

# CONDENSED MATTER SCIENCES SEMINAR

## Dr Emanuel Tutuc

University of Texas

### Host

Dr Oskar Vafek

### Title

**Tunneling and Interlayer Coherence in Twist-Controlled van der Waals Heterostructures**

Friday, February 14<sup>th</sup>, 2025

1<sup>st</sup> Floor – B101

15:00-16:00

### Abstract

Van der Waals (vdW) heterostructures of two-dimensional materials offer an unprecedented playground to combine materials with different electronic properties, without the constraints of lattice matching associated with epitaxial growth. Recent years have witnessed the emergence of interlayer twist as a new parameter that controls the electronic properties of vdW heterostructures and allows the realization of flat energy bands. This presentation will provide an overview of experimental techniques to control interlayer twist, with an emphasis on twist-controlled double layers. We show that interlayer tunnelling serves as unique tool to probe interlayer coherence in twist-aligned, closely spaced double layers where interaction leads to a coherent superposition of electronic states in individual layers, with Josephson junction-like tunnelling characteristics robust to temperature, and layer density detuning. We describe a novel tunneling spectroscopy technique in twist-aligned double layers, where momentum-conserving tunneling between different energy bands serves as an energy filter for the tunneling carriers and allows a measurement of the quasi-particle state broadening at well-defined energies with respect to the Fermi level.

### Bio

Emanuel Tutuc received the B.Sc. degree in 1997 from Ecole Normale Supérieure, The University of Paris, and the Ph.D. degree in 2004 from Princeton University, in Physics. He held research positions at Princeton University and I.B.M. T.J. Watson Research Center from 2004 to 2006 and joined the faculty of The University of Texas at Austin in 2007. His research interests are the electronic properties of low- dimensional systems, and the realization of novel devices. He is a Fellow of the American Physical Society, and a recipient of the 2023 James McGroddy Prize for New Materials from the American Physical Society.