# EDUCATION

**University of Maryland, College Park** College Park, Maryland

*Doctor of Philosophy, May 2017* June 2011 – May 2017

Department: Physics

Focus: Advanced Accelerator Concepts

Advisor: Prof. Howard Milchberg

**Rutgers University** New Brunswick, New Jersey

*Bachelor of Science, May 2011* May 2010 – May 2011

Major: Physics / Minor: Mathematics

*Bachelor of Science, May 2010* August 2006 – May 2010

Major: Chemical Engineering / Minor: Physics

Honors: Summa cum Laude

# PERTINENT SKILLS

* **High intensity pulsed laser systems.** Experienced in the maintenance and operation of a variety of pulsed laser systems including mode-locked oscillators, regenerative amplifiers, and chirped pulse amplification systems. Experienced operator and caretaker of several high-power pulsed laser systems:
  + ***Coherent Astrella.*** (1 kHz, 800 nm, 30 fs, 7 mJ)

High-repetition rate ultrashort Ti:Sapphire laser.

* + ***Light Conversion TOPAS Prime.*** (1 kHz, 1.2-2.6 µm, 30 fs, 400-900 µJ)

Tunable mid-infrared optical parametric amplifier pumped by the Astrella.

* + ***Coherent 25 TW Laser.*** (10 Hz, 800 nm, 40 fs, 1 J)

Custom Ti:Sapphire laser including multiple Q-switched Nd:YAG pump lasers.

* + ***Mode-locked Nd:YAG Laser.*** (10 Hz, 1064 nm, 140 ps, 1 J)

Legacy flashlamp pumped Nd:YAG laser with a mode-locked oscillator.

* **Nonlinear optics in solids, gasses, and plasmas.**Experienced in the application of intense lasers to drive nonlinear optical processes:
  + ***Single-Cycle THz Generation.*** Experienced with the generation of ultrabroadband THz radiation by optical rectification - experiment and theory.
  + ***THz Characterization.*** Experiencedwith the detection and characterization of ultrabroadband THz radiation.
  + ***Laser Wakefield Acceleration.*** Experienced with the interaction of high-energy laser pulses with gas targets and the generation of electrons by laser wakefield acceleration.
* **Linear and singular optics.**Experience modeling and measuring the linear behavior of light under novel conditions:
  + ***Ultrabroadband Pulsed Beam Propagation.*** Experienced at modeling multioctave, single- and sub-cycle pulsed beam behavior.
  + ***Spatiotemporal Optical Vortices.*** Experienced with spatiotemporal optical vortices arizing in linear and nonlinear systems.
* **Particle Accelerator Operation.** Experienced with accelerator design and particle detection:
  + ***LINAC Operation*.** Certified operator of kilowatt-class electron LINAC at University of Maryland Radiation Facilities.
  + ***Accelerator design.*** Experienced with the design of accelerators and beam diagnostics.
* **Mentorship.** Developed projects for and mentored three undergraduates through the DOE Science Undergraduate Laboratory Internship (SULI) program.

# RESEARCH EXPERIENCE

**Linac Systems Physicist** July 2020– Present  
Superconducting RF Group  
Spallation Neutron Source  
Oak Ridge National Laboratory

**Postdoctoral Researcher** August 2018– July 2020  
Linac Systems Group  
Spallation Neutron Source  
Oak Ridge National Laboratory

**Faculty Research Assistant/Postdoctoral Research Assistant** March 2017 – August 2018  
With Prof. Timothy Koeth  
A. James Clark School of Engineering - Materials Science and Engineering  
University of Maryland, College Park

**Graduate Research Assistant** June 2011 – March 2017  
With Prof. Howard Milchberg  
Institute for Research in Electronics and Applied Physics (IREAP)  
University of Maryland, College Park

**Experimentation/Design**

* ***Single-Cycle THz Radiation.*** Independently designed and implemented the generation of ultrabroadband THz radiation by optical rectification of ultrashort mid-infrared laser pulses in organic crystals. Characterized ultrabroadband THz radiation spatial and temporal characteristics by novel variations on electro-optic sampling techniques. (*ongoing research*)
* ***Advanced Accelerator Concepts.*** Led experiments studying high repetition rate laser-based electron and ion acceleration. Designed and fabricated versatile charged particle spectrometer for the detection of electrons and protons.
* ***Laser Target Design.*** Improved upon current state of the art gas jet nozzle designs used for generating centimeter scale cluster jet targets enabling the production of plasma waveguides with improved stability and coupling properties. Designed, fabricated, and characterized unique targets for producing 100 micron scale near-critical density plasmas and centimeter-length hollow plasma channels.
* ***Permanent Magnet Electron Spectrometer.*** Designed, fabricated, and implemented a permanent magnet spectrometer with interchangeable magnets to characterize electrons generated by laser wakefield acceleration.
* ***LINAC Beams and Dielectric Breakdown.*** Operated an electron LINAC to study the dielectric breakdown of solids exposed to energetic particles.
* ***Magnetic Fields for a 12” Cyclotron.*** Designed novel magnetic pole-tips for improved beam confinement in a 12” cyclotron.

**Theory/Computation**

* ***Simulation of lasers in plasmas.*** Performed particle-in-cell simulations of laser-based particle acceleration.
* ***Nonlinear Optical Vortex Formation.*** Studied the formation of optical vortices by laser driven relativistic particle motion.

# PROFESSIONAL SERVICE

* Refereed articles for MDPI, Optica, and AIP journals.
* Refereed DOE SBIR proposals.
* Served on search committee for research safety staff at University of Maryland.

# PUBLICATIONS

*Peer Reviewed Journals*

* **G.A. Hine**, M. Doleans, “Intrinsic spatial chirp of subcycle terahertz pulsed beams” Phys. Rev. A **104**, 032229 (2021).
* **G.A. Hine**, A.J. Goers, L. Feder, J.A. Elle, S.J. Yoon, and H.M. Milchberg. “Generation of axially modulated plasma waveguides using a spatial light modulator.” Optics Letters **41**(15), 3427 (2016).
* R. J. Shalloo, C. Arran, A. Picksley, A. von Boetticher, L. Corner, J. Holloway, **G. Hine**, J. Jonnerby, H. M. Milchberg, C. Thornton, R. Walczak, and S. M. Hooker, “Low-density hydrodynamic optical-field-ionized plasma channels generated with an axicon lens.” Physical Review Accelerators and Beams **22**, 041302 (2019).
* F. Salehi, A.J. Goers, **G.A. Hine**, L. Feder, D. Kuk, K.Y. Kim, and H.M. Milchberg. “MeV electron acceleration at 1 kHz with < 10mJ laser pulses.” Optics Letters **42**, 215-218 (2017).
* A.J. Goers, **G.A. Hine**, L. Feder, B. Miao, F. Salehi, and H.M. Milchberg. “Multi-MeV electron acceleration by sub-terawatt laser pulses.” Physical Review Letters **115**, 194802 (2015).
* A.J. Goers, S.J. Yoon, **G.A. Hine**, J.A. Elle, J. Palastro, and H.M. Milchberg. “Laser wakefield acceleration of electrons with ionization injection in a pure N5+ plasma waveguide.” Applied Physics Letters **104**(21), 214105 (2014).
* S.J. Yoon, A.J. Goers, **G.A. Hine**, J.D. Magill, J.A. Elle, Y.-H. Chen, and H.M. Milchberg. “Shock formation in supersonic cluster jets and its effect on axially modulated laser-produced plasma waveguides.” Optics Express **21**(13), 15878 (2013).

*Conference Proceedings*

* **G.A. Hine**, “Spatiotemporal Structure in Intense THz Pulsed Beams” (Invited) 31st Int. Linear Accel. Conf., TH1AA04.
* **G.A. Hine**, “Observation of Spatiotemporal Optical Vortices in Subcycle Terahertz Pulses” Frontiers in Optics + Laser Science 2021, JTu7A.5.
* **G.A. Hine**, “Spatio-Temporal Measurements of THz Pulses”, Proc. IPAC'21, Campinas, SP, Brazil, May 2021, pp. 4021-4023.

# PRESENTATIONS & CONFERENCE PROCEEDINGS

*Invited Talks*

* “Spatiotemporal Structure in Intense THz Pulsed Beams” International Linear Accelerator Conference 2022
* “Observation of Spatiotemporal Optical Vortices in Subcycle Terahertz Pulses” Optica Frontiers in Optics + APS Laser Science Division, November 2021.
* “Multi-MeV Electron Acceleration by Subterawatt Laser Pulses.” High Intensity Lasers and High Field Phenomena Meeting, March 2016.

*Contributed Talks*

* “Electro-optic Sampling of Broadband Terahertz Radiation in 2+1 Dimensions Using a CCD” APS April Meeting, April 2021.
* “Self-guiding of laser pulses and spatio-temporal optical vortices in plasmas.” APS Division of Plasma Physics annual meeting, October 2016.
* “Optical Guiding and Electron Acceleration in Programmably Modulated Plasma Waveguides.” APS Division of Plasma Physics annual meeting, October 2014.

*Posters*

* “Spatio-Temporal Measurements of THz Pulses.” International Particle Accelerator Conference, June 2021
* “Simulations of Ion Acceleration in Thin Dense Gas Jets.” APS Division of Plasma Physics annual meeting, November 2015.
* “Modulated plasma waveguides generated by intense Bessel Beams patterned with a Spatial Light Modulator.” CLEO Applications and Technology, June 2015.
* “Dynamically controlled generation of plasma structures using a spatial light modulator.” APS Division of Plasma Physics annual meeting, November 2013.

# PATENTS

* *Laser-driven high repetition rate source of ultrashort relativistic electron bunches.* Howard M. Milchberg, Andrew Goers, **George Hine**, Fatholah Salehi, Linus Feder, Bo Miao, US10524344B2 (2017)
* *Energy-Loaded Dielectrics, Systems Including Energy-Loaded Dielectrics, and Methods for Fabrication and Use Thereof.* Tim Koeth, **George Hine**, US11115010B1 (2021).

# ADDITIONAL USEFUL SKILLS AND EXPERIENCE

*Specialized Equipment*

* **Optical Patterning systems.** Researched and implemented a Spatial Light Modulator(SLM) for 1 J 140 ps Nd:YAG laser system. Pioneered a technique using an SLM to pattern high power lasers beyond the damage threshold of SLMs.

*Computation*

* **Data Analysis/Programming.** Developed software for image processing and data analysis for use by a team of other students. Developed data analysis tools for use with results from simulations and experiment. Proficient with MATLAB and python, some experience with C++, currently implementing LabView. Experience with Git for software versioning.
* **3D Particle-in-Cell (PIC) simulations.** Experience simulating numerous laser-plasma interactions using particle-in-cell method, including laser wakefield acceleration of electrons, ion acceleration via magnetic vortex expansion, and broadband light generation from plasma wavebreaking. Simulations were parallelized with open MPI and run on HPC clusters.

*Design*

* **Charged particle detection.** Designed and fabricated electron spectrometer for single shot measurement of picocoulomb scale, multi-MeV electron beams generated from laser plasma interactions.
* **CAD software and modeling.** Experienced in use of SolidWorks and AutoCAD for experimental layout and component design. Experience modeling magnetic fields for particle spectrometers and particle accelerators.
* **Machining.** Experience designing and fabricating custom parts on milling machine and lathe using various materials including Teflon, Aluminum, Stainless Steel, Brass and Copper.

# HOBBIES AND ACTIVITIES

* Multi-instrumentalist in the Knoxville Shamisen Club.
* Founding member of St. Timothy Young Adult Community at St. Mary’s Catholic Church in Oak Ridge.
* Avid gardener and agricultural hobbyist, beekeeper.