CENIDE & WIN Seminar Series on 2D-MATURE

DFG IRTG 2803 & NSERC CREATE

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“Spin Currents in atomically thin materials and interfaces”

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Dr. Venkata Kamalakar Mutta is an Associate Professor of Quantum Technology in the Department of Physics and Astronomy at Uppsala University, where he leads the Quantum Material Devices Group and coordinates the Quantum Technology Master’s Programme. He received his master’s degree and PhD from the S. N. Bose National Centre for Basic Sciences, India, where his doctoral research (2010) focused on electron transport in magnetic nanowires. He subsequently held research positions at the University of Strasbourg, France, and Chalmers University of Technology, Sweden, where he investigated low-dimensional electronic systems, particularly graphene, two-dimensional materials, and van der Waals heterostructures for spintronics. Since joining Uppsala University in 2015, he has established a research program on quantum materials and devices and built a dedicated quantum device laboratory from scratch, supported by the Swedish Research Council, the European Research Council, and the Knut and Alice Wallenberg Foundation. His research addresses charge, spin, and orbital transport phenomena in atomic-scale systems, combining advanced nanofabrication, low-temperature magneto-transport and magneto-optic techniques, and in-operando synchrotron-based measurements. In 2021, he was awarded the Thuréus Prize from the Royal Scientific Society in Uppsala for contributions to spin transport in low-dimensional materials. He has been an elected member of the Board of the Condensed Matter Division of the European Physical Society since 2022.

Atomically thin materials such as graphene and molybdenum disulfide provide access to unconventional spin and quantum phenomena while offering a direct route to the atomic limit of device miniaturization. Graphene, with its intrinsically weak spin–orbit coupling, supports long-distance spin transport over tens of micrometres at room temperature, far exceeding that of conventional metals, and therefore serves as an ideal platform for two-dimensional spintronic circuits. In contrast, molybdenum disulfide, with strong spin–orbit coupling, enables interfacial spin manipulation and the emergence of new spin-dependent functionalities. In this talk, I will present our experimental work on 2D spintronic devices based on graphene and MoS_2. I will discuss how device-engineering strategies can suppress contact-induced spin relaxation and enable the observation of record room-temperature spin-transport lengths of up to 45 µm in large-area chemical vapour-deposited graphene. Accessing this regime enables new device concepts, including flexible spintronic architectures based on pure spin currents and ultrafast spin-field-effect junctions, in which magnetization speed limits in ferromagnets can be tuned via superdiffusive spin transport. Finally, I will show how the introduction of MoS_2 induces chiral spin transport in ferromagnetic heterostructures hosting complex spin textures.