Nathan Jansen

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Education

PhD Student in Physical Chemistry 09/2019 – Present
Michigan State University (MSU)

Bachelor of Science (B.S.) in Chemistry 09/2015 – 6/2019
Portland State University (PSU)

Experience

Research

Graduate Research Assistant, *Michigan State University* 09/2019-Present

Hunt Group: Quantum Chemistry and Quantum Computing

- Current project: Entropy growth and thermalization of isolated quantum systems
  - Determination of the single-qubit entropy, total entropy, conditional probability, and mutual information of qubits after the application of Hadamard gates to the individual qubits, coupling into Schrödinger's cat states, or other gate operations, in runs on IBM's publicly accessible quantum computers
  - Investigation of the evolution of the density matrix and growth of the entanglement entropy under unitary time evolution of a many-body Hamiltonian; exploring whether this process is consistent with the eigenstate thermalization hypothesis, leading to thermalization of an isolated quantum system
  - Quantum computing experience with qiskit, aer, ignis, terra, and aqua; use of Jupyter notebooks and Python programming

- Planned project: Separation of adiabatic and nonadiabatic effects in photoexcitation, based on the Mandal-Hunt treatment of nonadiabatic transition probabilities for quantum systems in a time-dependent perturbation, evolution of wave packets on excited-state potential energy surfaces for small molecules in collaboration with Prof. Ben Levine's group, Stony Brook

- Completed project: *Ab initio* quantum chemical calculations of the dipole induced during collisions between two hydrogen molecules
  - Calculated the pair dipole using finite-field coupled-cluster methods in MolPro 2015 with an extended basis set
  - Analyzed dependence of the collision-induced dipole on the pair orientations and on bond lengths, to permit calculations of the collision-induced absorption spectrum of dense hydrogen gas, for astrophysical applications
  - Used spherical tensor analysis of the collision-induced dipole to determine the coefficients in an expansion in spherical harmonics of the bond vectors and the intermolecular vector, based on angular momentum coupling algebra
  - Developed codes in Mathematica to fit dipole data efficiently for 28 pair orientations and 24 intermolecular distances, and to calculate the

coefficients in the spherical harmonic series through coupled angular momentum values of 6.
    - Developed Python codes for large data set analysis of coupled cluster calculations and dipole values, plotting publication quality images, Numerov-Cooley Method to determine wavefunctions, work on scattering simulations.

Undergraduate Researcher, *Portland State University*

Jiao Group: Nanomaterial fabrication, characterization, and testing 09/2017 – 6/2019

- Control of phase and shape of graphene-supported iron oxide nanoparticles.
- Synthesized graphene-supported α-Fe_2O_3 and Fe_3O_4 nanoparticles using a solvothermal process
- Developed electro-magneto control of graphene-supported spinel ferrite (Fe_3O_4) in electrochemical cells, in collaboration with researchers at Shangdong University
    - Synthesized graphene-supported Fe_3O_4 nanoparticles
    - Designed electrode for supercapacitor and lithium ion battery
    - Performed electrochemical testing on materials as supercapacitors
    - Characterized graphene hybrid nanomaterials using Raman and UV-Vis spectroscopy
- Developed and tested binder-free supercapacitor electrodes
    - Designed and constructed supercapacitor
    - Synthesized nanoparticles directly on electrode surface, binder-free
    - Performed life-cycle electrochemical testing using potentiostat
- Lab Safety Officer
    - Produced lab safety protocol
    - Handled waste management and inventory control
    - Gave weekly safety presentations at group meeting
    - Served as the Nanomaterials Representative on PSU's Chemical Hygiene Committee

Rananavare Group: Nano-interfaces 05/2017 – 09/2017

- 1D high-temperature superconducting nanowires
    - Synthesized a high-temperature superconductor (BSCCO)
    - Designed and constructed a temperature control instrument to cool material past its critical temperature

Teaching

Teaching Assistant, *Department of Chemistry, Michigan State University* 09/2019 – Present

- Molecular Thermodynamics, CEM 484, 3 semesters
    - Prepared lecture presentations for weekly recitation sections in junior/senior level course for chemistry and chemical engineering majors
    - Created weekly quizzes and worksheets
    - Helped run Course Project website and guide students to determine heat capacities via statistical mechanical methods
    - Designed innovative exam questions in a "teaching as research" project for FAST fellowship

- General Chemistry Lab, CEM 161 — 09/2016 – 04/2017
  - Instructed general chemistry students in standard lab protocol and laboratory safety, lab report critical review and evaluation, held help-room hours

General Chemistry Workshop Leader, *Portland State University* — 08/2014 – 06/2019

- Independently led and directed a class of general chemistry students through homework and worksheets

Work Experience

Glass Artist, *Self Employed*

- Designed and sold my art
- Managed inventory, profit margins and customer service
- Tested products under rigorous quality-control metrics
- Marketed and established a network in the art community with social media

Publications and Presentations

- **N. Jansen**, M. Loucks, S. Gilbert, C. Fleming-Dittenber, J. Egbert, K. L. C. Hunt, "*Shannon and von Neumann entropies of multi-qubit Schrödinger's cat states*,"*Phys. Chem. Chem. Phys.*, **24**, 7666-7681 (2022) doi: 10.1039/d1cp05255a

- **N. Jansen,** H. Lee, E. Quintas Sanchez, R. Dawes, K. L. C. Hunt, *"Collision-Induced Dipole in Diatomic Hydrogen Pairs, Ab initio Results and Spherical Tensor Analysis"* (in preparation)

- **N. Jansen,** J. Yuzon, E. McCardle-Blunk, J.Barnes, A. Gotforth, J. Jiao, *"Non-Aqueous Synthesis of Graphene Supported Spinel Ferrite Nanoparticles,*" *Microscopy and Microanalysis*, 25(S2), 2252-2253, (2019) doi:10.1017/S1431927619011991

- **N. Jansen**, M. Loucks, S. Gilbert, C. Fleming-Dittenber, J. Egbert, K. L. C. Hunt, "*Shannon and von Neumann entropies of multi-qubit Schrödinger's cat states*," Nuclear and Mesoscopic Physics (NMP) Conference Presentation, 05/2022, awarded distinction

- **N. Jansen**, M. Loucks, S. Gilbert, C. Fleming-Dittenber, J. Egbert, K. L. C. Hunt, "*Shannon and von Neumann entropies of multi-qubit Schrödinger's cat states*," Poster, Midwest Theoretical Chemistry Conference, The Ohio State University, 06/2022

- **N. Jansen,** K. Meduri, J. Yuzon, E. McCardle-Blunk, J. Jiao, *"Control of Phase of Iron Oxide Nanoparticles,"* NSF REU Symposium Presentation, 08/2018

- **N. Jansen**, K. Meduri, J. Yuzon, J. Jiao, "*Binder Free Graphene Hybridized Fe_3O_4 Nanoparticles for Supercapacitor Applications,"* Poster, SRC Symposium, 05/2018

Instruments

- Raman spectroscopy, infrared spectroscopy, NMR spectroscopy, UV-Vis spectroscopy, GCM spectroscopy, Galvano/potentiostat, photolithography processes and Clean room procedure
- Experience with SEM and AFM

Awards/ Achievements

- *Young Presenter Award, Distinction for Presentation by Junior Researcher,* NMP Conference (2022)
- *Scholarship, Telluride School for Theoretical Chemistry,* Telluride (2021)
- *Future Academic Scholars in Teaching (FAST) Fellow,* MSU (2021)
- "*Clyde Johnson Award for Outstanding Junior in the Chemistry Department,"* PSU (2018)
- President of Student Affiliates of the American Chemical Society (SAACS), PSU (2018-2019)
- Participant in the Semiconductor Research Corporation's Undergraduate Research Mentorship Program (URMP), PSU (2017-2018)
- Participant in the NSF Nanomicroscopy Research Experience for Undergraduates (REU), PSU (2018)
- 97^{th} percentile on the national ACS Organic Chemistry test
- 5-time member of the Dean/President's list, PSU

Selected Courses

- Graduate:
  - Quantum Mechanics (CEM 991), Statistical Mechanics (CEM 992), Algebraic and Diagrammatic Methods for Many-Fermion Systems (CEM 993), Computational Physics (PHY 905), Mathematical Methods in Theoretical Physics (PHY 810)
- Undergraduate
  - Physical Chemistry Sequence, Surface Chemistry, Electronic Materials, Vector Calculus, Linear Algebra, Differential Equations, Organic Chemistry Sequence, Advanced Inorganic Chemistry, Quantitative Analysis, Bioinorganic Chemistry, Biophysics