QuEST: Quantum Electrodynamics for Selective Transformations Center for Chemical Innovation

Grant CHE-2124398 PI: Todd D. Krauss, University of Rochester

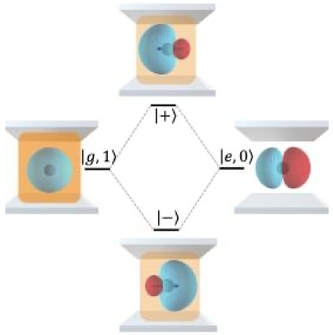
The goal of QuEST is to *change chemical reactivities* using molecular polartions.

Can the reactivity of molecules be altered by changing their molecular orbitals through strong light-matter coupling?

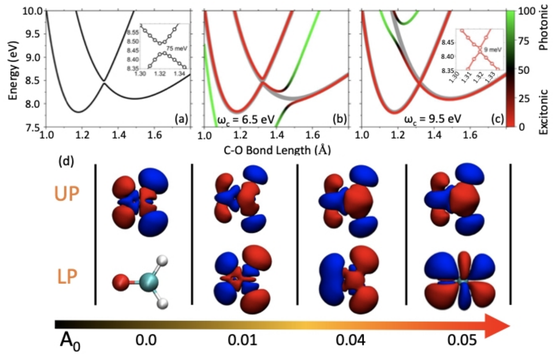
- A ***grand challenge*** in chemistry is to exhibit **selectivity and control** over a chemical transformation
- ***Established rules*** of reactivity fundamentally depend on the **interaction of molecular orbitals**
- To ***change these rules***, we will change molecular orbitals through **coupling molecules to an optical cavity**

Electron Polariton: quasiparticle formed by hybridizing electronic states of molecules with the quantum-radiation field of an optical cavity

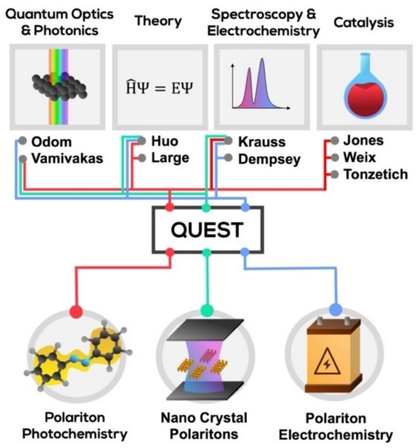
- Polaritons result in a superposition of ***excited and ground states*** creating **new molecular orbitals**



- Polaritons can offer a **new tool for chemists** to change the pathway of a reaction, similar to chemical catalysts
- **Tune** reaction outcomes with properties of **light**



Multidisciplinary Team



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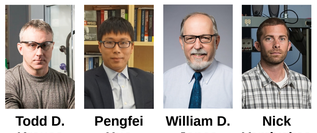

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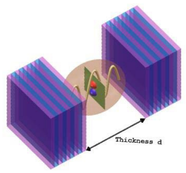
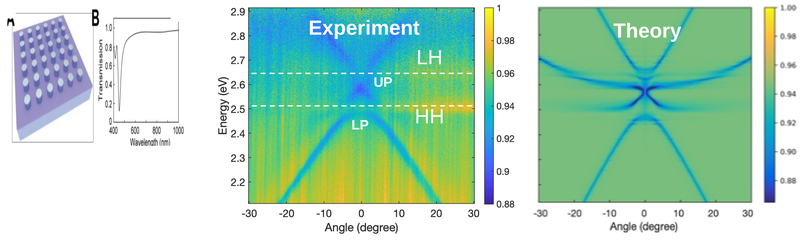
Couple Nanocrystals to Optical Cavities

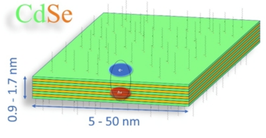
Dielectric Optical Cavity



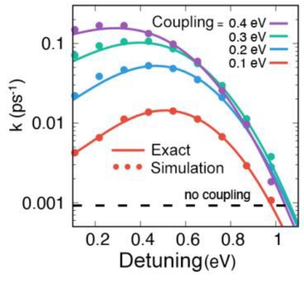


Lattice Plasmon Array

2D Nanocrystals

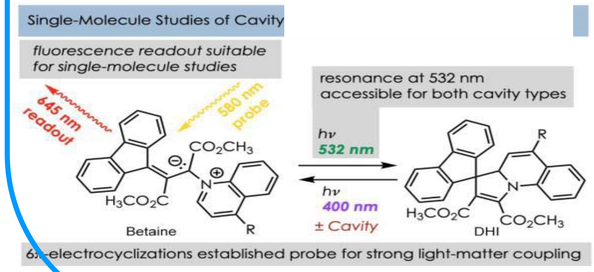


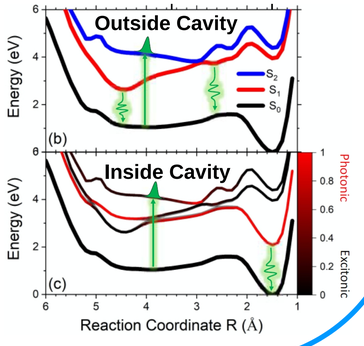
- Large oscillator strength
- 2D transition dipole in plane
- Narrow fluorescence spectra



Modify Electron Transfer Rates

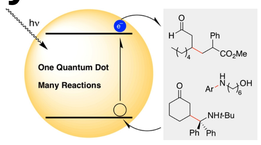
Polariton Mediated Reactivity





Sustainability Initiative

Using (sun)light and nanocrystals inside an optical cavity to **unlock new chemistries** for:



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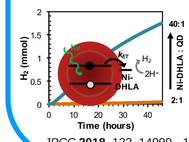

- Sustainable fuel forming reactions
- Photoredox Catalysis
- Greener chemical syntheses

JPCC **2018**, 122, 14099 - 14106

Broader Impacts

Education and Professional Development
Training in:
- Mentorship
- Science communication
- Science writing for general and expert audiences

Broadening Participation
- QuEST-specific REU program
- Address STEM "leaky pipeline" for URM students

Outreach and Informal Science Communication
Educate Public about Quantum Science
- Collaborate with local science centers
- Community events
- Social media

QuEST Winter Conference

UTSA undergraduate honored with Outstanding Research Award for QuEST research

Outreach at local market

Acknowledgements

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https://www.rochester.edu/quest/