Anatomy of Spin-Orbit Torques In Topological-Insulator/Ferromagnet Heterostructures

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The perfect spin-momentum locking on the surface of three-dimensional (3D) topological insulators leads to enhancement of current-driven nonequilibrium spin density and thereby induced field-like spin-orbit torque (SOT) in lateral topological-insulator/ferromagnet (TI/F) heterostructures (where injected current flows parallel to the interface). However, very recent experiments have also observed large antidamping SOT whose theoretical explanation remains under scrutiny. This talk will overview recent theoretical approaches to SOT in TI/F heterostructures, while emphasizing the role of evanescent wavefunctions in generating antidamping SOT, 3D nature of spin and charge transport in these devices, and first-principles description of hybridization and proximity effects at their interfaces which can assist in finding optimal materials combinations. Additional insights into these phenomena and the potential of TI/F interfaces for spintronic applications is provided by studying spin-to-charge conversion when magnetization of the F layer is brought into precession, or tunneling anisotropic magnetoresistance and the corresponding SOT in vertical TI/F heterostructures.

BIO: Branislav K. Nikolić is Professor of Physics at the University of Delaware and a Senior Visiting Scientist at RIKEN Center for Emergent Matter Science in Japan. He received his Ph.D. in theoretical condensed matter physics from Stony Brook University, and B.Sc. degree from the University of Belgrade, Serbia. He was visiting Professor at the University of Regensburg, National Taiwan University and Centre de Physique Théorique de Grenoble-Alpes. His research is focused on nonequilibrium many-body quantum systems, first-principles quantum transport and high-performance computing applied to nanostructures of interest to spintronics, nanoelectronics, thermoelectrics and nan-bio interface. His recent contributions include studies of the spin Hall effect in multiterminal geometries, spin pumping and spin torque in the presence of spin-orbit coupling, spin-dependent shot noise, nonequilibrium electron-magnon systems, and graphene nanopores for ultrafast DNA sequencing.