Gerard Lawler

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Education

2017 - present PhD in Physics (in progress) at **University of California, Los Angeles**
2016 - 2017 MS in Physics at **University of California, Los Angeles**
2015 - 2020 Coursework from **US Particle Accelerator School** (4 courses)
2012 - 2016 BA in Physics from **Boston Univeristy**

Summary

Graduate student in physics specializing in the development of novel techniques for increasing electron photoinjector brightness particularly for reducing the size of free electron lasers (FELs). I have additional interest in light-matter interaction and radio-frequency engineering, especially in the context of micron to nanometer scale structures and their effects on field emission of electrons.

Research Experience

Particle Beam Physics Laboratory (PBPL), UCLA Aug 2016 - present

- Cryogenic hardware design for RF cavity accelerator
- Laser optics and vacuum engineering for high harmonic generation experiment
- Teaching and management of up to 6 undergraduate research projects
- Plasmonic and beam dynamics simulations for surface studies involved in high harmonic generation
- Novel multipole magnet design
- Fabrication of nanoscales structures with anisotropic wet etches of silicon wafers

AEgIS Collaboration, CERN 2015 - 2016

- Antiproton beam dynamics simulations
- Ion optics design and manufacturing: incl. einzel lenses, hemispheric analyzers, and Penning traps

Center for Space Physics, BU 2012 - 2015

- Data mining and analysis for characterization of daily Martian ionosphere measurements
- semi-empirical modeling of peak electron density and totel electron content of Martian ionosphere
- web design and maintenance of Mars International Reference Ionosphere (MIRI) website

Projects

MOTHRA Laboratory Link to Webpage

Worked on commissioning of the new Multi-Objective Testing of High Gradient Radiofrequency Accelerators (MOTHRA) laboratory space on the site of the former UCLA cyclotron lab. The space includes a 30 in concrete bunker and associated laser clean room to perform studies relevant to the development of ultra high gradient RF accelerators and infrascture development towards an ultra compact xray free electron laser.

SAMURAI Laboratory Link to Webpage

Worked on development of an electron linear accelerator test facility located on UCLA's southwest campus in Westwood called SAMURAI (Spontaneous Amplified Micro-Undulator Radiation And Interactions).

Beam Production and Cathode Development Read more

Electrons used in linear accelerators are generated via materials known as cathodes. At PBPL we study emission physics from a theoretical perspective in order to study cathode behavior in order to improve beam brightness, current, and other figures of merit. Developed several concepts for higher brightness photo and field emission cathodes.

MIRI Link to Homepage

The Mars International Reference Ionosphere (MIRI) is a semi empirical modeling reference for Martian ionosphere properties.

Teaching Experience

UCLA Department of Physics and Astronomy, TA 2019

- Upper division lab for physics majors
- Aided in curriculum redesign focusing more on scripting and data analysis with statistical software packages

Boston University Physics Department, LA 2014 - 2015

- Ran discussions with graduate teaching assistant, and held independent office hours to assist students
- Taught introductory electromagnetism course for pre-medical students and advanced lab course for graduate students

Boston University Physics Department, Lab technician 2012 - 2015

- Maintained physics demonstration stock room for department.
- Designed and created new demonstrations of physical phenomenon for classes and special events.

Museum of Science Boston, SciCORE Intern 2011

- Educated visitors and taught/interpretated exhibits for them.
- Designed exhibit displays and interpretations for use with the general public.
- Trained new staff and volunteers

Publications

Mendillo, Michael et al. (2013). "A new semiempirical model of the peak electron density of the Martian ionosphere". In: *Geophysical Research Letters* 40.20, pp. 5361–5365.

Mendillo, M et al. (2015). "The equivalent slab thickness of Mars' ionosphere: Implications for thermospheric temperature". In: *Geophysical Research Letters* 42.9, pp. 3560–3568.

Pacifico, N. et al. (2016). "Direct detection of antiprotons with the Timepix3 in a new electrostatic selection beamline". In: *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* 831. Proceedings of the 10th International "Hiroshima" Symposium on the Development and Application of Semiconductor Tracking Detectors,

pp. 12–17. ISSN: 0168-9002. DOI: https://doi.org/10.1016/j.nima.2016.03.057. URL: https://www.sciencedirect.com/science/article/pii/S0168900216300808.

Rosenzweig, J.B., A. Cahill, et al. (2018). "Ultra-high brightness electron beams from very-high field cryogenic radiofrequency photocathode sources". In: *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* 909. 3rd European Advanced Accelerator Concepts workshop (EAAC2017), pp. 224–228. ISSN: 0168-9002. DOI: https://doi.org/10.1016/j.nima.2018.01.061. URL: https://www.sciencedirect.com/science/article/pii/S0168900218300780.

Rosenzweig, J.B., F. Filippi, et al. (2018). "Adiabatic plasma lens experiments at SPARC". In: *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* 909. 3rd European Advanced Accelerator Concepts workshop (EAAC2017), pp. 471–475. ISSN: 0168-9002. DOI: https://doi.org/10.1016/j.nima.2018.02.016. URL: https://www.sciencedirect.com/science/article/pii/S0168900218301669.

Roussel, R., G. Andonian, M. Conde, et al. (2018). "Measurement of transformer ratio from ramped beams in the blowout regime". In: *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* 909. 3rd European Advanced Accelerator Concepts workshop (EAAC2017), pp. 130–133. ISSN: 0168-9002. DOI: https://doi.org/10.1016/j.nima.2018.02.002. URL: https://www.sciencedirect.com/science/article/pii/S0168900218301529.

Lawler, Gerard, Kunal Sanwalka, et al. (2019). "Electron Diagnostics for Extreme High Brightness Nano-Blade Field Emission Cathodes". In: *Instruments* 3.4. ISSN: 2410-390X. DOI: 10.3390/instruments3040057. URL: https://www.mdpi.com/2410-390X/3/4/57.

Mann, Joshua et al. (2019). "1D Quantum Simulations of Electron Rescattering with Metallic Nanoblades". In: *Instruments* 3.4. ISSN: 2410-390X. DOI: 10.3390/instruments3040059. URL: https://www.mdpi.com/2410-390X/3/4/59.

Roussel, Ryan et al. (2019). "Externally Heated Hollow Cathode Arc Plasma Source for Experiments in Plasma Wakefield Acceleration". In: *Instruments* 3.3. ISSN: 2410-390X. DOI: 10.3390/instruments3030048. URL: https://www.mdpi.com/2410-390X/3/3/48.

Rosenzweig, J B et al. (Sept. 2020). "An ultra-compact x-ray free-electron laser". In: *New Journal of Physics* 22.9, p. 093067. DOI: 10.1088/1367-2630/abb16c. URL: https://dx.doi.org/10.1088/1367-2630/abb16c.

Roussel, R., G. Andonian, W. Lynn, et al. (Jan. 2020). "Single Shot Characterization of High Transformer Ratio Wakefields in Nonlinear Plasma Acceleration". In: *Phys. Rev. Lett.* 124 (4), p. 044802. DOI: 10.1103/PhysRevLett.124.044802. URL: https://link.aps.org/doi/10.1103/PhysRevLett.124.044802.

Fukasawa, Atsushi et al. (2021). "Advanced Photoinjector Development at the UCLA SAMURAI Laboratory". In.

Lawler, GE, Atsushi Fukasawa, et al. (2021). "Rf testbed for cryogenic photoemission studies". In.

Lawler, GE et al. (2021). "Cryogenic Component and Material Testing for Compact Electron Beamlines". In.

Majernik, Nathan et al. (2021). "Demonstration FELs Using UC-XFEL Technologies at the SAMURAI Laboratory". In.

Mann, Joshua, G Lawler, et al. (2021). "Simulations of Nanoblade-Enhanced Laser-Induced Cathode Emissions and Analyses of Yield, MTE, and Brightness". In.

Nicks, Bradley Scott et al. (2021). "High-Density Dynamics of Laser Wakefield Acceleration from Gas Plasmas to Nanotubes". In: *Photonics* 8.6. ISSN: 2304-6732. DOI: 10.3390/photonics8060216. URL: https://www.mdpi.com/2304-6732/8/6/216.

Sakai, Y et al. (2022). "Introduction of Westwood Linear Accelerator Test Facility in University of California Los Angeles". In: *Proc. IPAC'22*, pp. 1085–1088.

Lawler, Gerard, Atsushi Fukusawa, et al. (n.d.). "CrYogenic Brightness-Optimized Radiofrequency Gun (CYBORG)". In: ().

Skills

Programming	Python, C/C++, JAVA, Fortran, IDL, Matlab, Mathematica, LaTeX
Other Software	HFSS, CST, SolidWorks, Lumerical, IDL, ROOT, Matlab, Mathematica, LabVIEW
Operating Systems	Linux (Ubuntu, CentOS, Debian), Windows
Nanofabrication	Photomask layout and write, spin coating, photolithography, sputtering, plasma-enhanced chemical vapor deposition
Electronics	Microcontrollers, signal processing, robotics, fast electronics

Student Advising

Jake Parsons, *UCLA Post-Bac Researcher* Jan 2021 - present

Developed cryogenic testing infrastructure and Cband RF power infrastructure at UCLA Mothra laboratory. Several proceedings contributions authored and publication in progress.

Nathan Montanez, *UCLA Undergraduate* Jan 2022 - present

Trained in nanofabrication procedures in coordination with UCLA Nanolab. Data analysis of nanoblade cathode measurements. Developed additional calibration tests for diagnostics. Developing nanofabrication recipe modifications.

Arathi Suraj, *UCLA Undergraduate* Jan 2021 - 2022

Developed testing infrastructure for novel solenoid development and assisted in development of novel solenoid magnets for electron beam diagnostics in UCLA Mothra laboratory.

Oliver Shao, *UCLA Undergraduate* 2019-2020

Performed high frequency cavity simulations using HFSS and magnet simulation of novel pole shape leading to conference proceedings contribution.

Victor Yu, *UCLA Undergraduate* Jan 2018 - 2021

Trained in nanofabrication procedures in coordination with UCLA Nanolab. Manufactured several generations of nanoblade patterned field emission cathodes for characterisation diagnostics. Developed electron beam diagnostics for nanoblade cathodes. Developed two novel cathodes based on AMO techniques leading to multiple provisional patents.

River Robles, *UCLA Undergraduate* Jan 2018 - 2020

Trained in nanofabrication procedures in coordination with UCLA Nanolab. Manufactured several generations of nanoblade patterned field emission cathodes for characterisation diagnostics.

Yumeng Zhuang, *UCLA Undergraduate* 2018-2019

Ran beam dynamics simulations using C++ library Ion Beam Simulator and designed beam optics and diagnostic elements for low energy ($<$ 1keV) electrons from novel cathodes.

Kunal Sanwalka, *UCLA Undergraduate* 2017 - 2019

Ran beam dynamics simulations using GPT and designed beam optics and diagnostic elements for low energy (< 1keV) electrons from novel cathodes.

Conferences and Workshops

MeVArc22, Contributed Talk 2022

Title: *High Gradient CrYogenic Brightness-Optimized Radiofrequency Gun (CYBORG) Test Bed*

NAPAC22, Invited Contributed Talk 2022

Title: *Development of Nanopatterned Strong Field Emission Cathodes*

NAPAC22, Poster Talk 2022

Title: *Cyborg Beamline Development Updates*

NAPAC22, Poster Talk 2022

Title: *Design of a High-Power RF Breakdown Test for a Cryocooled C-Band Copper Structure*

NAPAC22, Poster Talk 2022

Title: *Nanopatterned Cathodes*

IPAC22, Poster Talk 2022

Title: *Emittance Measurements of Nanoblade-Enhanced High Field Cathode*

IPAC22, Poster Talk 2022

Title: *Introduction of Westwood Linear Accelerator Test Facility in University of California Los Angeles*

IPAC22, Poster Talk 2022

Title: *Temperature Dependent Effects on RF Surface Resistivity*

IPAC22, Poster Talk 2022

Title: *CrYogenic Brightness-Optimized Radiofrequency Gun (CYBORG)*

IPAC22, Poster Talk 2022

Title: *Temperature Dependent Effects on Quality Factor in C-band RF Cavities*

HG22, Invited Talk 2022

Title: *UCLA Breakdown & HG Research Updates*

HG22, Invited Talk 2022

Title: *CrYogenic Brightness-Optimized Radiofrequency Gun (CYBORG)*

IPAC21, Poster Talk 2021

Title: *RF Testbed for Cryogenic Photoemission Studies*

IPAC21, Poster Talk 2021

Title: *Initial Nanoblade-Enhanced Laser-Induced Cathode Emission Measurements*

IPAC21, Poster Talk 2021

Title: *Cryogenic Component and Material Testing for Compact Electron Beamlines*

USPAS20 Winter Session 2020

Course Title: *Particle Driven Wakefield Accelerators; High Brightness Electron Injectors and Applications*

2019 NSF STC Professional Development Workshop 2019

Student representative for NSF Center for Bright Beams

Canadian-American-Mexican Graduate Student Physics Conference, Poster Talk 2019

Title: *Electron Diagnostics for Extreme High Brightness Nano-Blade Field Emission Cathode*

Physics and Applications of High Brightness Beams Workshop 2019

Title: *Electron Diagnostics for Extreme High Brightness Nano-Blade Field Emission Cathode*

USPAS18 Winter Session 2019

Course Title: *Advanced Accelerator Physics*

Joint-US-CERN-Japan-Russia International Accelerator School 2017

Topic *RF Technologies*

APS April Meeting 2017

Title *Generating a Reduced-energy Antiproton beam using Channeling Electrostatic elements (GRACE)*

USPAS16 Summer Session 2016

Course Title: *Self-Consistent Simulations of Beam and Plasma Systems; Unifying Physics of Accelerators, Lasers and Plasma Synergy and Bridges*

USPAS15 Summer Session 2015

Course Title: *Fundamentals of Accelerator Physics and Technology with Simulations and Measurements Lab*

Professional Organization

2018-present	**IEEE**, Nuclear and Plasma Sciences Society; Photonics Society; Young Professionals
2018-present	**SPIE**
2016-present	**APS**,Physics of Beams (DPB); Plasma Physics (DPP); Physics and Society (FPS); Laser Science (DLS); International Physics (FIP); Industrial and Applied Physics (FIAP); Graduate Student Affairs (FGSA); Far West Section (FWS); Early Career Scientists (FECS)