Here, There, and Back Again: A Story of Delocalization, Re-localization, and Light

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Associate Professor
Career Development Chair
Department of Chemistry
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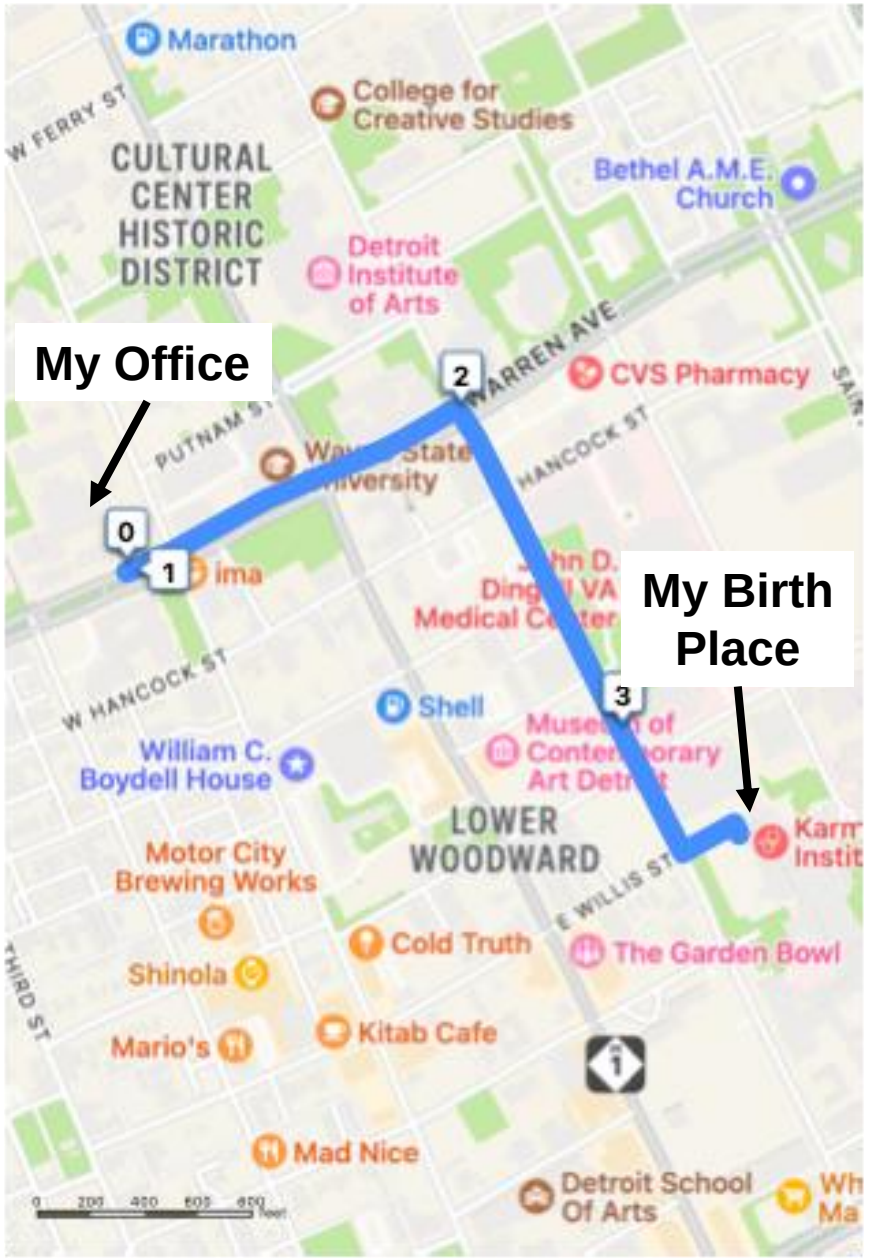
Wayne State and Detroit: Shallow Roots



Early Life:

Born in Detroit, MI, 1981

Father taught American History at Wayne State as adjunct faculty, 1980-1981

Mother took Lamaze classes at Wayne State while I gestated

I attend pre-school at the Clark Park YMCA, 1985-1987

Delocalization (The First Part)

Formative Years:

Moved to Chicago, IL in 1987

Attended inner city Catholic elementary school in Logan Square

Lived in 15 different apartments following my parents' divorce in 1992

Graduated from the International Baccalaureate program at Lincoln Park High School (Chicago Public Schools)

Delocalization (The Second Part)

‘Aaron can’t make up his mind if he’s a chemist or a physicist’

-Prof. Bern Kohler, Ohio Eminent Scholar, OSU

Education and Training:

B.S., Physics (minor in Chemistry), University of Illinois at Urbana-Champaign

<u>Interlude</u> (can expand on during questions)

M.S.E, Electrical Engineering (Focus in Optics), University of Michigan-Ann Arbor

Ph.D, Applied Physics, University of Michigan-Ann Arbor (Molecular Spectroscopy)

Postdoc, Quantum Science and Technology Group, JPL, Caltech (Cavity Photonics)

Postdoc, Department of Chemistry, University of Southern California (Ultrafast Materials Science)

Re-localization

Coming back ‘home’:

I joined the Department of Chemistry in August 2017 as an Assistant Professor

I earned early career grants from American Chemical Society, Air Force Office of Scientific Research, and the National Science Foundation

I have been awarded ~$5M in federal research funds since 2019

Wayne State honors include University Research Grant, Career Development Chair, and AOS Junior Scholar award (thank you!)

Tenured in August 2023

Publications

21. 'Assessing the determinants of cavity polariton relaxation using angle-resolved photoluminescence excitation spectroscopy', Elizabeth Odewale, Sachithra T. Wanasinghe, and Aaron S. Rury, accepted at *The Journal of Physical Chemistry Letters*

20.'Deciphering Between Enhanced Light Emission and Absorption in Multi-mode Molecular Cavity Polariton Samples', Elizabeth Odewale, Aleksandr G. Avramenko, and Aaron S. Rury accepted at *Nanophotonics*

19. 'Decorrelated Singlet and Triplet Exciton Delocalization in Weakly Bound Porphyrin Dimers', Hasini Medagedara, Teferi Mandefro, Sachithra T. Wanasinghe, Jens Niklas, Oleg Poluektov, and Aaron S. Rury, *Chemical Science*, 2024, 15, 1736-1751

18. 'Motional Narrowing through Photonic Exchange: Rational Design of Excitonic Disorder from Molecular Cavity Polariton Formation', Sachithra T. Wanasinghe, Adelina, Gjoni, Wade Burson*, Caris Majeski*, Bradly Zaslona*, and Aaron S. Rury, *The Journal of Physical Chemistry Letters,* 2024, 15, 2405-2418

17. 'Spacer Dependent Excited State Structural Reorganization in Ag-Bi Double Perovskite-like Quantum Wells' Adedayo M. Sanni, Tyler Danielson*, and Aaron S. Rury, in preparation

16. 'Evidence of defect-induced broadband light emission from 2D Ag–Bi double perovskites grown at liquid–liquid interfaces', Aaron S. Rury, Adedayo M Sanni, Destiny Konadu, Tyler Danielson*, *The Journal of Chemical Physics,* 158, 011101, (2023); invited contribution to the 2022 Emerging Investigators Collection

15. 'Molecular cavity polariton formation using multimode resonator structures', Aaron S. Rury, *Physical Chemistry of Semiconductor Materials and Interfaces XXI*, 12199,1219902

14. 'Cavity Polaritons formed from Spatially Separated Quasi-degenerate Porphyrin Excitons: Structural Modulations of Bright and Dark State Energies and Compositions', Aleksandr G. Avramenko and Aaron S. Rury, *The Journal of Physical Chemistry C,* 2022, 126, 15776–15787

13. 'Light Emission from Vibronic Polaritons in Coupled Metalloporphyrin-Multi-mode Cavity Systems' Aleksandr G. Avramenko and Aaron S. Rury *The Journal of Physical Chemistry Letters,* 2022, 13, 4036-4045

12. 'Vibrational Probes of Temperature Dependent Structure in Crystalline Methylbenzimidazole', Sachithra Wanasinghe, Sydney N. Lavan, Adedayo M. Sanni, and Aaron S. Rury, *Vibrational Spectroscopy,* 2022, 120,103384

11. 'Defect-Induced Narrowband Light Emission from a 2D Hybrid Lead Iodide Perovskite', Adedayo M. Sanni, Sydney N. Lavan, Zhen-Fei Liu, and Aaron S. Rury, *The Journal of Physical Chemistry C*, 2021, 125, 28004–28012

10. 'Local molecular probes of ultrafast relaxation in strongly coupled metalloporphyrin-cavity systems.' Aleksandr G. Avramenko and Aaron S. Rury, *The Journal of Chemical Physics,* 155, 064702, (2021); invited contribution to the special issue on cavity polaritons

9. 'Characterization of the Ammonium Bending Vibrations in Two-Dimensional Hybrid Lead-Halide Perovskites from Raman Spectroscopy and First-Principles Calculations.' Sydney N. Lavan, Adedayo M. Sanni, Aaron S. Rury, and Zhen-Fei Liu, *The Journal of Physical Chemistry C,* 2021, 125, 223-236

8. 'Kinetic Molecular Cationic Control of Defect-Induced Broadband Light Emission in 2D Hybrid Lead Iodide Perovskites.' Adedayo M. Sanni, and Aaron S. Rury, *The Journal of Physical Chemistry Letters,* 2021, 12, 101-110

7. 'Anharmonic Molecular Vibrational Probes of Dynamical Organic-Inorganic Interactions in 2D Hybrid Lead Iodide Perovskites' Adedayo M. Sanni, Sydney N. Lavan, and Aaron S. Rury, *The Journal of Physical Chemistry C,* 2020, 124, 13942-13955

6. 'Structural Anharmonicity Explains Continuous Frequency Shifts of Intramolecular Ring Vibrations in a Hydrogen-Bonded Antiferroelectric Crystal', Sydney N. Lavan, Cathleen A.Saraza, Kanwar Bhullar*, Sardou Sabeyo-Yonto*, Adedayo M. Sanni, and Aaron S. Rury, *The Journal of Physical Chemistry C,* 2020, 124, 12933-12947

5. 'Quantum Control of Ultrafast Internal Conversion using Nanoconfined Virtual Photons', Aleksandr G. Avramenko and Aaron S. Rury, *The Journal of Physical Chemistry Letters,* 2020, 11, 1013-1021

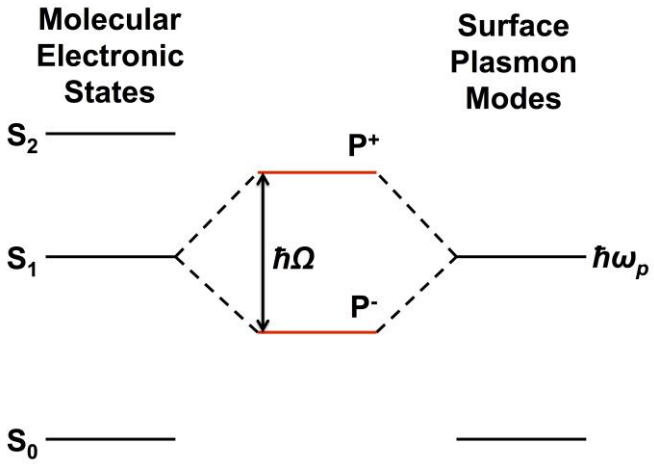
4. 'Interrogating the Structure of Molecular Cavity Polaritons with Resonance Raman Scattering: An Experimentally Motivated Theoretical Description', Aleksandr G. Avramenko and Aaron S. Rury, *The Journal of Physical Chemistry C,* 2019, 123, 30551-30561

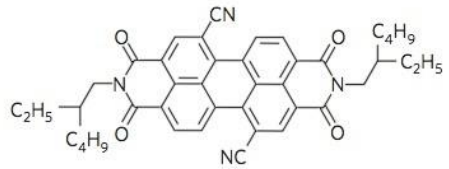
3. 'Probing the Fabry-Perot Modes of Self-Assembled Excitonic Microcrystals with Subgap Light Emission', Adedayo M. Sanni, Shofikur Shohag*, and Aaron S. Rury, *The Journal of Physical Chemistry C,* 2019, 123, 23103-23112

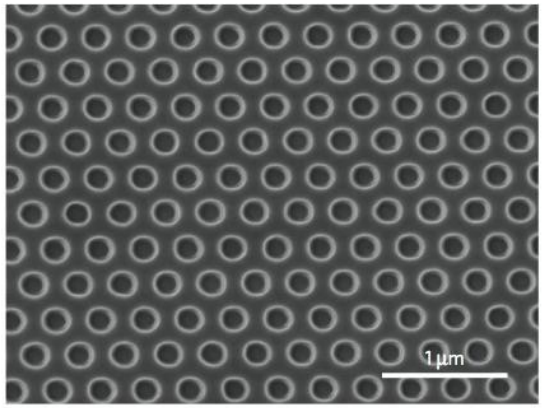
2. 'Room Temperature Broadband Light Emission From Hybrid Lead Iodide Perovskite-Like Quantum Wells: THz Spectroscopic Investigation of Metastable Defects', Adedayo M. Sanni, Sydney N. Lavan, Aleksandr Avramenko, Federico Rabuffetti, Leopoldo Suescun, and Aaron S. Rury, *The Journal of Physical Chemistry Letters,* 2019, 10, 1653-1662

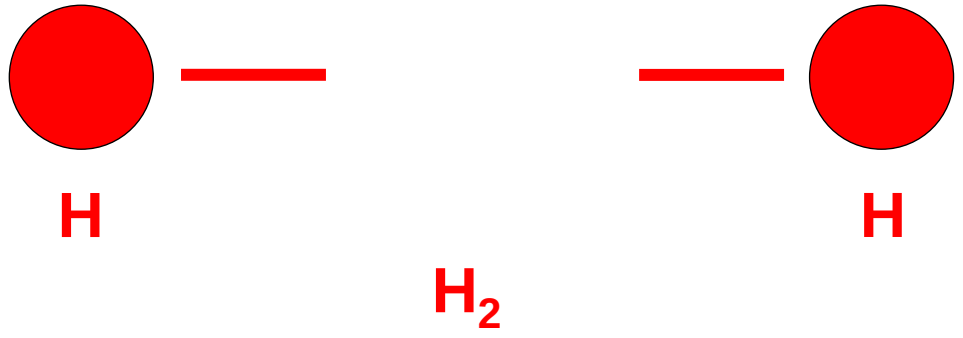
1. 'Defects Cause Subgap Luminescence from a Crystalline Tetracene Derivative', R. Eric McAnally, Jon A. Bender, Laura Estergreen, Ralf Haiges, Stephen E. Bradforth, Jahan M. Dawlaty, Sean T. Roberts, and Aaron S. Rury, *The Journal of Physical Chemistry Letters*, 2017, 8, 5993–6001

Light: A Partner in Delocalization







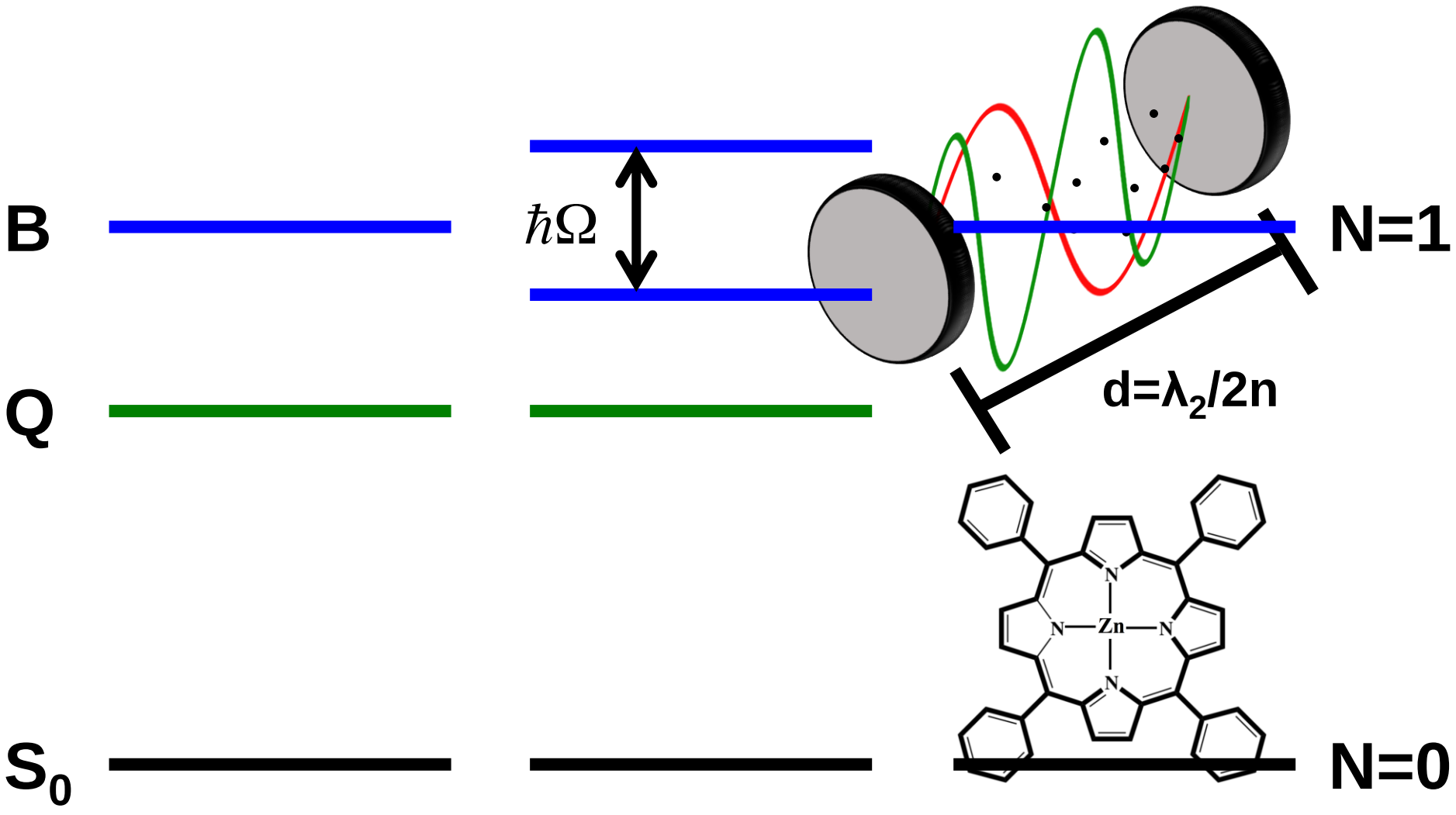


- **semiconductor carrier transport**
- **chemical reactions**
- **ultrafast optical signal processing**

What about photophysics?

Orgiu *et al*., *Nat. Mater.*,***14***, 1123, (2015).

Molecular Cavity Polaritons: Property Design using Delocalized Photons



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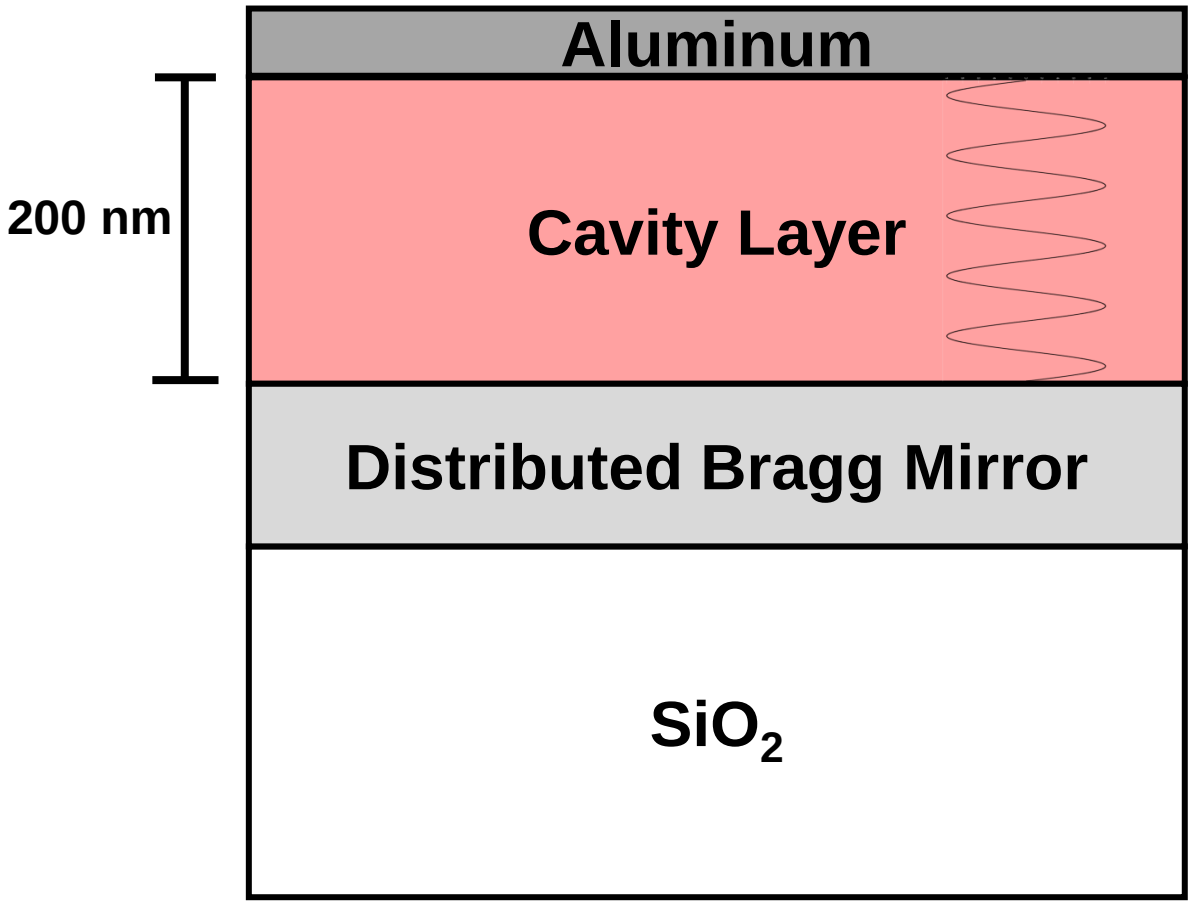
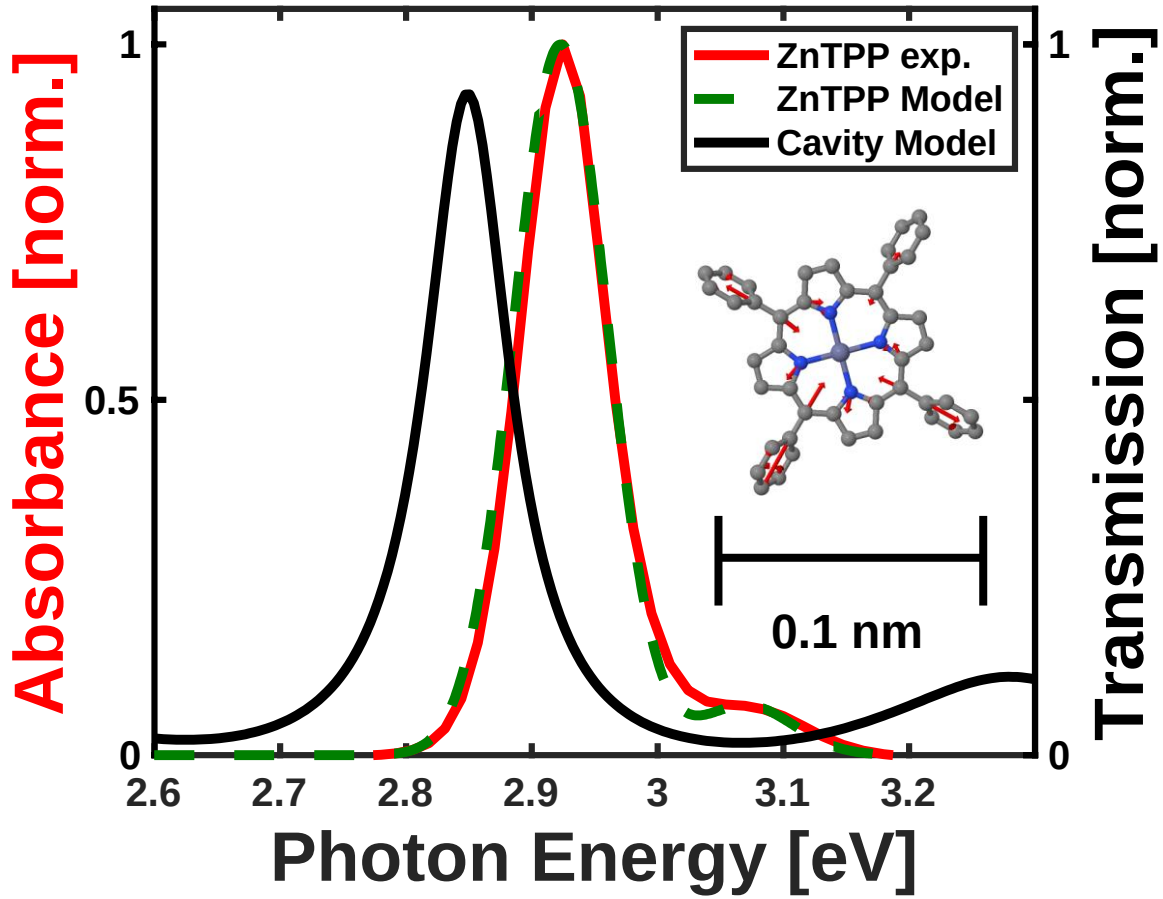
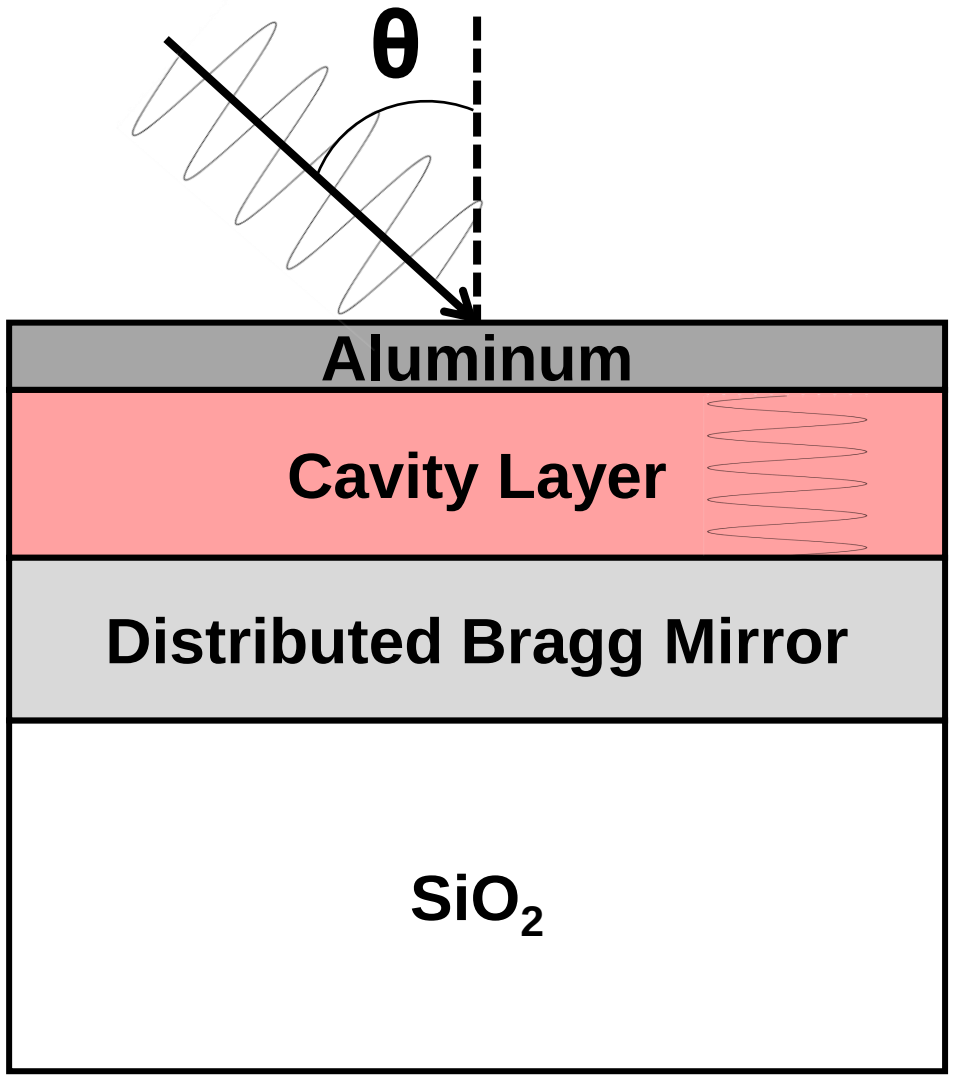


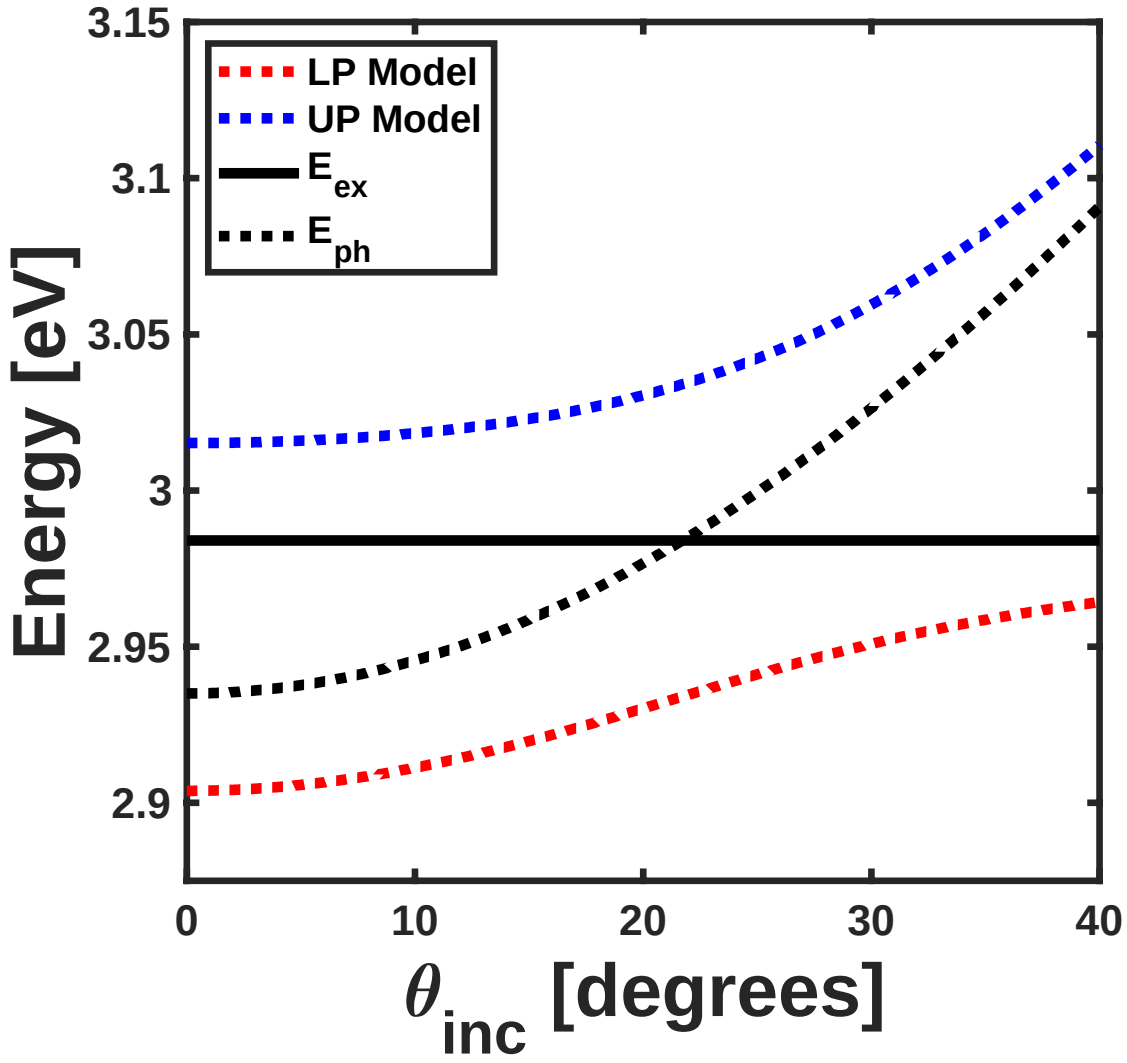


How do we control photo-physics?

A. Avramenko and **ASR** *J. Phys. Chem. Lett.* **2020**, 11, 1013
A. Avramenko and **ASR** *J. Chem. Phys.*, **155**, 064702 (2021)

Molecular Cavity Polaritons: Property Design using Delocalized Photons





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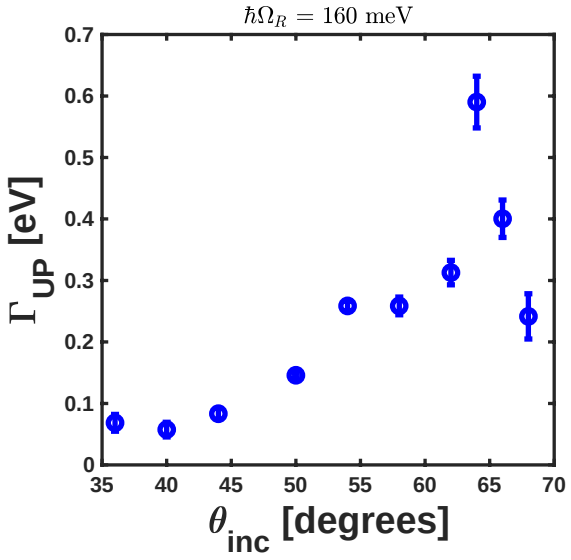

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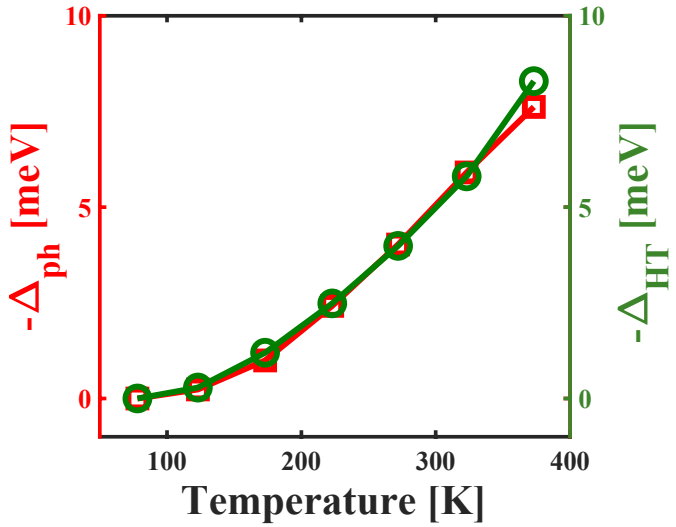
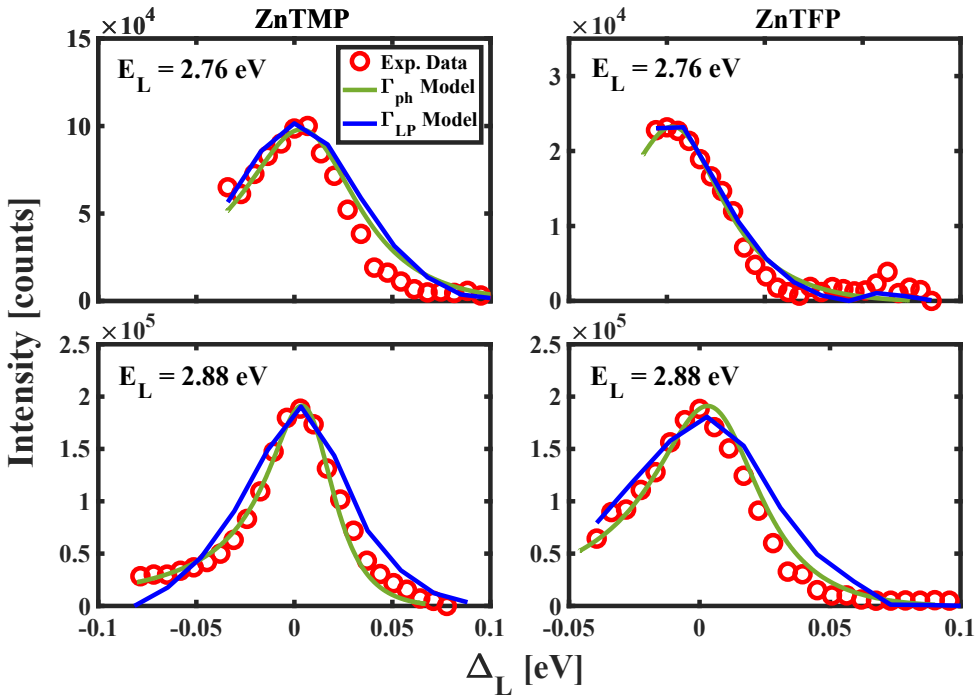
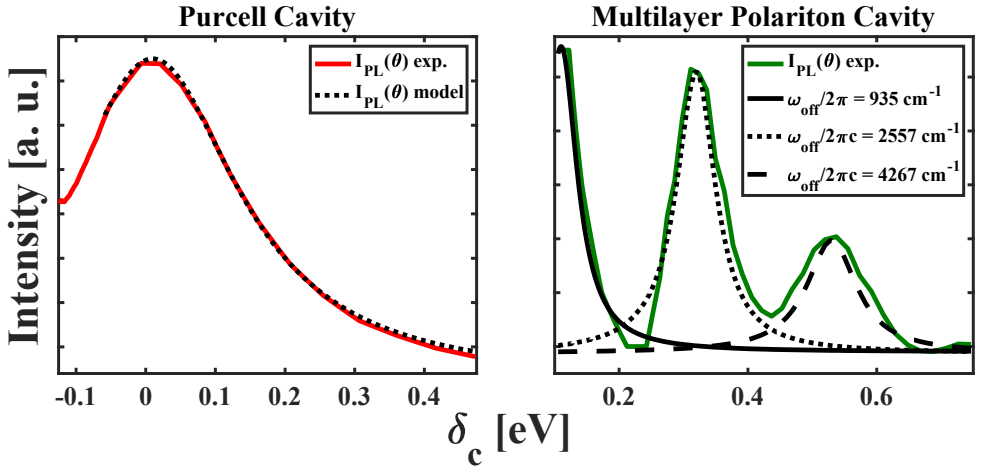


A. Avramenko and **ASR**
J. Phys. Chem. Lett. **2022**, 13, 4036–4045



E. O. Odewale, S. T. Wanasinghe, and **ASR**, *J. Phys. Chem. Lett.* **2024**



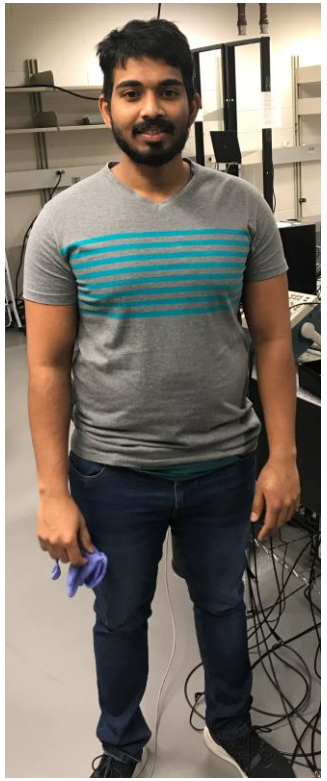
E. O. Odewale, A. Avramenko and **ASR**, *Nanophotonics,* (2021)

This approach has allowed my group and I to understand what determines the lifetimes and usefulness of these systems.

Acknowledgements

- WSU Start-Up
- WSU LIC
- UMich LNF
- Dr. Tom Knisley

2236921 DE-SC-0022134 FA9550-19-1-0231 (concluded) 60003-DNI6 (concluded)



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