

Curriculum Vitae

Jacob S. Higgins

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EDUCATION

The University of Chicago **Chicago, IL**
Ph.D. in Physical Chemistry Winter/Spring 2022 (*expected*)
M.S. in Physical Chemistry December 2017
NSF Graduate Research Fellow 2018-2021
Thesis Title: “Dynamic Mechanisms of Electronic-Vibrational Coupling in Excited State
Pigment-Protein Complexes”
Advisor: Prof. Gregory S. Engel

Hendrix College **Conway, AR**
B.A. in Chemical Physics with Honors, *Summa Cum Laude* May 2016
Thesis Title: “The Nature of Unidentified Infrared Emission Bands in Interstellar Space”
Advisors: Prof. Courtney D. Hatch, Prof. Andrew M. Schurko

AWARDS, HONORS, & FELLOWSHIPS

- 2018-2021 NSF Graduate Research Fellowship Program (GRFP): Awarded
- 2019 Joan Shiu Chemistry Department Student Service Award, University of Chicago
- 2019 Graduate Council Travel Fund Award, University of Chicago
- 2019 Inclusive Pedagogy Grant, Office of the Provost, Diversity, Equity & Inclusion Initiative, University of Chicago
- 2019 Graduate Council Grant, Diversity, Equity & Inclusion Initiative, University of Chicago
- 2019 Social Committee Grant, Diversity, Equity & Inclusion Initiative Physical Sciences Division, University of Chicago
- 2016-2018 University of Chicago McCormick Fellowship
- 2016 Induction into Phi Beta Kappa
- 2016 American Chemical Society Undergraduate Environmental Chemistry Award
- 2015 Barry M. Goldwater Scholarship

RESEARCH EXPERIENCE

The University of Chicago, Department of Chemistry **Chicago, IL**
Graduate Student Worker, Engel Group 2016-present

- Studied redox-dependence of excited state dynamics in photosynthetic pigment-protein complexes
- Improved and performed ultrafast two-dimensional electronic spectroscopy experiments of biophysical systems
- Wrote new code and designed figures to analyze data and present them to scientific community
- Developed new data method to extract kinetic time constants from two-dimensional spectra
- Cultured bacterial cells and isolated endogenous pigment-protein complexes

Hendrix College, Department of Chemistry*Undergraduate Research Assistant, Hatch Group***Conway, AR**

2015-2016

- Worked with high volume air sampler to extract aerosols from the atmosphere
- Developed analytical method to study aerosols using gas chromatography/mass spectrometry to be implemented into undergraduate laboratory curriculum

Hendrix College, Department of Physics*Undergraduate Research Assistant, Tinsley Group***Conway, AR**

2015-2016

- Educational research studying gender differences between junior high students' perception of physical sciences and becoming a scientist

Hendrix College, Department of Biology*Undergraduate Research Assistant, Schurko Group***Conway, AR**

2013-2015

- Used bioinformatics, gene expression studies (qPCR), and protein mass spectrometry to study the role of histones in the DNA repair mechanism of bdelloid rotifers

Vanderbilt University, Department of Biomedical Engineering*NSF REU Undergraduate Researcher***Nashville, TN**

2013

- Studied the effects of shear stress and lipoprotein involvement in genetic regulation of human aortic endothelial cells using cone and plate device and qPCR
- Correlated presence and concentration of urine analytes in patients with bladder cancer using liquid chromatography/mass spectrometry data

PUBLICATIONS

In Press

1. Redox conditions correlated with vibronic coupling modulate quantum beats in photosynthetic pigment-protein complexes
J. S. Higgins*, M. A. Allodi*, L. T. Lloyd, J. P. Otto, S. H. Sohail, R. G. Saer, R. E. Wood, S. C. Massey, P.-C. Ting, R. E. Blankenship, G. S. Engel, *Proceedings of the National Academy of Sciences*, 118 (49) e2112817118 [*Equal Contribution].
2. Photosynthesis tunes quantum mechanical mixing of electronic and vibrational states to steer exciton energy transfer,
J. S. Higgins, L. T. Lloyd, S. H. Sohail, M. A. Allodi, J. P. Otto, R. G. Saer, R. E. Wood, S. C. Massey, P.-C. Ting, R. E. Blankenship, G. S. Engel, *Proceedings of the National Academy of Sciences* 118 (11) e2018240118 (2021).
3. Quantum Coherence in Chemical and Photobiological Systems
J. S. Higgins, W. R. Hollingsworth, L. T. Lloyd, G. S. Engel, *Emerging Trends in Chemical Applications of Lasers* (American Chemical Society, 2021), Vol. 1398, Chap. 18 pp. 411-436.
4. Sub-10 fs intervalley exciton coupling in monolayer MoS₂ revealed by helicity-resolved two-dimensional electronic spectroscopy
L. T. Lloyd, R. E. Wood, F. Mujid, S. Sohoni, K. Ji, P.-C. Ting, **J. S. Higgins**, J. Park, G. S. Engel, *ACS Nano* 15, 6, 10253-10263 (2021).
5. Leveraging scatter in two-dimensional spectroscopy: passive phase drift correction enables a global phasing protocol,
L. T. Lloyd, R. E. Wood, M. A. Allodi, S. Sohoni, **J. S. Higgins**, J. P. Otto, G.S Engel, *Optics Express* 28, 32869-328 (2020).

6. DNA scaffold supports long-lived vibronic coherence in an indodicarbocyanine (Cy5) dimer
S. H. Sohail, J. P. Otto, P. D. Cunningham, Y. C. Kim, R. E. Wood, M. A. Allodi, **J. S. Higgins**, J. S. Melinger, G. S. Engel, *Chemical Science* 11, 8546-8557 (2020).

Under Revision

7. Observation of Exciton Annihilation along Phycocyanin rods in the Phycobilisome of *Synechococcus elongates* PCC 7942
P. Navotnaya*, S. Sohoni*, L. T. Lloyd, S. M. Abdulhadi. P.-C. Ting, **J. S. Higgins**, G. S. Engel, Under revision at *Journal of Physical Chemistry B* [*Equal Contribution].

In Preparation

8. Leveraging Dynamical Symmetries in Two-Dimensional Electronic Spectra to Extract Population Transfer Pathways
J. S. Higgins, A. R. Dardia, C. J. Ndife, E. M. Bain, L T. Lloyd, G. S. Engel, To be Submitted December 2021.
9. Vibronic Coherences in the Core Light Harvesting Complex LH1 from Purple Bacterium *Rhodobacter sphaeroides*
P.-C. Ting, **J. S. Higgins**, M. O. Elue, P. D. Dahlberg, S. C. Massey, E. C. Martin, C. N. Hunter, G. S. Engel.
10. Evidence for intracomplex singlet-singlet annihilation in isolated LH2 from *Rba. Sphaeroides*
E. M. Bain*, Q. Shen*, **J. S. Higgins**, S. Sohoni, G. S. Engel, S. C. Massey [*Equal Contribution].
11. Exploring the interplay between histones, epigenetics and DNA repair in the bdelloid rotifer *Adineta vaga*
A. M. Schurko, M. Ebijoyeldhas, **J. S. Higgins**, A. C. Jones, M. A. McFadden, M. Boerma, S. D. Byrum, L. M. Orr, A. J. Tackett.

TEACHING EXPERIENCE

The University of Chicago, Department of Chemistry Chicago, IL

- Spring 2019 Teaching Assistant and Grader, *Chemical Dynamics*
- Spring 2018 Grader, *Biophysical Chemistry*
- Fall 2016-Spring 2017 Laboratory & Discussion Teaching Assistant, *General Chemistry*

Hendrix College, Department of Chemistry Conway, AR

- Spring 2015, Spring 2016 Laboratory Assistant, *Organic Chemistry Lab*
- Fall 2013, Fall 2015 Laboratory Assistant, *General Chemistry Lab*

GRADUATE LEADERSHIP EXPERIENCE

Graduate Recruitment Initiative Team (GRIT), The University of Chicago Chicago, IL
Co-director of Recruitment, Physical Sciences Division (PSD) 2019-2020

- Established GRIT as a student-led Equity & Justice organization in the PSD
- Headed a leadership team of graduate students across six PSD departments aimed at connecting recruited undergraduates from underrepresented backgrounds with on-campus resources
- Planned, organized, and secured funding for student recruitment trip to national *Society for the Advancement of Chicanos and Native Americans in Science (SACNAS)* conference in Honolulu, HI
- Coordinated diversity-themed events into graduate recruitment across six PSD departments
- Developed multiple Zoom-based undergraduate recruitment panels with student groups at Howard University, University of Illinois, and Columbia University

Chemistry Department Representative 2018-2019

- Secured funding for recruitment and retention events from the Chemistry Department
- Recruited undergraduate students at the national *SACNAS* meeting in San Antonio, TX
- Organized retention events centering underrepresented identities and experiences

Equity, Diversity, & Inclusion (EDI) Committee, UChicago Dept. of Chemistry Chicago, IL
Member 2020-2021

- Bridged departmental and divisional resources to first year Chemistry graduate students
- Helped write and begin implementation of five-year EDI plan in the Department of Chemistry

@rtifice Tech Education, The University of Chicago Chicago, IL
Leadership Board Member 2019-2021

- Organized board meetings & planned logistics for the year's activities

Center Coordinator 2016-2019

- Volunteered and led volunteers at an after-school tech center in Chicago

PRESENTATIONS

Oral Presentations

- April 2021 "Steering of photosynthetic excitons with redox-dependent vibronic coupling," *Department of Chemistry Tiger Talk*, University of Chicago, Chicago, IL.
Video Link: <https://www.youtube.com/watch?v=5KXsjBdidUU>
- Oct. 2014 "Investigating the role of histone H2A variants in the unprecedented DNA repair system of bdelloid rotifers," *Hendrix Biological Society Meeting*, Hendrix College, Conway, AR

Poster Presentations

- April 2021 "Photosynthetic pigment-protein complexes steer excitons toward quenching sites using redox-dependent vibronic coupling," *Am. Chem. Society Conference*, Online
- July 2019 "Extracting exciton energy transfer efficiency and system-bath interactions from two-dimensional spectroscopic signals," *Photochemistry Gordon Research Conference*, Easton, MA
- May 2019 "Extracting exciton energy transfer efficiency and system-bath interactions from two-dimensional spectroscopic signals," *Am. Chem. Society Great Lakes Regional Meeting*, Lisle, IL

- Oct. 2018 “Probing system-bath dynamics in pigment-protein complexes with two-dimensional electronic spectroscopy,” *Midwest/Southeast Photosynthesis Meeting*, Marshall, IN
- March 2016 “Method development to study atmospheric aerosols,” *Am. Chem. Society Conference*, San Diego, CA
- Nov. 2015 “Method development to study atmospheric aerosols,” *Arkansas IDeA Network of Biomedical Research Excellence Conference*, Fayetteville, AR
- July 2015 “Method development to study atmospheric aerosols,” *Central Arkansas Undergraduate Research Symposium*, Little Rock, AR
- Mar. 2015 “Evaluating the role of histone H2A variants and epigenetic modification in the DNA repair system of bdelloid rotifers,” *Experimental Biology Conference*, Boston, MA
- Nov. 2014 “Evaluating the role of histone H2A variants and epigenetic modification in the DNA repair system of bdelloid rotifers,” *Arkansas IDeA Network of Biomedical Research Excellence Conference*, Fayetteville, AR
- July 2014 “Investigating the role of histone H2A variants in the unprecedented DNA repair system of bdelloid rotifers,” *Central Arkansas Undergraduate Research Symposium*, Little Rock, AR

Equity, Diversity, & Inclusion Presentations

- July 2020 “Navigating conversations of race with faculty,” *Co-presentation to graduate students* with Elaine Kouame, Christina Roman, and Linsin Smith, Online
- Jan. 2020 “GRIT information session,” *Co-presentation to graduate students* with Katie Aracena and Elaine Kouame, Chicago, IL
- Nov. 2019 “GRIT – gaining momentum in the PSD,” *UChicago Physical Sciences Division Dean’s meeting co-presentation* with Jean Salac, Chicago, IL
- May 2019 “GRIT – Gaining Momentum in the PSD,” *UChicago Physical Sciences Division Equity, Diversity and Inclusion Coordination Team meeting co-presentation* with Rebecca Thompson, Chicago, IL

POPULAR PRESS RELEASES

Research

- Science Alert, “Bacteria Could Be The First Organisms Found to Use Quantum Effects to Survive”, March 2021
- PhysOrg, “Bacteria know how to exploit quantum mechanics, study finds”, March 2021
- SciTechDaily, “Bacteria Know How to Exploit Quantum Mechanics to Steer Energy”, March 2021
- Futuricity, “Bacteria use Quantum Mechanics for Protection”, March 2021
- UChicago News, “Bacteria know how to exploit quantum mechanics, UChicago study finds”, March 2021
- EurekAlert, “Bacteria know how to exploit quantum mechanics, UChicago study finds”, March 2021
- Bioengineer.org, “Bacteria know how to exploit quantum mechanics, UChicago study finds”, March 2021

Outreach

- UChicago Chemists Club, “GRIT: A student-led effort to enhance diversity, inclusion, and equity in Chemistry and Beyond”, Fall 2021
- UChicago Chemistry, “Graduate Recruitment Initiative Team (GRIT) grows to the PSD and beyond”, February 2019

OTHER SERVICE

- Undergraduate/post-baccalaureate research students mentored: Carlos Olivares, Nick Cleland, Danika Nimlos, James Hayman, Anna Dardia, Chidera Ndife, Malachi Elue
- Sep. 2021 Search Committee, UChicago Physical Sciences Division Director of Equity, Diversity, and Inclusion
- Aug. 2021 Panelist for UChicago Leadership Alliance Summer Program
- Jan. 2021 Panelist for Imposter Syndrome Workshop, UChicago Department of Chemistry
- Winter 2020 UChicago Department of Chemistry Graduate Recruitment Committee
- Sep. 2020 Panelist for “Life During Grad School” series, UChicago Physical Sciences and Biological Sciences Division
- Feb. 2020 Panelist for first year workshop, “Candid Peer Conversations about the Graduate Student Experience,” UChicago Department of Chemistry
- Feb. 2020 Panelist for graduate school information session for undergraduate students, UChicago Department of Chemistry
- Aug. 2019 Search Committee, UChicago Physical Sciences Division Dean of Students
- Summer 2019 Coordinator, UChicago “Chemistry Lunch and Learn” series for first year graduate students
- May 2019 Volunteer, UChicago *Women in STEM symposium*, Chicago, IL
- April 2019 Volunteer, *Society for the Advancement of Chicanos and Native Americans in Science* regional conference, Chicago, IL
- Winter 2019 UChicago Department of Chemistry Graduate Recruitment Committee
- July 2018 Volunteer, “Girls 4 Science” nonprofit event at UChicago, Chicago, IL

SKILLS

- Laboratory: Two-dimensional electronic spectroscopy, transient absorption spectroscopy, UV-visible spectroscopy, data analysis method development, phenomenological modeling and simulation, molecular dynamics simulations, electronic structure calculations, bacterial cell culture, quantitative PCR, protein design, expression, and isolation, gas chromatography/mass spectrometry (GC/MS)
- Software: MATLAB, Mathematica, Gaussian, GROMACS, PyMOL, Adobe Illustrator, Adobe Photoshop