Dear Colleagues & Students,
You are cordially invited to a special seminar on

Date: 3 July 2026, Friday
Time: 11am - 12pm
Venue: E3-06-01 Seminar Room, Block E3, 2 Engineering Drive 3, Singapore 117581(Map)

Nonlinear Thermoelectrics through Low-Symmetry van der Waals Materials

By Marcos H. D. Guimarães
Cavendish Laboratory, University of Cambridge, UK
Zernike Institute for Advanced Materials, University of Groningen, The Netherlands

Hosted by Assistant Professor Ahmet Avsar

Abstract:
Low-symmetry transition-metal dichalcogenides (TMDs) provide a rich platform to explore how crystal symmetry, spin–orbit coupling, and topology intertwine to shape transport and optical properties. The low crystal symmetry in these systems allow for unconventional effects to appear, such as the out-of-plane antidamping torque in spin torque devices and the nonlinear Hall effect due to Berry curvature dipole.

In this talk I will show how the low crystal symmetry TMDs can give rise to nonlinear thermoelectric effects. I will begin with a short introduction on the basic thermoelectric phenomena – the Seebeck and Nernst effects. I will then discuss how nonlinear thermoelectrics, specifically those which are proportional to the square of the temperature gradient, are allowed in crystals where only one mirror symmetry is present. Then I will present our results on WTe_2 and $TaIrTe_4$, showing all the symmetry-allowed nonlinear thermoelectric phenomena up to room temperature and at zero magnetic field. Through a simple analysis of the temperature dependence of the signals, we demonstrate that both Berry-curvature-related and scattering-induced contributions govern the different nonlinear thermoelectric responses. Our results show that nonlinear thermoelectricity arises intrinsically from reduced crystal symmetry. They also establish low-symmetry TMDs as a versatile platform for exploring higher-order heat-to-charge conversion beyond the linear response, with potential relevance for next-generation thermal-management and energy-conversion technologies.

Biography:
Marcos H. D. Guimarães is an Associate Professor in the Physics of Energy Materials at the University of Cambridge, and Professor of Applied Physics at the University of Groningen. Marcos received his PhD from the University of Groningen (NL) in 2015 working on spin transport in graphene devices. He then moved to Cornell University (USA) working on electronics and spintronics in van der Waals materials, including pioneering works on spin-orbit torque devices using low-symmetry van der Waals crystals. In 2017 he moved to Eindhoven University of Technology (NL), where he worked on the ultrafast spin and magnetisation dynamics of van der Waals materials. In 2019 he established his research group at the University of Groningen (NL), and in 2026 he joined the Cavendish Laboratory at the University of Cambridge as Associate Professor. He was awarded several grants and awards throughout his career, among them a Kavli Institute Postdoctoral fellowship (2014), NWO Veni (2016), and an ERC Starting Grant (2022). The Guimarães group uses a combination of high-quality van der Waals heterostructure and nanodevice fabrication with state-of-the-art (time-resolved) (magneto-)optical, optoelectronic and electronic transport techniques to investigate how charge, light, and spins and magnetism interact at the nanoscale.