

DEPARTMENT OF PHYSICS & ASTRONOMY

Physics & Astronomy Colloquium

Prof. Joshua Tropp (TTU Chemistry)

(Host: Yun Suk Eo)



3:30 - 4:30 p.m. | Tuesday, Nov. 4

ESB I Building 120

Conjugated Polymers for Bioelectronic Soft Matter: Mixed Transport and Infrared Emission

Abstract: Conjugated polymers are a unique class of soft matter that supports electronic, ionic, and optical signal transduction. These unique properties and operation as hydrated, deformable, and biocompatible materials make them ideal candidates for sensors, imaging agents, and semiconducting interfaces within biological environments. In this talk, I will explore how molecular design and ordering across length scales govern two key properties central to emerging bioelectronic applications: mixed ionic/electronic transport and near-infrared (NIR) emission. First, I will discuss the current state of mixed conduction in organic materials and how polymer architecture, molecular weight, and network formation modulate transport pathways. I will highlight our recent investigations on the role of polymer molecular weight and the development of electrochemical tools to decouple ionic and electronic contributions; both of which reveal design rules for high-performance mixed conductors. Subsequently, I will outline the challenge of generating efficient NIR emission through the lens of the energy gap law; strategies to overcome this limitation, including aggregation control and backbone engineering will be discussed, drawing on our recent development of conjugated polymers that exhibit rare NIR emission and aggregation-induced behavior. Together, these perspectives show how electronic structure and polymer morphology can be designed to create soft, adaptive conjugated materials capable of both transporting charge and generating NIR emission, laying the foundation for multifunctional bioelectronic soft matter.



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Biography:

Dr. Tropp obtained his ACS Certified B.A. in Chemistry from Washington & Jefferson College in 2011. He then moved to the University of Southern Mississippi (USM) for his graduate education under the supervision of Professor Jason D. Azoulay, where he studied the design and synthesis of pi-conjugated polymers for environmental sensing applications in the Gulf of Mexico. After completing his Ph.D. in Polymer Science & Engineering in 2020, he began his postdoctoral studies at the Center for Advanced Regenerative Engineering at Northwestern University under the guidance of Professor Jonathan Rivnay, where he synthesized electroactive biomaterials and organic mixed ionic-electronic conductors (OMIECs) for bioelectronic applications. In 2020 he was distinguished as a CAS Future Leader, and in 2022 as a Future Faculty Scholar by ACS PMSE and a Rising Star in Soft and Biological Matter by the Universities of Chicago and San Diego. Dr. Tropp recently started his career as research faculty at Texas Tech University in the Department of Chemistry and Biochemistry in 2023.

