Magneto-Ionics and 3D Nanowire Networks

Kai Liu

Physics Department, Georgetown University, Washington, DC 20057

Magneto-ionics has shown promise for energy-efficient nanoelectronics, where ionic migration can be used to achieve atomic scale control of interfaces in magnetic nanostructures, and in turn modulate a wide variety of functionalities. Recently, we have discovered that chemisorbed oxygen and hydrogen on the surface of ferromagnetic films can induce significant Dzyaloshinskii–Moriya interaction (DMI) [1], a handle to introduce topology into nanoscale magnets. This has enabled direct tailoring of skyrmions winding number as well as wall type at room temperature via oxygen chemisorption. We have also demonstrated a sensitive and reversible chirality switching of magnetic domain walls [2] and writing/deleting of skyrmions [3] via hydrogen chemisorption/desorption [3] or changing the thickness of a sub-monolayer Pd capping layer [4]. These effects offer an ideal platform to gain quantitative understanding of magneto-ionics at buried interfaces, where the ionic motion can be further controlled by an electric field [5]. They are relevant for 3-dimensional information storage as a potentially contactless way to address spin textures, such as in interconnected nanowire networks [6]. Interestingly, nanoporous metal foams made of random assemblies of nanowires have found applications in deep-submicron particulate filtration, relevant to combatting COVID-19 and air pollution [7]. Our mask design based on such foams has been selected by BARDA-NIOSH as a finalist of the Mask Innovation Challenge [8].

Work supported by NSF, SRC/NIST, KAUST, UCD and GU.

Kai Liu is a Professor and McDevitt Chair in Physics at the Georgetown University. He received his Ph.D. in Physics from the Johns Hopkins University in 1998, and then carried out postdoctoral research at the University of California - San Diego. He joined the University of California - Davis faculty in 2001, and moved to the Georgetown University in 2018. His research interest is in experimental studies of magnetism and spin transport in nanostructured materials. He was recipient of an Alfred P. Sloan Research Fellowship and a UC Davis Chancellor's Fellowship. He is also elected Fellow of the Institute of Physics (UK), American Physical Society, IEEE and American Association for the Advancement of Science. He served as the General Chair for the 61st Annual Conference on Magnetism and Magnetic Materials (2016 MMM), and an Associate Editor for *APL Materials* (2018-2019). He is the currently the Chair of the International Union of Pure and Applied Physics (IUPAP) Commission on Magnetism (2021-2024).