

Kevin K. Schwarm

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Education

- Ph.D. – Mechanical Engineering** **October 2023**
Dissertation: Real-time laser absorption spectroscopy for polyfuel combustion engines
University of California, Los Angeles (UCLA) – Los Angeles, CA
Advisor: Prof. R. Mitchell Spearrin
- M.S. – Mechanical Engineering** **June 2020**
University of California, Los Angeles (UCLA) – Los Angeles, CA
- B.S. – Mechanical Engineering** **May 2016**
University of Miami – Miami, FL

Professional Experience

Jet Propulsion Laboratory – Pasadena, CA **November 2023 – Present**
Laboratory Studies and Atmospheric Observations Group

JPL Postdoctoral Fellow

- Development of miniature tunable laser spectrometers for planetary science missions
- Lead WISTLS project for water isotope analysis on the lunar surface

UCLA – Los Angeles, CA **September 2017 – October 2023**
Laser Spectroscopy & Gas Dynamics Laboratory

Graduate Researcher

- Developed novel laser absorption spectroscopy-based sensors for combustion, medical, and environmental applications
- Managed projects through full lifecycles from inception to procurement, design, manufacturing, testing and final presentation of work in peer-reviewed journals and conferences
- Coordinated with funding agencies and industry collaborators on project goals and technical reports
- Mentored undergraduate and graduate students to foster a collaborative team environment with realistic goals and tangible milestones within aggressive project timelines

Select Research Projects

UCLA – Los Angeles, CA **January 2020 – October 2023**
Adaptive Polyfuel Camless Reciprocating Engine

- Designed a laser absorption sensor utilizing multi-pass optics and fiber-coupling for cycle-resolved (10 kHz) analysis of high-temperature (>1000 K) exhaust in production reciprocating piston engines
- Integrated the sensor into a commercial IC engine (Honda EU7000is) and quantified exhaust temperature, CO and NO emissions in response to low-carbon fueling with natural gas, ammonia, and hydrogen
- Implemented minimal-size neural networks onto an FPGA for end-to-end processing of laser absorption sensor data in real-time with latencies below 100 μ s
- Designed and manufactured an electro-hydraulic camless valvetrain for deployment on the commercial IC engine for future work in optimizing performance and fuel flexibility through real-time feedback control

UCLA – Los Angeles, CA **September 2018 – December 2022**
Mid-Infrared Laser Absorption Imaging

- Developed a novel imaging diagnostic expanding mid-infrared laser absorption spectroscopy capability to high-resolution (<100 μ m) and time-resolved (2 kHz) imaging of small-scale flames
- Designed optical systems and flame burner geometries to maximize the ability to capture flame chemistry and structure given limitations in available high-speed infrared camera hardware
- Implemented diffraction filtering, machine learning and tomographic algorithms to reconstruct 2D cinematography and quantitative 3D spatial profiles of temperature and species concentrations (CO, CO₂, CH₄, C₂H₆)

- Collaborated with Opto-Knowledge engineers to develop a compact (<10 lbs, <0.5 ft³) laser absorption- and NDIR-based spectrometer for UAV deployment to measure airborne CO and CO₂ concentrations
- Quantified 3D spatial profiles (>100 m) and temporal evolution (>1 Hz resolution) of emissions over a series of active forest burns during a field campaign at the UC Berkeley Blodgett Forest Research Station
- Coordinated with academic and industry research partners at the field campaign to maximize measurement quality, evaluate complimentary sensors and analyze emissions factors of burned vegetation

- Developed a laser absorption sensor for detecting trace acetone concentrations (0.1 – 200 ppm) in human breath to monitor ketogenic diet therapy for childhood epilepsy patients
- Utilized a Herriott optical cell (238-pass) with multi-species wavelength modulation spectroscopy to increase dynamic range and correct for interference from other absorbing species in convoluted breath mixtures
- Instructed medical professionals and patients on repeatable breath sample collection for valid comparison to blood samples within a pilot clinical study

Honors and Awards

National Defense Science and Engineering Graduate (NDSEG) Fellowship	2018 – 2021
Cum Laude – University of Miami	2016
Tau Beta Pi Honor Society	2016
Pi Tau Sigma Honor Society	2014
Sigma Alpha Mu Foundation Young Scholars Program	2014

Publications

- [1] **Schwarm, K.K.**, Spearrin, R.M. (2023). Real-time FPGA-based laser absorption spectroscopy using on-chip machine learning for 10 kHz intra-cycle emissions sensing towards adaptive reciprocating engines. *Applications in Energy and Combustion Science, In Press*. <https://doi.org/10.1016/j.jaecs.2023.100231>
- [2] Wei, C., **Schwarm, K.K.**, Pineda, D.I., Spearrin, R.M. (2023). Quantitative volumetric laser absorption imaging of methane and temperature in flames utilizing line-mixing effects. *Proceedings of the Combustion Institute*. <https://doi.org/10.1016/j.proci.2022.07.092>
- [3] **Schwarm, K.K.**, Minesi, N.Q., Jeevaretanam, B., Enayati, S., Tsao, T.C., Spearrin, R.M. (2022). Cycle-resolved emissions analysis of polyfuel reciprocating engines via in-situ laser absorption spectroscopy. *Proceedings of the ASME 2022 ICE Forward Conference*. <https://doi.org/10.1115/ICEF2022-88543>
- [4] **Schwarm, K.**, Nair, A.P., Wei, C., Spearrin, R.M., Ozen, E. Gonzalez, E., Kriesel, J. (2022). Three-dimensional real-time mapping of CO and CO₂ concentrations in active forest burns with a UAV Spectrometer. In *AIAA SciTech 2022 Forum*. <https://doi.org/10.2514/6.2022-2291>
- [5] Wei, C., **Schwarm, K.K.**, Pineda, D.I., Spearrin, R.M. (2021). Learning network for laser absorption imaging in flames using mid-fidelity simulations. In *Computational Optical Sensing and Imaging, CTh5A.6*. <https://doi.org/10.1364/COSI.2021.CTh5A.6>
- [6] Wei, C., **Schwarm, K.K.**, Pineda, D.I., Spearrin, R.M. (2021). Physics-trained neural network for sparse-view volumetric laser absorption imaging of species and temperature in reacting flows. *Optics Express* 29(4), 22553-22566. <https://doi.org/10.1364/OE.427730>
- [7] Li, J., **Schwarm, K.K.**, Wei, C., Spearrin, R.M. (2021). Robust cepstral analysis at variable wavelength scan depth for narrowband tunable laser absorption spectroscopy. *Measurement Science and Technology* 32(4), 045502. <https://doi.org/10.1088/1361-6501/abcd6a>
- [8] Wei, C., **Schwarm, K.K.**, Pineda, D.I., Spearrin, R.M. (2021). Volumetric laser absorption imaging of temperature, CO and CO₂ in laminar flames using 3D masked Tikhonov regularization. *Combustion and Flame* 224, 239-247. <https://doi.org/10.1016/j.combustflame.2020.10.031>

- [9] Sanders, I.C., Bendana, F.A., Stacy, N., **Schwarm, K.K.**, Spearrin, R.M. (2021). Swirl injection in hybrid polymethylmethacrylate combustion assessed by thermochemical imaging. In *AIAA Propulsion and Energy 2021 Forum*, 3513. <https://doi.org/10.2514/6.2021-3513>
- [10] Li, J., Nair, A.P., **Schwarm, K.K.**, Pineda, D.I., Spearrin, R.M. (2020). Temperature-dependent line mixing in the R-branch of the ν_3 band of methane. *Journal of Quantitative Spectroscopy and Radiative Transfer* 255, 107271. <https://doi.org/10.1016/j.jqsrt.2020.107271>
- [11] Wei, C., **Schwarm, K.K.**, Pineda, D.I., Spearrin, R.M. (2020). 3D laser absorption imaging of combustion gases assisted by deep learning. In *Laser Applications to Chemical, Security, and Environmental Analysis, LTh5F.1*. <https://doi.org/10.1364/LACSEA.2020.LTh5F.1>
- [12] Mehta, Y., Razavian, S., **Schwarm, K.**, Spearrin, R.M., Babakhani, A. (2020). Terahertz gas-phase spectroscopy of CO using a silicon-based picosecond impulse radiator. In *Conference on Lasers and Electro-Optics, SM2F.7*. https://doi.org/10.1364/CLEO_SI.2020.SM2F.7
- [13] Wei, C., **Schwarm, K.K.**, Pineda, D.I., Spearrin, R.M. (2020). Deep neural network inversion for 3D laser absorption imaging of methane in reacting flows. *Optics Letters* 45(8), 2447-2450. <https://doi.org/10.1364/OL.391834>
- [14] **Schwarm, K.K.**, Strand, C.L., Miller, V.A., Spearrin, R.M. (2020). Calibration-free breath acetone sensor with interference correction based on wavelength modulation spectroscopy near 8.2 μm . *Applied Physics B* 126(1), 9. <https://doi.org/10.1007/s00340-019-7358-x>
- [15] Pineda, D.I., Bendana, F.A., **Schwarm, K.K.**, Spearrin, R.M. (2019). Multi-isotopologue laser absorption spectroscopy of carbon monoxide for high-temperature chemical kinetic studies of fuel mixtures. *Combustion and Flame* 207, 379-390. <https://doi.org/10.1016/j.combustflame.2019.05.030>
- [16] **Schwarm, K.K.**, Wei, C., Pineda, D.I., Spearrin, R.M. (2019). Time-resolved laser absorption imaging of ethane at 2 kHz in unsteady partially premixed flames. *Applied Optics* 58(21), 5656-5662. <https://doi.org/10.1364/AO.58.005656>
- [17] **Schwarm, K.K.**, Dinh, H.Q., Goldenstein, C.S., Pineda, D.I., Spearrin, R.M. (2019). High-pressure and high-temperature gas cell for absorption spectroscopy studies at wavelengths up to 8 μm . *Journal of Quantitative Spectroscopy and Radiative Transfer* 227, 145-151. <https://doi.org/10.1016/j.jqsrt.2019.01.029>