden

ABSTRACT

Superconductors are fascinating quantum materials that have great potential for future technological applications, ranging from energy storage and medicine to transport and quantum computers. To date, the highest critical temperature (Tc) at which available materials superconduct under ambient conditions is merely 133 Kelvin, thus hindering the wide use of such technology. The road to achieving functional superconductivity at elevated temperatures necessarily goes through the deeper understanding of the specifics of the electron-boson interaction mechanisms that mediate the superconducting state, a task that has proven to be one of the greatest challenges in condensed matter physics for decades. To reach this goal, advanced theoretical tools with sufficient predictive capability that go hand-in-hand with the available cutting-edge experimental techniques will be indispensable.

In this colloquium, I will first give a brief overview of basic aspects of superconductivity with a focus on its microscopic theoretical description. Then I will show how the statistical quantum field theory of Eliashberg when combined with ab initio calculations constitutes the most powerful method available for explaining superconductors from first principles and discuss a few examples. I will focus on two superconducting systems that spearhead current research in the field: the high-Tc monolayer FeSe on $SrTiO_3$ substrate and flat-band twisted bilayer graphene, and demonstrate how advanced Eliashberg theory can provide an explanation to recent experimental observations and pave the way for further discoveries of novel phenomena in quantum materials.