ABSTRACT

Organic Chemistry and Quantum Information Science – How to Merge Two Scientific Disciplines

The Chernick group specializes in synthetic organic chemistry of complex, highly functional conjugated systems for *quantum information science* (QIS) applications. A substantial amount of research in organic chemistry has focused on the tailored synthesis and characterization of molecules that undergo electron/energy processes for use in renewable energy applications, such as optoelectronic devices that rely upon charge transfer processes. This research has revealed key challenges that arise when the operating size of a device drops below the 10 nm size range. To reduce the size of the microchips that sustain the operation of a computing device, advancement to a single-molecule quantized regime is necessary. Hence, the research field of renewable energy devices has branched into the field of QIS, which is the study of quantum phenomena covering research disciplines pertaining to quantum teleportation, quantum entanglement, and quantum computation. The organic molecules the Chernick group synthesize are specifically designed to harvest light energy to produce electronically excited states that will undergo a charge transfer process. The generated charge transfer species contains an orbital lacking an electron (radical cation state) and an orbital with an additional electron (radical anion state) within the same molecule. These electrons can be spin-paired in either a singlet or triplet state. When these unpaired spin-states interact in an intramolecular manner with a covalently bound neighboring unpaired electron in the form of a stable free radical, multiple spin-states can be populated. This opens the door to the opportunity of creating single molecule organic quantum bits for QIS applications. Additionally, the Chernick group synthesizes organic molecules to explore the quantum phenomenon of the chiral induced spin selectivity effect (CISS).

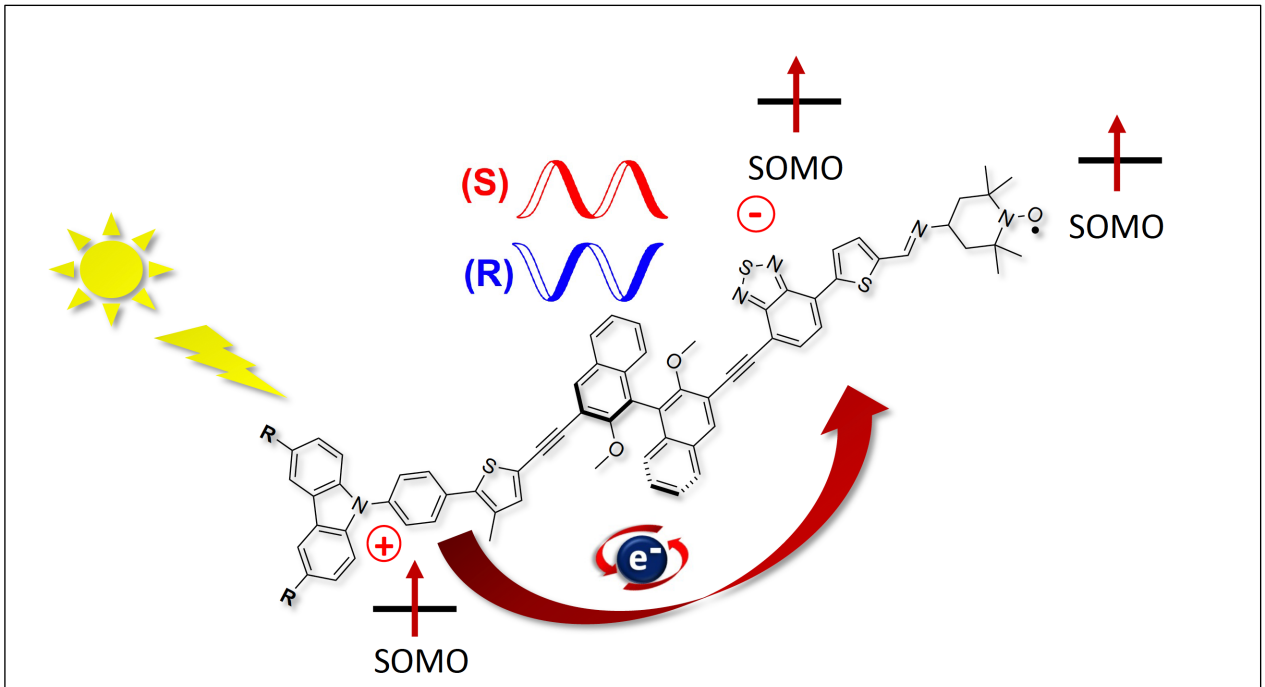

Figure 1. Proposed organic molecule that undergoes charge transfer through a chiral bridge and interacts with a neighboring unpaired spin.