Dr. Kirk A. Larsen
Associate Staff Scientist
Linac Coherent Light Source - Laser Sciences Department
SLAC National Accelerator Laboratory
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Education

University of California, Berkeley - Berkeley, CA (08/2015 - 12/2020)
PhD, Applied Science and Technology
Thesis: Two-photon ionization and dissociation dynamics in atoms and molecules studied using vacuum ultraviolet laser harmonics and coincidence momentum imaging
Advisor: Prof. Roger Falcone

University of Oregon - Eugene, OR (09/2009 - 06/2014)
BS, Physics and BS, Mathematics - Cum Laude, Physics Departmental Honors

Research Experience

SLAC National Accelerator Laboratory, Linac Coherent Light Source - Laser Sciences Department
Associate Staff Scientist (11/2022 - Present)
Experience: Developing tunable few-cycle UV light sources using soliton dynamics and resonant dispersive wave emission in hollow core fibers. Primary contact for laser delivery and support at the coherent x-ray imaging (CXI) instrument at LCLS. Developing advanced photoinjector methods at LCLS for temporal x-ray pulse shaping and attosecond x-ray pulse generation at high repetition rates.
Supervisors: Dr. Joe Robinson, Prof. Ruaridh Forbes

Stanford PULSE Institute - Stanford University and SLAC National Accelerator Laboratory
Postdoctoral Scholar (01/2021 - 10/2022)
Experience: Researching electron-beam based strong-field physics and plasma based attosecond light sources at FACET-II. Developing and characterizing attosecond x-ray pump-probe techniques at LCLS and harnessing newly developed methods to study attosecond electron dynamics in gas phase systems at the time-resolved AMO (TMO) instrument at LCLS.
Supervisor: Prof. Agostino Marinelli

University of California, Berkeley and Lawrence Berkeley National Laboratory
Graduate Student Researcher (06/2015 - 12/2020)
Experience: Vacuum ultraviolet driven two-photon ionization and dissociation dynamics in isolated atoms and small molecules probed using femtosecond high harmonic pulses and coincidence 3-D momentum imaging. One-photon single and double photoionization and dissociation dynamics in small molecules studied using coincidence 3-D momentum imaging and synchrotron radiation.
Supervisors: Prof. Roger Falcone, Dr. Daniel Slaughter, Dr. Thorsten Weber

Lawrence Berkeley National Laboratory

Department of Energy SULI Research Intern and Research Assistant (08/2014 - 05/2015)
Experience: Interrogating excited state gas phase molecular dynamics with ultrafast multidimensional spectroscopy, transient absorption spectroscopy, soft x-ray synchrotron radiation, and velocity map imaging.
Supervisor: Dr. Daniel Slaughter

Talks and Presentations

-LCLS Scientific Research Division Science Bi-Weekly Meeting (2025)
Invited: Measurement of a record 13 fs IRF at CXI enabled by 8 fs optical laser pulses generated via spectral broadening and post compression
-SSRL/LCLS Users' Meeting (2024)
Lasers for LCLS gas phase experiments
-Frontiers in Optics + Laser Science (FiO, LS) (2023)
X-ray polarimetry of the 14.6 Å laser transition in core-ionized neon
-SSRL/LCLS Users' Meeting (2023)
Ultrashort UV-Vis laser development approaches and progress
-Lawrence Berkeley National Laboratory WD&E SULI Internship - Scientific Outreach Talk (2022)
Invited: There's plenty of time in a short time: what's going on at 1e-18 seconds?
-SLAC Photon Science Seminar (2020)
Invited: Exploring electron-electron correlation and continuum electronic structure in atoms and molecules
-51st Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics (2020)
Energy- and angle-resolved non-resonant 2-photon single valence ionization of N_2 using 9.3 eV femtosecond pulses
-The 40th International Conference on Vacuum Ultraviolet and X-ray Physics (2019)
Angularly resolved non-resonant two-photon single ionization of Ar using 9.3 eV photons produced via high harmonic generation
-49th Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics (2018)
Nuclear Dynamics of $H^+ + H^+$ Fragmentation in NH_3 Following Direct Single-Photon Double Photoionization at 61.54eV

Honors and Awards

-Stanford PULSE Institute Ultrafast X-ray Summer School - Award for Best Mock XFEL Beamtime Proposal (2018)
-University of California, Berkeley, Applied Science and Technology Summer Stipend Awardee (2016): $10,000
-University of Oregon Physics Departmental Honors Graduate (2013)
-University of Oregon Cum Laude Honors Graduate (2013)
-University of Oregon Dean's List: Winter 2010, Spring 2010, Fall 2011
-University of Oregon Dean's Scholarship (2009-2013)

Publications

34. Gabalski, I., Green, A. E., Lenzen, P.,… **Larsen, K. A.**,… and Glownia, J. M. "Imaging valence electron rearrangement in a chemical reaction using hard x-ray scattering." *Physical Review Letters* (in review).

33. Green, A. E., Liu, Y., Allum, F., Graßl, M., Lenzen, P.,... **Larsen, K.A.,** ... and Wolf, T. J. A. “Imaging the Photochemistry of Cyclobutanone using Ultrafast Electron Diffraction: Experimental Results.” *Journal of Chemical Physics* (in review)

32. Driver, T., Guo, Z., Isele, E., Grell, G., Ruberti, M.,... **Larsen, K.A.**, ... and Cryan, J. P., “Attosecond Coherent Electron Motion in a Photoionized Aromatic Molecule.” *Nature* (in review)

31. Ji, J. B., Guo, Z., Driver, T., Trevisan, C. S., Cesar, D.,... **Larsen, K.A.**, ... and Wörner, H. J. "Attosecond Core-level Photoionization Delays of Aromatic Molecules." *Nature Chemistry* (in review)

30. Robles, R. R., **Larsen, K. A.**, Cesar, D., Driver, T., Duris, J., Franz, P., ... and Marinelli, A., "Spectrotemporal shaping of attosecond x-ray pulses with a fresh-slice free-electron laser." *Physical Review Letters* 134: 115001 (2025)

29. Wang, J., Driver, T., Franz, P. L., Kolorenč, P.,…**Larsen, K.A.,** ... and Cryan, J. P. (2025). “Probing Electronic Coherence between Core-Level Vacancies at Different Atomic Sites.” *Physical Review X* 15.1: 011008 (2025)

28. Emma, C., Majernik, N., Swanson, K., Ariniello, R.,... **Larsen, K.A.**, ... and Yocky, G., “Experimental generation of extreme electron beams for advanced accelerator applications.” *Physical Review Letters* 134: 085001 (2025)

27. Borne, K., ONeal, J. T., Wang, J., Isele, E., Obaid, R.,... **Larsen, K.A.**, ... and Driver, T. "Design and Performance of a Magnetic Bottle Electron Spectrometer for High-Energy Photoelectron Spectroscopy." *Rev. Sci. Instrum.* 95 (12): 125110 (2024)

26. Li, S., Zhang, Z., Alverson, S., Cesar, D., Driver, T.,... **Larsen, K.A.**, ... and Marinelli, A., “‘Beam à la carte’: Laser heater shaping for attosecond pulses in a multiplexed x-ray free-electron laser.” *Appl. Phys. Lett.* 125 19: 191101 (2024)

25. Alexander, O., Egun, F., Rego, L., Gutierrez, A.M., Garratt, D.,... **Larsen, K.A.**,... and Marangos, J.P., "Attosecond impulsive stimulated X-ray Raman scattering in liquid water." *Science Advances* 10.39: eadp0841 (2024)

24. Ma, L., Goff, N., Carrascosa, A.M., Nelson, S., Liang, M., Cheng, X.,... **Larsen, K.A.**, … and Weber, P.M., "Quantitative x-ray scattering of free molecules." *Journal of Physics B: Atomic, Molecular and Optical Physics* 57.20: 205602 (2024)

23. Iskandar, W., Rescigno, T.N., Orel, A.E., **Larsen, K.A.**, Severt, T., Streeter, Z.L., Jochim, B., Griffin, B., Call, D., Davis, V. and McCurdy, C.W., … and Weber Th., "Tracking ultrafast non-adiabatic dissociation dynamics of the deuterated water dication molecule." *The Journal of chemical physics* 161.4 (2024)

22. Hessami, R., Morgan, J., Robles, R., **Larsen, K.A.**, Marinelli, A. and Emma, C., "Wavelength scaling and multicolor operation of a plasma-driven attosecond x-ray source via harmonic generation." *Physical Review Accelerators and Beams* 27.7: 070701 (2024)

21. Franz, P., Li, S., Driver, T., Robles, R.R., Cesar, D., Isele, E., Guo, Z., Wang, J., Duris, J.P., **Larsen, K.A.**, and Glownia, J.M.,... Cryan, J.P., and Marinelli, A., "Terawatt-scale attosecond X-ray pulses from a cascaded superradiant free-electron laser." *Nature Photonics* 1-6 (2024)

20. Guo, Z., Driver, T., Beauvarlet, S., Cesar, D., Duris, J., Franz, P.L., Alexander, O., Bohler, D., Bostedt, C., Averbukh, V. and Cheng, X., … **Larsen, K.A.**, ... Cryan, J.P., and Marinelli, A., "Experimental demonstration of attosecond pump–probe spectroscopy with an X-ray free-electron laser." *Nature Photonics* 1-7 (2024)

19. Li, S., Lu, L., Bhattacharyya, S., Pearce, C., Li, K., Nienhuis, E.T., Doumy, G., Schaller, R.D., Moeller, S., Lin, M.F.,

Dakovski, G., Hoffman D., Garratt D., **Larsen K.A.**, ... and Young L., "Attosecond-pump attosecond-probe x-ray spectroscopy of liquid water." *Science* 383.6687: 1118-1122 (2024)

18. Zhang, H., Gilevich, S., Miahnahri, A., Alverson, S.C., Brachmann, A., Duris, J., Paris, F., Fry, A., Hirschman, J., **Larsen, K.A.**, ... and Carbajo, S. "The Linac Coherent Light Source II photoinjector laser infrastructure." *High Power Laser Science and Engineering* 12 (2024)

17. **Larsen, K.A.**, Borne, K., Obaid, R., Kamalov, A., Liu, Y., Cheng, X., James, J., Driver, T., Li, K., Liu, Y. and Sakdinawat, A., David C., Wolf T.J.A., Cryan J.P., Walter P., and Lin M.F., "Compact single-shot soft X-ray photon spectrometer for free-electron laser diagnostics." *Optics Express* 31.22: 35822-35834 (2023)

16. Iskandar, W., Rescigno, T. N., Orel, A. E., Severt, T., **Larsen, K. A.**, Streeter, Z. L., Jochim, B., Griffin, B., Call, D., Davis, V., McCurdy, C. W., Lucchese, R. R, Williams, J. B., Ben-Itzhak, I., Slaughter, D. S. and Weber, Th., "Efficiency of charge transfer in changing the dissociation dynamics of OD+ transients formed after the photo-fragmentation of D2O." *The Journal of Chemical Physics* 159.9 (2023)

15. **Larsen, K.A.**, Bello, R.Y., Lucchese, R.R., McCurdy, C.W., Slaughter, D.S. and Weber, T., "Strongly coupled intermediate electronic states in one-color two-photon single valence ionization of O2." *The Journal of Chemical Physics* 158.2 (2023)

14. Iskandar, W., Rescigno, T.N., Orel, A.E., **Larsen, K.A.**, Griffin, B., Call, D., Davis, V., Jochim, B., Severt, T., Williams, J.B. and Ben-Itzhak, I., "Atomic autoionization in the photo-dissociation of super-excited deuterated water molecules fragmenting into D++ O++ D." *Physical Chemistry Chemical Physics* 25.32: 21562-21572 (2023)

13. Severt, T., Streeter, Z. L., Iskandar, W., **Larsen, K. A.**, Gatton, A., Trabert, D., Jochim, B., Griffin, B., Champenois, E. G., Brister, M. M., Reedy, D., Call, D., Strom, R., Landres, A. L., Dorner, R., Williams, J. B., Slaughter, D. S., Lucchese, R. R., Weber, T., McCurdy, C. W., Ben-Itzhak, I., "Step-by-step, state-selective tracking of fragmentation dynamics of water dications by momentum imaging," *Nature Communications* 13.1: 5146 (2022)

12. Nadgir, A., Thurston, R., **Larsen, K. A.**, Shivaram, N., Brister, M. M., & Slaughter, D. S., "SILIA: software implementation of a multi-channel, multi-frequency lock-in amplifier for spectroscopy and imaging applications," *Measurement Science and Technology*, *32*.12: 125501 (2021)

11. Slaughter, D. S., Sturm, F. P., Bello, R. Y., **Larsen, K. A.**, Shivaram, N., McCurdy, C. W., Lucchese, R. R., Martin, L., Hogle, C. W., Murnane, M. M., Kapteyn, H. C., Ranitovic, P., Weber, T., "Nonequilibrium dissociative dynamics of D2 in two-color, few-photon excitation and ionization," *Physical Review Research* 3.3: 033191 (2021)

10. **Larsen, K. A.**, Bello, R. Y., Lucchese, R. R., Rescigno, T. N., McCurdy, C. W., Slaughter, D. S., Weber, T., "The role of dipole-forbidden autoionizing resonances in non-resonant one-color two-photon single ionization of N2," *Physical Review A* 102.6: 063118 (2020)

9. **Larsen, K. A.**, Rescigno, T. N., Severt, T., Streeter, Z. L., Iskandar, W., Heck, S., Gatton, A. Champenois, E. G., Strom, R., Jochim, B., Reedy, D., Call, D., Moshammer, R., Dorner, R., Landres, A. L., Williams, J. B., McCurdy, C. W., Lucchese, R. R., Ben-Itzhak, I., Slaughter, D. S., Weber, T., "Photoionization and dissociation dynamics of the $NH_2^+ + H^+$ and $NH^+ + H^+ + H$ fragmentation channels upon single-photon double ionization of NH_3 at 61.5 eV," *Journal of Physics B: Atomic, Molecular and Optical Physics* 53.24: 244003 (2020)

8. **Larsen, K. A.**, Rescigno, T. N., Severt, T., Streeter, Z. L., Iskandar, W., Heck, S., Gatton, A. Champenois, E. G., Strom, R.,

Jochim, B., Reedy, D., Call, D., Moshammer, R., Dorner, R., Landres, A. L., Williams, J. B., McCurdy, C. W., Lucchese, R. R., Ben-Itzhak, I., Slaughter, D. S., Weber, T., "Photoelectron and fragmentation dynamics of the H+ + H+ dissociative channel in NH3 following direct single-photon double ionization," *Physical Review Research* 2.4: 043056 (2020)

7. **Larsen, K. A.**, Lucchese, R. R., Slaughter, D. S., Weber, T., "Distinguishing resonance symmetries with energy-resolved photoion angular distributions from ion-pair formation in O2 following two-photon absorption of a 9.3 eV femtosecond pulse," *The Journal of Chemical Physics* 153.2: 021103 (2020)

6. **Larsen, K. A.**, Slaughter, D. S., Weber, T., "Angle-resolved nonresonant two-photon single ionization of argon using 9.3 eV photons produced via high-order harmonic generation," *Physical Review A* 101.6: 061402 (2020)

5. Heck, S., Gatton, A., **Larsen, K. A.**, Iskandar, W., Champenois, E. G., Strom, R., Landers, A. L., Reedy, D., Daily, C., Williams, J. B., Severt, T., Jochim, B., Ben-Itzhak, I., Moshammer, R., Dorner, R., Slaughter, D.S., Weber, T., "Symmetry breaking in the body-fixed electron emission pattern due to electron-retroaction in the photodissociation of H2+ and D2+ close to threshold," *Physical Review Research* 1.3: 033140 (2019)

4. Iskandar, W., Gatton, A. S., Gaire, B., Sturm, F. P., **Larsen, K. A.**, Champenois, E. G., Shivaram, N., Moradmand A., Williams, J. B., Berry, B., Severt, T., Ben-Itzhak, I., Metz, D., Sann, H., Weller, M., Schoeffler M., Jahnke, T., Dorner, R., Slaughter, D. S., Weber, T., "Tracing intermolecular Coulombic decay of carbon-dioxide dimers and oxygen dimers after valence photoionization," *Physical Review A* 99.4: 043414 (2019)

3. Champenois, E. G., Greenman, L., Shivaram, N., Cryan, J. P., **Larsen, K. A.**, Rescigno, T. N., McCurdy, C. W., Belkacem, A., Slaughter, D. S., "Ultrafast photodissociation dynamics and nonadiabatic coupling between excited electronic states of methanol probed by time-resolved photoelectron spectroscopy," *The Journal of Chemical Physics* 150.11: 114301 (2019)

2. **Larsen, K. A.**, Trevisan, C. S., Lucchese, R. R., Heck, S., Iskandar, W., Champenois, E. G., Gatton, A., Moshammer, R., Strom, R., Severt, T., Jochim, B., Reedy, D., Weller, M., Landers, A. L., Williams, J. B., Ben-Itzhak I., Dorner, R., Slaughter, D. S., McCurdy, C. W., Weber, T., Rescigno, T. N., "Resonance signatures in the body-frame valence photoionization of CF4," *Physical Chemistry Chemical Physics* 20.32: 21075-21084 (2018)

1. **Larsen, K. A.**, Cryan, J. P., Shivaram, N., Champenois, E. G., Wright, T. W., Ray, D., Kostko, O., Ahmed, M., Belkacem, A., Slaughter, D. S., "VUV and XUV reflectance of optically coated mirrors for selection of high harmonics," *Optics Express* 24.16: 18209-18216 (2016)

Academic Mentorship

PhD Students:
-Jose Godinez, DOE–SCGSR SLAC Intern (2024 | Chemistry Dept USC)
-Chris Lantigua, DOE–SCGSR SLAC Intern (2024 | Physics Dept UCF)
-Paris Franz (2022-present | Applied Physics Dept Stanford)
-Rafi Hessami (2021-present | Applied Physics Dept Stanford)
-River Robles (2021-present | Applied Physics Dept Stanford)

Undergraduate Students:
-Rose Wilson, SLAC/LCLS Intern (2024 | Chemistry Dept ASU)
-Chelsea Kincaid, SLAC/LCLS Intern (2023-present | Physics Dept UCF/OSU)

-Amrut Nadgir, UC Berkeley Undergraduate (2018-2020 | Physics Dept UC Berkeley)
-Ryland Wala, LBNL SULI Intern (2018 | Physics Dept ASU)
-Tahiyat Rahman, LBNL SULI Intern (2017-2018 | Physics Dept UW)

Academic Service

-Peer Reviewer: Journal of Physics B: Atomic, Molecular and Optical Physics
-Organization and coordination of the LBNL Monthly AMOS Forum (2016-2019)
-LBNL WD&E SULI Internship - Graduate Student Panel Member (2015-2019)
-University of California, Berkeley Graduate Student Assembly Co-Delegate (2015)