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FOR BASIC SCIENCES
Block JD, Sector III, Salt Lake, Kolkata 700 106

DEPARTMENTAL SEMINAR
Chemical and Biological Sciences

21st December,2023 **4.00 PM** **ONLINE / Room No. 404**

SPEAKER

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TITLE OF THE TALK

Ultrafast Energy and Electron Transfer in Natural and Synthetic Light Harvesting Investigated by Coherent Multidimensional Spectroscopy

ABSTRACT

Energy crisis is one of the greatest challenges to the world. In quest of alternative renewable energy source, solar energy appears to be the most viable energy resource. However, the light harnessing efficiency of the solar energy materials till date is too low to fulfill the global energy needs. To improve the efficiency, we need to delve into the mechanistic details of light energy harvesting [1]. In light absorbing molecular systems such as natural photosynthetic complexes, photocatalysis, solar cells, optoelectronic devices, the outcome of these light-matter interactions, such as quantum efficiency and reaction rate, depend upon energy dissipation pathways governed by intrinsic intra- and inter-molecular electronic interactions. While well-established concepts such as the Jablonski diagram and Marcus electron transfer theory provide paramount guidance in understanding many photochemical processes, they are often insufficient for predicting reaction outcomes especially when correlated nuclear and electronic motions (beyond Born-Oppenheimer approximation) determine the reaction fate. Such scenario demands advanced sophisticated spectroscopic methods, which can capture structural dynamics in terms of electron and nuclear responses in real time and away from thermal equilibria.

In this talk, I will discuss two novel multidimensional spectroscopies: two-dimensional electronic-vibrational spectroscopy (2DEVS) and time-resolved Raman spectroscopy (TRRS), which are emerging out to be the ideal tools to capture real time electronic structural dynamics and map out excited state trajectories on the potential energy landscape. In particular, I will majorly focus on 2DEVS, which not only possess the unique feature to probe the dynamic correlation between electronic and nuclear degrees of freedom but also offers high spectral resolution that ultimately unravels the detailed picture of the spatio-temporal flow of excitation energy/electron in spectrally congested multi-chromophore complexes [2]. I will discuss four of my recent research works: (a) solvent-mediated proton transfer in indigo carmine [3], (b) excitation energy flow in phycocyanine photosynthetic complexes [4], (c) synthetic control of exciton dynamics in bioinspired cofacial porphyrin dimers [5], and (d) light-driven electron transfer by vibronic quantum ratcheting [6],which demonstrate how the coherent multidimensional spectroscopy toolbox can provide invaluable information about the underlying molecular mechanism of solar energy capture and subsequent, energy and charge transfer processes in natural and synthetic solar energy material.

References

1. Scholes et al, Nat. Chem., 2011, 3, 763–774.
2. Arsenault et al, J. Chem. Phys., 2021, 155, 020901.
3. Roy et al, J. Phys. Chem. Lett., 2020, 11, 4156-4162.
4. Roy et al, J. Phys. Chem. B, 2023, 127 (20), 4460-4469.
5. Roy et al, J. Am. Chem. Soc., 2022, 144, 6298-6310.
6. Roy et al, in review, 2023.

HOST FACULTY

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