A photophysical investigation of small molecules from chemosensing to drug delivery

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Chemistry Seminar on Photophysical properties of small molecules

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Abstract: Ion sensing using triazole-based compounds has attracted considerable interest due to their structural versatility and strong coordination affinity toward a wide range of ionic species. In particular, triazole derivatives have demonstrated high selectivity and sensitivity toward heavy metal cations such as Cu^{2+} and Al^{3+}, as well as biologically and environmentally relevant anions including F^-, $H_2PO_4^-$, and OAc^-, through pronounced chemosensory and fluorometric responses. These attributes have positioned triazoles as promising platforms for the development of molecular sensors. Building on this foundation, the present study extends triazole-based ion detection into biomimetic environments to better approximate physiologically relevant conditions. We designed model systems based on organized self-assemblies, such as micellar media, to investigate the sensing behavior of triazole derivatives within microheterogeneous environments. The broader objective is to assess the feasibility of employing small organic molecules for the early detection of fluoride and copper overexposure under conditions relevant to biological systems. These organized assemblies mimic key features of physiological media by enabling enhanced solubilization, compartmentalization, and targeted localization of molecular probes. Steady-state fluorescence spectroscopy revealed pronounced environment-independent photophysical behavior and distinct localization patterns of triazole derivatives in non-ionic, cationic, and anionic micelles. Complementary analyses of hydrodynamic size and surface morphology confirmed the stability of the probes within these assemblies. Collectively, these results highlight the potential of triazole-based systems for early-stage fluoride and copper sensing in biologically relevant environments.

About the speaker: Dr. Debanjana Ghosh is an experimental physical chemist. She currently serves as an Assistant Professor in the Department of Chemistry at Southern Illinois University Edwardsville (SIUE). Debanjana's educational journey began in India, where she earned a B.Sc. in Chemistry (Honours) from the University of Calcutta, followed by an M.Sc. in Chemistry from the University of Delhi. For a brief period, she worked with Dr. Anindya Datta at IIT Bombay as a summer research student during her M.Sc. and later with Dr. Mukul Biswas in Presidency University as a junior research scholar. She completed her Ph.D. in Science from Jadavpur University, India, with Dr. Nitin Chattopadhyay on the energy transfer from selected fluorophores to probes and metal nanoparticles. Subsequently, she conducted postdoctoral research at Georgia Southern University with Dr. Marshall Ming on the early detection and remediation of metal corrosion using smart coating techniques.

Debanjana's research group explores the photophysical properties of small organic molecules within organized assemblies and biomimetic environments. She investigates host-guest dynamics in supramolecular assemblies and develops small-molecule sensors for the early detection of toxic metal and inorganic ions. Debanjana has mentored/co-mentored several undergraduates and Masters' students at different institutions. Debanjana's scholarly output includes articles and book chapters with an overall citation above 1000.

At SIUE, Debanjana is the recipient of the Annette and Henry Baich Award, which is viewed as best representing the principles of basic research within the scope of activity of the Sigma Xi Society. Among all her other academic responsibilities, Debanjana also serves as a Section Editor for the Environmental Sensing Journal from MDPI.

Debanjana actively works to cultivate an inclusive learning environment. She has successfully secured funding twice as a Co-Investigator from the University System of Georgia, focusing on textbook transformation and the development of open educational resources for chemistry courses. In recognition of her dedication to teaching and learning, Debanjana was awarded the 2020 Scholarship of Teaching and Learning (SoTL) Fellowship by Georgia Southern University.