Title of the Talk: Bio-inspired Devices for Sensing, Computing, Storage, and Hardware Security based on Two-dimensional (2D) Materials

Abstract: My group is developing a new paradigm of sensing, computing, storage, and hardware security inspired by the neurobiological architectures and neural algorithms found inside various animal brains that allow evolutionary success in resource constrained environments. Towards the realization of our vision, we exploit unique electronic and optoelectronic properties of layered two dimensional (2D) materials such as graphene, MoS_2, WSe_2, black phosphorous etc., to design high performance, ultra-low-power, artificially intelligent, and inherently secure solid state devices inspired by natural intelligence. For example, we have mimicked auditory information processing in barn owl (*Nature Communications, 10, 3450, 2019*), collision avoidance by locust (*Nature Electronics, 3, 646–655, 2020*), and subthreshold signal detection by paddlefish and cricket using stochastic resonance (*Nature Communications, 2020*). We have also mimicked probabilistic computing in animal brains using low-power Gaussian synapses (*Nature Communications, 10, 4199, 2019*), and memristive graphene synapses (*Nature Communications, 11, 5474, 2020*) and realized biomimetic devices that can emulate neurotransmitter release in chemical synapses (*ACS Nano, 11, 3, 2017)* and neural encoding in afferent neurons *(Nature Communications, 12, 2143, 2021)*. We have also made these device secure through SAT-attack resistant hardware obfuscation using camouflaged 2D heterostructures (*ACS Nano, 15, 2, 2021*) and by realizing machine learning resilient and reconfigurable physically unclonable functions (*Nature Electronics 4, 364-374, 2021*).