



## College of Natural Sciences & Mathematics

UNIVERSITY OF DENVER

### Physics & Astronomy Colloquium

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#### Chiral Organic/Inorganic Hybrid Semiconductors

Here, I will discuss the unique properties of chiral hybrid organic-inorganic semiconductors. Metal-halide perovskite semiconductors are being widely developed for low-cost solution processable solar cells at NREL and around the world. These systems have unique and beneficial properties that make them ideal for solar energy capture and conversion. Typically, the three-dimensional version of these semiconductors consists of corner sharing  $\text{PbI}_4$  octahedra with small organic cations (methyl ammonium or formamidinium) spaced in the interstices of the octahedra (i.e. the A site of the  $\text{ABX}_3$  perovskite structure). When larger ammonium cations are used a unique family of layered semiconductor perovskites form, analogous to semiconductor superlattices. Here, 2D sheets of  $\text{PbI}_4$  octahedra are spaced by the larger organic cation. There is an interesting interplay between the organic component and inorganic component that can be tuned through the methods of inorganic chemistry to yield tunable properties that are not in either present in the organic or inorganic subcomponents. The presentation here will focus on when the organic cation is chiral and how that imbues chiroptical and chiral electrical properties to the inorganic components.

The interplay between spin and charge in chiral semiconductors is both of fundamental interest and can impact numerous potential applications, e.g., spintronics, spin chemistry, quantum information technologies, enantiomeric separations, biological functionality, etc., Traditional methods of controlling charge and spin requires the use of magnetic fields and/or ferromagnets (FM), employing complicated heterostructures and/or low temperatures to realize efficient spin-injection and spin-accumulation. Recently, a new way of controlling spins at room temperature and without FM contacts or magnetic fields has been demonstrated through the use of chirality. The spin-polarization and subsequent spin-injection are driven by the chirality induced spin selectivity (CISS) effect. The CISS effect describes a process whereby the structural and/or molecular chirality is coupled to the motion of charge carrier spins resulting in spin polarization of those charge carriers under an applied bias along the chiral axis. CISS has now been observed in a wide range of chiral systems including chiral-molecules and polymers, chiral metal-organic frameworks, carbon nanotubes, chiral hybrid organic-inorganic semiconductors, and chiral-metals. The CISS effect has enabled the development of room-temperature spin light emitting diodes (spin-LED) with the degree of circular polarized light emission increasing from 3 to 15% in the last few years, spin-selective electrocatalysis, enantiomer separation in pharmaceutical industries, and spin qubits for quantum technology.