MONTANA STATE UNIVERSITY | College of LETTERS & SCIENCE

Physics Colloquium

March 25
4:00 – 5:00 PM
Roberts 301

Engineering Quantum Properties in Two-Dimensional Van der Waals Materials

Dr Dharmraj Kotekar-Patil
University of Arkansas

Abstract:

The development of new materials is essential for advancing our scientific understanding and is critical for addressing the growing demands of technology and sustainability. Van der Waals (vdW) materials provide a versatile platform with novel properties and functionalities, enabling breakthroughs in quantum science and microelectronics. In this talk, I will present our experimental studies on charge transport through single defects in atomically thin Molybdenum disulfide (MoS_2), which reveal key material properties such as the effective gfactor and spin-orbit splitting. By engineering the dielectric environment surrounding atomically thin MoS_2, we observe suppression of charge scattering effects that give rise to phase-coherent transport at low temperatures, manifesting as Fabry-Pérot interference patterns confirming wave nature of electrons in high-k dielectric capped MoS2. Furthermore, I will propose a device architecture designed to reach the few-electron regime, a crucial step toward implementing spin-valley qubits. In the second part of my talk, I will discuss our recent efforts at the MonArk Quantum Foundry to automate two-dimensional material handling, identification, and sample preparation using robotic elements. This automation enhances efficiency in quantum device fabrication and enables broader participation in STEM outreach. Finally, I will outline my future research directions aimed at addressing key open questions in quantum materials and device engineering.

Host:

**** Refreshments served in the Barnard Hall second floor atrium at 3:45 PM ****