Chiral Molecular Spintronics: Electron Dichroism in Biomolecular Assemblies

Recent observations of spin-dependent and enantioselective interactions between electrons and chiral biomolecules (e.g., amino acids, α-helical peptides, and DNA) have catalyzed studies to elucidate the roles of spin and chirality in biological processes and in charge transfer at metal-molecule interfaces. We investigated spin filtering in DNA-mediated charge transfer within patterned self-assembled monolayers on ferromagnetic thin films. Using fluorescence microscopy, emission quenching of photo-excited dye molecules precisely bound within DNA duplexes was used to analyze substrate magnetization-dependent charge transfer to the surface. Our results suggest that electron helicity, or spin projection along the helical axis, is preferentially aligned parallel to its velocity direction within this charge transport regime through DNA.

Yet, while we and others have demonstrated that chiral molecules can polarize electrons, unifying mechanisms remain elusive. Molecular spin-orbit coupling that is related to broken inversion symmetry is thought to play a dominant role due to chiral electrostatic potentials experienced by transmitted electrons. We tested this hypothesis by binding mercury to specific motifs of bovine serum albumin, a protein with multiple α-helical subunits. Our goal was to influence the relativistic effects felt by transmitted electrons via the larger effective nuclear charge of the bound heavy metal species. We measured the relative energy barriers to photoemission quantitatively through albumin films assembled on ferromagnetic substrates magnetized up versus down, and discovered that heavy atom incorporation increases these energy barriers. These results, in conjunction with measurements of spin-dependent conduction using protein films as spin filters, validate the influence of chiral electrostatic fields on biomolecule spin selectivity.

Presented by:

John M. Abendroth
Professor Paul Weiss’s Group

Department of Chemistry & Biochemistry
University of California, Los Angeles

Thursday, April 5, 2018
2033 Young Hall
12:00 PM