



SCHOOL OF NATURAL SCIENCES CHEMISTRY SEMINAR 291

Molecules in Cavities: Topological Phases and Novel Chemical Reactivities

Joel Yuen-Zhou

Department of Chemistry and Biochemistry
University of California, San Diego

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For more information contact:

Liang Shi, lshi4@ucmerced.edu

ABSTRACT

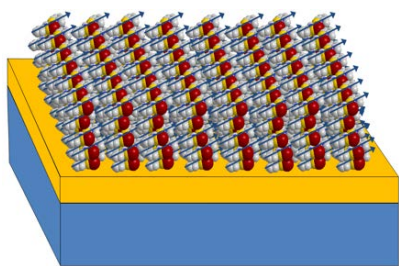


Fig. Topological phases in plasmon-exciton systems. From Ref. [2]

Organic molecules interact strongly with confined electromagnetic fields in plasmonic arrays or optical microcavities owing to their bright transition dipole moments. This interaction gives rise to molecular polaritons, hybrid light-matter quasiparticles. Molecular polaritonics opens new room-temperature opportunities for the nontrivial control of energy transport in the nano and mesoscales, Bose-Einstein condensation, and modification of physico-chemical properties of molecular assemblies. In this talk, I'll showcase some of these opportunities that we have been exploring in the past few years within the context of physical chemistry. First, I'll show that topologically nontrivial phases can be realized in excitonic and polaritonic systems of organic dye molecules that support Frenkel excitations [1,2]. Next, I will discuss some intriguing optical properties of plexcitons (surface plasmon-exciton polaritons) associated with van Hove singularities [3]. Finally, I will end my talk with an outlook on how kinetics and thermodynamics of chemical reactions can be controlled via strong coupling to cavity modes [4].

[1] J. Yuen-Zhou, S. Saikin, N. Yao, and A. Aspuru-Guzik, Topologically protected excitons in porphyrin thin films, *Nature Mater.* 13, 1026 (2014).

[2] J. Yuen-Zhou, S. K. Saikin, T. Zhu, M. Onbalsi, C. Ross, V. Bulovic, and M. Baldo, Plexcitons: Dirac points and topological modes, *Nat. Commun.*, 11783 (2016).

[3] J. Yuen-Zhou, S. Saikin, V. Menon, van Hove anomalies in plexciton emission, in preparation.

[4] L. Martínez-Martínez, R. Ribeiro, J. Campos-Angulo, F. Herrera, J. Yuen-Zhou, Chemistry at the ultrastrong coupling regime, in preparation.

BIO:

Prof. Joel Yuen-Zhou received a B.S. in Chemistry and a B.S. in Math from MIT in 2007, where he did undergraduate research under the late Prof. Robert J. Silbey. In 2012, he graduated with a Ph.D. in Chemical Physics under the supervision of Prof. Alan Aspuru-Guzik at Harvard University. He was the Robert J. Silbey Postdoctoral Fellow in the Center for Excitonics at MIT in 2012-2015. Since July 2015, he is an Assistant Professor in the Department of Chemistry and Biochemistry at the University of California, San Diego. He is a co-author of the book "Ultrafast Spectroscopy: Quantum Information and Wavepackets," and recently received the National Science Foundation CAREER award. His research group are interested in a variety of topics involving interaction of molecular systems with light in various forms. Topics range broadly from optical spectroscopy to polaritonics and topological phases. His research lies at the interface between chemical physics, materials science, and condensed matter theory.