

## **Seminar**

### **Unravelling Collective Excitations in Quantum Materials with On-Chip THz Spectroscopy**

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The advancement of quantum technologies—spanning quantum computing, ultrafast sensing, and next-generation optoelectronics—relies on the discovery and control of exotic electronic phases in quantum materials. Understanding these phases requires not only new material platforms but also advanced experimental techniques capable of probing their fundamental excitations. In this talk, I will explore how engineered two-dimensional van der Waals (vdW) heterostructures provide a versatile platform to realise and manipulate novel electronic states, including fractional topology, unconventional superconductivity, and symmetry-broken phases. A key open question is how collective electronic excitations, such as isospin fluctuations, influence emergent phenomena like superconductivity in bilayer graphene. To address this, I will introduce on-chip terahertz (THz) spectroscopy as a powerful tool for probing low-energy electrodynamics, alongside complementary transport and capacitance measurements. Finally, I will discuss future directions in multi-modal spectroscopy, outlining how next-generation techniques can unlock deeper insights into correlated quantum matter.

***Tuesday, Apr 29<sup>th</sup> 2025***

***16:00 Hrs (Tea / Coffee 15:45 Hrs)***

***Auditorium, TIFRH***