THE INSTITUTE OF OPTICS

INDUSTRIAL ASSOCIATES

Program & Resource Guide

Fall 2021

October 20-22

HAJIM SCHOOL OF ENGINEERING & APPLIED SCIENCES

UNIVERSITY of ROCHESTER

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Message from the Interim Director

Welcome to the Fall 2021 Edition of the Industrial Associates of the Institute of Optics! Our students, faculty and staff have been looking forward to this for quite some time. After 18 months of remote meetings, we are excited to meet in person. Yes, we will be carefully following Covid-19 protocols, but that won't dampen the spirit and excitement of resuming our in person meetings.

Much has changed at the Institute since we last met in person. We've welcomed two new faculty members, Susana Marcos and Pablo Postigo. Faculty have received promotions and honors. Our undergraduate and graduate enrollment increased even during the difficulties of Covid-19. And we were able to increase our scope of course offerings. Through it all, we've had unwavering and enthusiastic support from our alumni and our Industrial Associates members; because of you, we were able to avoid the kind of cut backs so common elsewhere. So this message is, first and foremost, an expression of thanks.

We continue to be excited about our students and proud of their achievements. In this meeting you will get a chance to meet first & second year undergraduates, upper level undergraduates who are looking toward the Next Step, MS students who are poised to make an impact in your companies, and PhD students carrying out truly groundbreaking research. Many of these students have continued to contribute to your company activities through internships.

The program this year is designed to give you a taste of the full spectrum of optics at the Institute. You will hear about photonic medical testing from Ben Miller, a little about the history of optics in our area from John Greivenkamp, a taste of what our advanced lens design students experience with Julie Bentley, and hear just one of many possible examples of entrepreneurial and business leadership from Turan Erdogan. You will hear an update from Optica (the organization formerly known as OSA), get a chance to feature your company in our IA showcase, and hear about business-ready research results from UR Ventures. Finally, those who have job or internship openings have an opportunity to interview students on Friday and Saturday.

Thanks once again for investing in our students; they are the future leaders of our community. As you meet them, I believe you will feel that the future of optics will be in good hands.

Sincerely,

Tom Brown
Interim Director
The Institute of Optics

Agenda

Hyatt Regency Rochester - 125 E Main St, Rochester, NY 14604

Symposium Agenda - October 20-22, 2021

Please click here to participate Via Zoom, Meeting ID: 998 7402 3445, Passcode: 630654. * = Available via zoom

WEDNESDAY, October 20, 2021: *5 PM – 8 PM ET* *Hyatt Regency Hotel, Downtown Rochester*

5:00 – 7:00 PM: Director's Advisory Council (DAC) Dinner Reception, By Invitation Only
Main Street Gallery Restaurant, Hyatt

7:00 – 8:00 PM: Industrial Associates Networking Hour, All Members Welcome
Main Street Gallery Restaurant, Hyatt

THURSDAY, October 21, 2021: *8 AM – 8:00 PM ET* *Hyatt Regency Hotel, Downtown Rochester*

8:00 – 8:45 AM: Continental Breakfast
Grand Ballroom, Hyatt

***8:45 – 9:10 AM: Thomas Brown,** Professor & Interim Director, University of Rochester, The Institute of Optics.

Jessica DeGroote Nelson, Director of Technology and Strategy, Optimax. Adjunct Professor, The Institute of Optics.
Topic: *Welcome and Institute of Optics Update*

***9:10 – 9:40 AM: Benjamin Miller,** Professor, University of Rochester – Dermatology, Biochemistry and Biophysics, Biomedical Eng, Materials Science.
Title: "Leveraging the AIM Photonics platform to open new frontiers in optical biosensing and biomedical diagnostics"

***9:40 – 10:00 AM: John E Greivenkamp,** Professor, University of Arizona, Wyant College of Optical Sciences. 2021 SPIE Immediate Past President
Title: "Optics Goes to the Movies"

10:00 – 10:15 AM: Masters Student Showcase

10:15 – 11:00 AM: Networking Break and Poster Session
Grand Ballroom, Hyatt

***11:00 – 11:30 AM: Julie Bentley**, Professor, University of Rochester, The Institute of Optics.
Title: "Automated Monte Carlo starting point search methods for the rapid design of complex zoom lenses"

***11:30 – 12:00 PM: Curtis Broadbent,** Sr. Licensing Manager, University of Rochester, UR Ventures.
Title: "Optics Tech Showcase - Short-form pitches of 5 licensable technologies"

***12:00 – 12:10 PM: Katie Dunn, SPIE Chapter President**
University of Rochester, The Institute of Optics
Topic: SPIE Student Chapter Update

***12:10 – 12:20 PM: Antony Georgiadis, Optica Chapter President**
University of Rochester, The Institute of Optics
Topic: Optica Student Chapter Update

12:30 – 2:00 PM: Lunch & SPIE Women in Optics Lunch
Grand Ballroom, Hyatt

***2:00 – 2:30 PM: Turan Erdogan**, President, Plymouth Grating Laboratory, Inc.
Title: "A Tale of Two Optics Companies"

***2:30 – 2:45 PM: Chad Stark,** Executive Director, Optica Foundation (formerly OSA)
Title: "Optica Forward: A look to 2022"

2:45 – 3:15 PM: Break, companies set up tables for showcase.

3:15 – 3:30 PM: Company Connection Self Introductions

3:30 – 5:00 PM: Company Connection Showcase
Regency Ballroom, Hyatt

5:00 – 5:30 PM: Break

5:30 – 8:00 PM: Cocktail Hour & Dinner Reception
Grand Ballroom, Hyatt

FRIDAY, October 22, 2021: *8:30 AM – 5 PM ET* *Hyatt Regency Hotel, Downtown Rochester*

8:30 – 12:00 PM: Company/Student Employment Interviews
Grand Ballroom, Hyatt

12:00 – 1:00 PM: Interviewing Employer and Faculty Lunch
Grand Ballroom, Hyatt

1:00 – 5:00 PM: Company/Student Employment Interviews
Grand Ballroom, Hyatt

SATURDAY, October 23, 2021: *8:30 AM – 12 PM ET* *Hyatt Regency Hotel, Downtown Rochester*

8:30 – 12:00 PM: Company/Student Employment Interviews

Presentations

Benjamin Miller

Professor of Dermatology, Biochemistry and Biophysics, Biomedical Engineering, Materials Science, and Optics,
University of Rochester

Title: "Leveraging the AIM Photonics platform to open new frontiers in optical biosensing and biomedical diagnostics"

Abstract

As essential interfaces between our analog universe and data, sensors represent an exceptionally large opportunity for the field of photonics. The need for new technologies for biosensing and medical diagnostics is particularly well recognized, and is driven by events like the COVID-19 pandemic, growing understanding of the complexity of human health, and increasing focus on broadly available, equitable access to health care. However, although there has been intense activity in the development of new technologies for photonic biosensors, very few of them have been translated to the marketplace. This talk will detail our efforts in a consortium of researchers and companies working within AIM Photonics to develop scalable, manufacturable approaches to photonic biosensing, with a particular focus on a "disposable photonics" platform developed for rapid (≤ 1 minute) assessment of COVID-19 immunity. Emerging applications, including integration of photonic sensors with organ-on-a-chip systems for patient-centric therapeutic development, will also be discussed.

Biography

Prof. Benjamin L. Miller completed his undergraduate studies at Miami University (Ohio), receiving degrees in Chemistry (B.S.), Mathematics (A.B.), and German (A.B.) in 1988. He next moved to Stanford University, where he carried out his Ph. D. research in Chemistry under the direction of Paul Wender. Following a stint as an NIH postdoctoral fellow at Harvard in Stuart Schreiber's laboratory, he joined the University of Rochester faculty in 1996, where he is currently Dean's Professor of Dermatology, Biochemistry and Biophysics, Biomedical Engineering, Materials Science, and Optics. His group's expertise in molecular recognition, combinatorial chemistry, nanotechnology, and optical sensing has been applied to the development of novel optical biosensor platforms, and synthetic compounds targeting RNAs involved in several human diseases. He is a Fellow of the OSA, AIMBE, and AAAS. Miller is a founder of Adarza BioSystems, Inc., a multiplex optical biodetection company located in St. Louis, MO. He is also the Academic Lead for Integrated Photonic Sensors in AIM Photonics.

Contact Information: Benjamin_Miller@URMC.Rochester.edu

John E. Greivenkamp
Professor
Wyant College of Optical Sciences,
Arizona University
2021 SPIE Immediate Past President

Title: "Optics Goes to the Movies"

Abstract:

The Museum of Optics at the Wyant College of Optical Sciences at the University of Arizona has acquired a number of movies that provide interesting windows into the history of optical design and fabrication. Portions of several of these movies will be shown in a light-hearted manner while respecting the history of our field that these movies represent.

Biography:

John E. Greivenkamp is a Professor at the Wyant College of Optical Sciences of the University of Arizona where he has taught courses in optical engineering since 1991. He received is BS in Physics and Math from Thomas More College in 1976. After receiving a Ph.D. from the Optical Sciences Center in 1980, he was employed by Eastman Kodak. He is a fellow of SPIE-the International Society for Optics and Photonics and of OSA. He has served as the editor for the SPIE Field Guides Series and is the author of *Field Guide to Geometrical Optics*. He is the founder and curator of the Museum of Optics at the College of Optical Sciences. Professor Greivenkamp was honored with the 2017 SPIE Educator Award and he serves as the 2021 SPIE Immediate Past President.

Contact Information: greiven@optics.Arizona.EDU

Julie Bentley
Professor
The Institute of Optics,
University of Rochester

Title: "A look back at 10 years of student-led development of first-order search and evaluation tools for the design of complex zoom lenses"

Abstract:

When presented with a new design request it is not unusual for an optical designer to start from an existing design that was chosen based on its underlying design form and then scaled to meet system requirements (e.g. focal length). However, the design of a new zoom lens is complex and typically requires a designer to "start from scratch". As a result, considerable emphasis must be placed on the first-order configuration of the starting point design especially since constraints on packaging parameters (e.g. length, diameter, working distance) can change the first-order solution space significantly. This talk will take a historical look at the student-led development of Excel, Matlab, and Python zoom lens tools for automating the Monte Carlo first-order search, visualizing the zoom motion, and quickly evaluating the performance of a complex zoom lens.

Biography:

Julie Bentley received her BS degree in optics from the Institute of Optics, University of Rochester in 1990. She also received her PhD from the Institute of Optics, University of Rochester. Her PhD thesis focused on the integration of the design and manufacture of gradient-index optical systems. After graduating she spent two years at Hughes Aircraft Co. in California designing optical systems for the defense industry and twelve years at Corning Tropel Corporation in Fairport, New York, designing and manufacturing precision optical assemblies such as micro lithographic inspection systems. She started teaching at the University of Rochester in 1998. Her main teaching interests include geometrical optics, optical design, and tolerancing.

Contact information: julie.bentley@rochester.edu

Curtis J. Broadbent

Sr. Licensing Manager, UR Ventures
University of Rochester

Title: "Optics Tech Showcase - Short-form pitches of 5 licensable technologies"

Abstract:

After a brief introduction to IP management at the University of Rochester, we will quickly run through 5 promising technologies from Optics faculty by way of pre-recorded 5-minute quick-pitch non-confidential videos.

Biography:

Curtis first got involved with URVentures during his second postdoc in quantum optics as an inventor on a 3D real-space volumetric imaging device. One thing led to another and he's been with URVentures for 6 years now. He manages most of the IP coming out of the Institute of Optics as well as much of the IP in other departments on the River Campus. He's negotiated licenses with extremely large and small companies in Optics. Additionally, he is responsible for negotiating IP terms in sponsored research projects. Please don't hesitate to reach out if there is any way he can help your company create new IP with or make use of existing IP from the Institute of Optics.

Contact Information: curtis.broadbent@rochester.edu

Kaitlin Dunn

PhD Candidate in Optics
UR SPIE Student Chapter President

Topic: SPIE Student Chapter Update

Biography:

Kaitlin Dunn (Katie) is currently a PhD candidate in Andrew Berger's lab at the University of Rochester. Her research interests include computational microscopy and inverse light scattering, and her current work is on angular light scattering from single cells. Katie is currently the president of the SPIE student chapter at the University of Rochester, leading chapter initiatives in outreach, professional development, and diversity in optics. Katie holds a BS in Electrical Engineering and Physics from Clarkson University and an MS in Optics from the University of Rochester.

Contact Information: kdunn7@ur.rochester.edu

Antony Georgiadis

BS in Optics (anticipated ’23)
Optica Student Chapter President

Topic: Optica Student Chapter Update

Biography:

Antony Georgiadis is currently an undergraduate junior at the University of Rochester. His interests include lens and system design, automation, and optics education. Antony is currently the President of the Optica Student Chapter at the University of Rochester, leading efforts to engage students in professional development opportunities, outreach in the community and social events. Antony will graduate in May 2023 with a Major in Optical Engineering.

Contact Information: ageorgi2@u.Rochester.edu

Turan Erdogan

President, Plymouth Grating Laboratory

Title: "A Tale of Two Optics Companies"

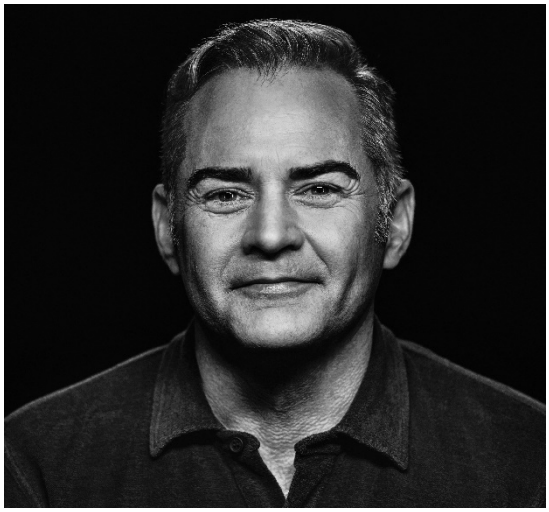
Abstract:

Every company has a story. Many technology companies are run by or at least supported by technically smart people with little formal business training. Stories from other companies which have flourished, weathered tough times, or even failed miserably are vital learning tools for these technologists. This talk will compare the stories from two optics companies as they evolved from start-up to mid-life: Semrock and Plymouth Grating Laboratory. We will investigate how they handled similar challenges in different ways, and some critical decisions which they would or wouldn't make differently in hindsight.

Biography:

Turan Erdogan has been studying, teaching, and practicing optics for over 30 years. He is currently President of Plymouth Grating Laboratory, Inc. Prior to this, Erdogan was the Site Leader of Melles Griot in Rochester, New York, a leading provider of high-performance lens assemblies and optical modules for biological imaging and semiconductor metrology. He also served simultaneously as the CTO and VP of Business Development for the IDEX Optics & Photonics platform. In 2000, Erdogan co-founded Semrock, Inc., which was then acquired by IDEX in 2008. Semrock revolutionized the manufacturing of high-performance thin-film optical filters for fluorescence and Raman spectroscopy applications. Prior to Semrock, he was a tenured professor at the The Institute of Optics at the University of Rochester, where he joined in 1994. There he conducted research primarily on fiber and waveguide devices and holographic optical materials. Erdogan was also a post-doctoral researcher at Bell Laboratories, then part of AT&T. He has a Ph.D. from The Institute of Optics at the University of Rochester, and B.S. Degrees in Electrical Engineering and in Physics from the Massachusetts Institute of Technology.

Contact Information: turan@plymouthgrating.com



Chad Stark
Executive Director
Optica Foundation

Title: "Optica Forward: A look to 2022"

Abstract:

Stark will provide an overview of the transition of The Optical Society to Optica while highlighting new programs and initiatives the society and foundation are launching in 2022.

Biography:

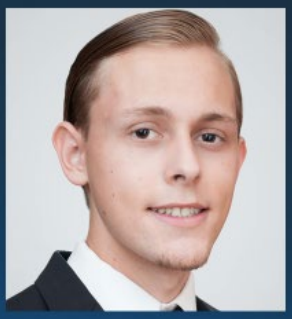
Stark serves as the executive director of the Optica Foundation. The foundation supports the next generation of scientists, engineers, and corporate leaders as the philanthropic arm of Optica, the society advancing optics and photonics worldwide. He oversees the development and implementation of the foundation's growth strategy through donor cultivation, fundraising and programs including schools, scholarships, prizes, grants, and awards. Additionally, Stark is a member of the Optica executive team focused on organizational strategy, market growth, and overall business operations.

Stark has worked in non-profit management for 30+ years. His expertise includes membership relations, meetings and conventions, strategic planning, marketing, communications and branding, fundraising, and new product development, and he has a passion for driving innovation and change.

Contact information: CSTARK@optica.org

MS Showcase

Adam Briggs



Education Highlights

- M.S. Optics, University of Rochester 2022
- B.S. Optical Engineering, University of Rochester 2021

Competencies

- CodeV, OpticStudio, FRED, LightTools, OptiLayer
- Python, MATLAB, RStudio

Work Experience

- **Optical Designer**, Circle Optics, Aug '21 – Present
  - Lens design
- **Intern**, Ball Aerospace, May '21 – Aug '21
  - Freeform design, stray light analysis, phase measuring deflectometry
- **Intern**, Texas Instruments, May '20 – Aug '20
  - Lens & Illumination design
- **Intern**, ChemImage, May '19 – Aug '19
  - Characterization/statistics for hyperspectral imaging

Objectives

- Full time in design/research

Lens Design

Stray Light Analysis

Illumination Design

Zhuo Hann Cheah

Education Highlights

MSc Optics : May 2022

Work Experience

- 3 years of Opto-Mechanical Engineer experience in Silicon Valley.
- Experience in designing, manufacturing prototyping and testing in fiber optics field.
- Data analysis and programming to interpret and process optical testing results.

Objective

I am looking for a full-time **Optical Engineer** position starting **summer 2022**.

Luke Potter

Education Highlights

- Bachelors of Science in Optical Engineering (U of R 2021)
- Masters of Science in Optics (Expected 2022)

Work Experience

- Optimax - R&D Engineering Intern
- URnano Facility- Student Technician
- Raytheon Technologies – Optical Engineering Intern

Objectives

- Full time position starting after graduation
- Lens Design, System Integration and Testing, Research and Development

Rohith Srikanth

Education Highlights

- Bachelor of Technology in Electronics and Communication

-Skilled in Python, MATLAB and C.

Work Experience

- Worked in a Crystal Growth and Nonlinear Optics Lab for 3 years
  - Hands-on experience using optical equipment and techniques including interferometry.

Objectives

- PhD
- Interested in a position post graduation

Martin Le

martin.le@rochester.edu

Education Highlights

M.S. in Optics, University of Rochester (Present)

B.S. in Medical Physics, University of Waterloo (2021)

Work Experience

Quantum Optics Engineering Intern | QEYnet Inc.
- Designed a QKD 'polarimeter' receiver for satellites using Zemax.
- Assembled, aligned, and characterized the receiver system.

Optical Designer | Single Quantum Systems Inc.
- Designed, assembled, and tested a DTOF single-photon LIDAR transmitter and receiver.

Research Assistant | PhotoMedicine Labs, UWaterloo
- 4 Peer-reviewed publications in the field of photoacoustic imaging
- Contributions include: optical design and assembly, experimental design, system characterization, technical writing.

Le, M., Abbasi, S., Sonier, B., Dinakaran, D., Bigras, G., Bell, K., Haji Reza, P. (2019). All-optical Reflection-mode Microscopic Histology of Unstained Human Tissues. **Nature Scientific Reports**, 9(13392); *https://doi.org/10.1038/s41598-019-49849-9*
Le, M., Abbasi, S., Sonier, B., Bell, K., Dinakaran, D., Bigras, G., Haji Reza, P. (2019). Chromophore selective multi-wavelength photoacoustic remote sensing of unstained human tissues. **Biomedical Optics Express**, 10(11): 5461-5469; *https://doi.org/10.1364/BOE.10.005461*
Chan, J., Zheng, Z., Bell, K., **Le, M.**, Haji Reza, P., Yeow, John T.W.(2019). Photoacoustic Imaging with Capacitive Micromachined Ultrasound Transducers: Principles and Developments. **Sensors**, 19(16): 3617; https://doi.org/10.3390/s19163617
Hosseinaee, Z., **Le, M.**, Bell, K., Haji Reza, P. (2020). Towards non-contact photoacoustic imaging [Review]. **Photoacoustics**, 100207; *https://doi.org/10.1016/j.pacs.2020.100207*

Skills

- Zemax (2yrs), MATLAB, Python, SolidWorks (Assembly)

Objectives

- Impactful 1 Year Co-op Placement *(Beginning Jan. 2022)*
- Full-time Position

Louis Marra

Education Highlights

- MS student ; BS in Physics
- Integrated Photonics, Optoelectronics, Nano-Optics, Electrodynamics, etc.

Work Experience

- Plasmonics research (COMSOL, MATLAB)
- Laboratory experience

Objectives

- Interested in Photonics, Plasmonics, Nano-Optics
- Seeking Co-op

INDUSTRIAL ASSOCIATES

Jing-Yi Wang

MS in Optics, U of Rochester

MS in Photonics, NCTU

- ✓ Thesis: A Study of Optical Phases in Polymer-Dispersed Liquid Crystals
- ✓ Poster award in annual meeting of PSROC
- ✓ Outstanding contribution award of NCTU Extracurricular Activities

BS in Physics, NTHU

- ✓ Undergraduate project: Saturation Absorption and Collision Effect of $40Ca^{+}$

Garmin Corporation

Advanced Display and Optical Engineer II

Good grasp of Optics

- ✓ Touch panel pattern design
- ✓ Display optical characterization methodologies
- ✓ Transparent solar cell design, manufacture, failure analysis

NCTU TA (MATLAB, Mathematica)

The Language of Technical Computing

➢ 2022 summer intern/ 2023 full time job (graduate in Dec 2022) as **Optical design engineer**

Montgomery Whalen

MS in Optics, University of Rochester

- Laboratory work, Wave Optics, Lenses, Precision Instrument Design

MS in Mathematics, Western Washington University

- Numerical Analysis, Neural Networks, Fourier Analysis, Statistics, Mathematical Modeling

BS Math, BA Econ, CS minor, WWU

- Databases, Data Structures

Western Washington University

- Graduate Teacher
  - Gave lectures to classes of over 30 students in pre-calculus, calculus, and linear algebra
  - Developed public speaking skills and general communication skills

❑ Experience with MATLAB, Mathematica, R, Java, Python, SQL

➢ Seeking Optical Engineering Co-op position for 2022

Poster Session

Nicholas Achuthan & Sinabu Pumulo – Optics ’23 & Optical Engineering ‘22

Title: Laser Frequency Stabilization for Integrated Photonics
Abstract: Laser interferometry is a highly precise metrological tool that has found applications in fields from optical surface testing to gravitational wave detection. It works by using the wavelength of light as a ruler against which sensitive measurements can be made. However, such a measurement relies on the length of the ruler being known and constant. If the laser has substantial frequency noise, it can greatly degrade the precision of an interferometric measurement. In integrated photonics, laser stability is just as vital. To address this, we theorize a laser stabilization system for a photonic chip interferometer in a completely fiber-coupled setup, using a high-Q ring resonator as a frequency reference.

Amira S. Ahsan – Optics PhD

Title: Vector Modulation Instability in Birefringent Graded-Index Multimode Fibers
Abstract: We study vectorial modulation instability occurring inside a birefringent graded-index (GRIN) fiber when the two polarization components of the optical field are coupled nonlinearly through cross-phase modulation.
In the scalar case, the geometric parametric instability is known to produce an infinite number of sidebands around the wavelength of the input optical beam. We show that the birefringence of a GRIN fiber splits each of these sidebands into a triplet, whose frequency spacing depends on the differential group delay between the orthogonally polarized components. We verify the predictions of the linear stability analysis numerically by solving two coupled nonlinear Schrödinger equations that include the spatial self-imaging effects through an effective nonlinear parameter.

Arnab Barman Ray – Optics PhD

Title: Trions trapped in Moire Heterostructures
Abstract: Moiré heterostructures have recently come into attention as they provide natural trapping sites for electronic bound states such as excitons in a class of atomically thin, direct-band gap semiconductors called Transition Metal Dichalcogenides(TMDCs). These traps hold promise as sites for quantum light emitters as well as lattice points in simulating many-body condensed matter physics. We construct a WSe2/MoSe2 Moiré heterostucture in a gating device and observe naturally trapped excitonic quantum emitters which, with electrostatic doping are seen to evolve into emitters of Trion origin. Trions offer larger nonlinearities in light-matter interactions that can pave the way for highly non-linear optical devices.

Debamitra Chakraborty – Materials Science PhD

Title: Pulsed Terahertz Imaging of Paraffin-Embedded Pancreatic Ductal Adenocarcinoma

Abstract: The terahertz (THz) region lies between optics and radiofrequency in the electromagnetic spectrum and is considered the 'molecular fingerprint region' in electromagnetics. THz radiation presently receives great international interest due to its unique applications ranging from ultrafast local wireless communications, through novel spectroscopy of materials and biosensing, to noninvasive security screening and medical diagnostics. In particular, the THz spectroscopy emerged as a new revolutionary tool in medical imaging. Properties like sub-millimeter resolution, high signal-to-noise ratio, non-ionizing nature, and ability to extract biomolecular features make pulsed terahertz time-domain spectroscopy (TDS) suitable for various applications, including in-vivo malignancy detection and ex-vivo cancer margin determination. We design and develop a terahertz time-domain imaging method for Pancreatic Adenocarcinoma(PDAC) detection. PDAC is a fatal malignancy, often diagnosed at the advanced state; thus, eliminating possibilities of curative treatments. We probe local changes in tissue's optical properties as novel imaging biomarkers to detect the immensely heterogeneous tumor microenvironment. Our results demonstrate refractive index as a potent marker capable of resolving heterogeneity within ex-vivo murine PDAC samples over conventional features from spectral or temporal THz signatures.

Romita Chaudhuri – Optics PhD

Title: Reconfigurable interferometric metrology using spatial light modulator

Abstract: We present the concept, design, and implementation of an interferometric null test based on a spatial light modulator (SLM) as an alternative to traditional computer-generated hologram (CGH) which is commonly used for measuring aspheres and freeform optics. While CGH-based interferometry is very successful in freeform and aspheric metrology, it involves significant expense and lead time to fabricate and test the custom CGH for each unique part. In our system, we use a high definition SLM as a reconfigurable nulling element to overcome the part-specific limitations of a CGH. Phase wrapping on a high-definition SLM enables the generation of hundreds of microns peak-valley wavefronts, which makes it lucrative for optical metrology as a nulling element. The hardware implementation of the method involves polarization control, SLM characterization, iterative wavefront optimization, management of diffraction orders and stray light, and optical alignment. We present the alignment and calibration protocol that we developed for the system, demonstrated on a sphere as a

simple test optic. Simulations for freeform metrology are presented and the implementation is currently underway in the laboratory.

Genyu Chen – Material Science PhD

Title: Ultrabroadband Spintronic THz emitters excited by femtosecond laser pulses
Abstract: Bilayers of ferromagnetic and heavy metal nanolayers excited with femtosecond laser pulses emit subpicosecond bursts of electromagnetic radiation with spectral frequencies up to several THz. We fabricated such spintronic THz emitters containing various ferromagnetic materials with vastly different magnetic remanence, saturation magnetization, and coercive field. In all cases, the THz amplitude versus magnetic field dependence follows the independently measured magnetization hysteresis loops and the THz polarization direction is perpendicular to the sample's magnetization M, both consistent with the inverse spin Hall effect as the physical origin.

Margaret Flaum – Optical Engineering '23

Title: Adaptive Nulling for Steep Aspheres using a Holographic Reference Surface
Abstract: Freeform optics are typically difficult to measure with interferometry because a reference surface such as a flat or a reference sphere will produce a very different wavefront from that which is produced by the optic. This causes a retrace error, where the light reflected off the reference surface does not follow the same path as the light reflected off the test surface. Our project is to create a Fizeau interferometer that uses a hologram of the surface under test as the reference surface. When the hologram is illuminated, it produces a beam that is theoretically identical to that of the surface. The source is a 532 nm doubled YAG, a green laser pointer, which operates at more than one mode. This appears in the measurement in coherence fringes, which are a pattern of visibility in the hologram itself, where some areas are exposed well and others are underexposed. The result is that the interferogram appears to have two sets of fringes, one from coherence and one from interference between the reference and test surfaces. Both sets of fringes contain information about the shape of the surface, with the coherence fringes providing a coarse surface shape and the interference fringes providing subwavelength accuracy.

Marissa Granados Baez – Optics PhD

Title: Integrated Photonics and 2D Materials
Abstract: We demonstrate room temperature lasing of monolayer WSe_2 integrated with a silicon nitride ring resonator. The monolayer, microring platform enables monolithic, on-chip, waveguide coupled light emission.

Xiaotong He – Optics PhD

Title: Compressed sensing based ring resonators spectrometer
Abstract: Optical spectrometer is an important component for wavelength measuring in scientific research. The current commercial spectrometers use prism or diffraction gratings as the dispersion unit. However, when coming to higher precision or broader bandwidth, the size and weight of the spectrometer becomes an issue. We are working on a novel integrated on chip spectrometer with ring resonators as wavelength dispersion unit. Compressed sensing algorithm is used for reconstruction.

Tyler V. Howard – Optics PhD

Title: Polarization Monitoring in Photonic Integrated Circuits
Abstract: Photonic integrated circuits (PICs) have an increasing range of applications, with national and international foundries now providing a readily accessible avenue for PIC technology. Quantitatively monitoring the polarization within a PIC in the packaging and testing stage is a challenging but important problem. Our proposed solution integrates an engineered subwavelength scattering element that can readily be incorporated in a foundry process. Using a scatter in the evanescent field of the waveguide, we simulate the pupil polarization distribution through combination of a finite-difference time-domain waveguide model with an EM propagation model describing the microscope. Experimental verification is possible through PICs fabricated through the AIM Photonics foundry. Scattering elements present on the silicon-nitride layer with a silicon waveguide demonstrate a polarization pattern close to that of a linear dipole.

Gregory Jenkins – Optics PhD

Title: Simultaneous Spectral Broadening and Contrast Improvement using Divided-Pulse Nonlinear Compression
Abstract: Temporal contrast is an increasingly important issue for high power lasers because prepulses with just a fraction of the main pulses intensity can ionize the target and change experimental conditions before the main pulse arrives. We have developed a method based on divided-pulse nonlinear compression that can simultaneously spectrally broaden the pulse and supress prepulses.

Siladitya Khan – Biomedical Engineering PhD

Title: Quantifying Hepatic Viscoelastic Properties using Model-based Approaches with Single Track Location Ultrasound Elastography
Abstract: Develops a noninvasive ultrasound-based imaging modality, which will be applied to assess the viscoelastic properties of hepatic fibrosis. It will be used to monitor in situ changes in biomechanical properties associated with chronic liver injury.

Ultrasound being a preferred choice in clinical assessments, has been established as an effective modality for monitoring fibrosis progression in patients. Biological tissues being predominantly viscoelastic exhibit frequency dependent shearwave speed and attenuation. Most elastography methodologies estimate the group speed of shear waves but refrain from estimation or measurement of the frequency dependence of shear wave speed or attenuation. Previous studies in our lab have shown, that shear wave propagation in a medium is itself a function of the Acoustic Radiation Force (ARF) push beam geometry and duration. We propose to develop a robust viscoelastic estimator that accounts for variation in excitation and track beam, and that can capture viscosity changes within the tissue based on local dynamics of the propagating shear wave. The overarching aim is to generate maps of the viscoelastic material properties from point-to-point analysis of particle displacement profiles in a parametric fitting fashion. The technology developed in this research program can be easily implemented on diagnostic ultrasound scanners with minor modifications, with the aim of improving diagnostic accuracy of elastography in chronic liver diseases.

Sushant Kumar – Optics PhD

Title: Chirped Pulse Generation On-Chip

Abstract: Coherent optical pulses are of vital importance and have potential applications in fields like communications, metrology, LiDAR, time keeping and even surgery. While solid-state and fibre based mode-locked lasers are the benchmark for high power, short duration pulses; they tend to be extremely bulky and expensive. To scale the technology for en masse applications, chip-scale coherent sources are needed. While such sources have been demonstrated on multiple platforms, they lack the pulse power and design flexibility to be of use in many of the above applications. This work aims to solve the issue via generation of coherent chirped pulses on chip.

David Lippman – Optics PhD

Title: Learning lens design from Rudolf Kingslake

Abstract: Rudolf Kingslake championed the importance of lens design fundamentals and, with the introduction of computer-aided design, was wary of what the future held for theory. The transition from ray tracing taking minutes to taking fractions of a second has changed the way lens design is taught and approached. Today's powerful computational tools have largely supplanted fundamentals, yet the synergy of thoughtfully combining theory with numerical capacity is what leads to the greatest insight, most efficiently. Recently uncovered materials of Professor Kingslake's highlight this fact and suggest how lens design's past has enduring importance today.

Zachary A. Manning & Rushnan Islam – Optics PhD

Title: High Dynamic Range Measurements of Femtosecond Pulses

Abstract: Femtosecond material processing techniques, such as LIRIC (Laser Induced Refractive Index Change) rely on tightly focused mode-locked pulses to achieve the high intensities needed for multiphoton excitation. The temporal profile of these pulses is assumed to be a sharp, narrow peak. However, a portion of the total energy is also contained in a long component with much lower intensity, ignored by most measurement techniques. We have developed a High Dynamic Range Autocorrelation system to study these low intensity features and their influence on the LIRIC process.

Arunabh Mukherjee – Optics PhD

Title: Spins at work: from determining the history of our Moon to enabling quantum technologies of the future

Abstract: Spin is an intrinsic type of rotation possessed by quantum mechanical particles like electrons and photons, and composite particles like atoms. Defects in the solid-state can act as “artificial atoms” with finite spin. Interestingly, the discreet spin-energy levels of defects can be used as long-lived quantum memories (qubits) for quantum information science, and as quantum sensors for external stimuli like magnetic and strain fields. Here, we present our work on using NV- centers in nano-diamond as sensors of magnetic inclusions embedded in lunar rocks procured by the Apollo 16 mission. Measuring the field strength emanating for these inclusions provides key historical insights on how the Earth’s Moon was formed. We also show unprecedented results on controlling the spatial location of individual spins in atomically thin semiconductors using nano-scale strain engineering. These spins could form the basis of spin-based quantum technologies of the future.

Juniyali Nauriyal – Electrical Engineering PhD

Title: Single-shot, Multiple I/O Photonic Chip to Fiber Array Packaging Using Fusion Splicing

Abstract: We show a novel multiple I/O photonic packaging method for 4 fiber array using fusion splicing. We demonstrate a minimum loss of 1.5dB per facet with a variation of +/-0.1dB through a 4-fiber array.

Francis Pellegrino & Heriniaina Rajaoberison – BS Optical Eng ‘22

Title: AGR's Spectre™: Handheld Spectroscopy Redefined

Abstract: Advanced Growing Resources Inc. (AGR™) is an optical sensing startup founded by three undergraduate students in the Hajim School of Engineering. The team is developing Spectre™, a patent-pending handheld scanner that enables users to combine the power of advanced optical spectroscopy and imaging in the field. Although spectroscopy has been around for decades, AGR’s™ innovation enables it to be accessible, portable, and affordable — thanks to novel optical technology, user-oriented software, and a cost-effective modular design. AGR™ has engineered its technology to work across a wide variety of applications, from industrial quality control to precision agriculture: It's initial target sector. Growers and crop specialists working the field can scan leaves at the tap of a button. The accompanying software, accessible from a smartphone and powered by machine learning, allows users to gain real-time information on plant growth and health to catch problems before they spread. This process seamlessly integrates into existing workflows and can help optimize yield while reducing the need for pesticides and fertilizers. Soon, growers from across the globe will be able to move the industry towards more cost-effective and sustainable practices with AGR™.

Learn more at agrsensors.com

Meiting Song – Optics PhD

Title: Enhanced On-Chip Phase Measurement by Inverse Weak Value Amplification

Abstract: Optical interferometry plays an essential role in precision metrology. Weak value amplification enhances the interferometric signal without amplifying certain technical noises. We implement a generalized form of weak value amplification on an integrated photonic platform with a multi-mode interferometer. We demonstrate a 7dB signal enhancement in our weak value device over a standard Mach-Zehnder interferometer with equal detected optical power, as well as frequency measurements with 2kHz sensitivity by adding a ring resonator.

Braden M. Weight – Physics PhD

Title: Non-adiabatic Dynamics Simulations of Single-Walled Carbon Nanotubes with Topological sp3-defects: An On-the-fly NEXMD Study

Abstract: Single walled carbon nanotubes (SWCNTs) with covalent surface defects have been well-explored over the last few years, and these systems have shown promise for use in single-photon telecommunication emission as well as in spintronic applications. The dynamical evolution of excitons in these systems has only been loosely discussed in the theoretical literature due to the size limitation of these large systems (# Atoms > 300). Herein, we present an application of an open-source

framework, Non-adiabatic EXcited state Molecular Dynamics (NEXMD), to perform a set of fewest switches surface hopping (FSSH) calculations in the excitonic picture using a semi-empirical Hamiltonian on a variety of SWCNT chiralities as well as single-defect functionalizations. We find a strong chirality and defect-composition dependence on the population relaxation between the pristine E11 state and the defect-associated, single-photon-emitting S1 state and gives insight into the dynamic trapping nature of these localized excitonic states. Engineering fast population decay into the quasi-two-level sub-system {S0, S1} with weak coherence to higher-energy states increases the effectiveness and controllability of these novel quantum light emitters.

Jiewei Xiang – Optics PhD

Title: Monolithic broadband multispectral CMOS filter
Abstract: We demonstrate a multispectral Fabry-Perot color filter based on two-dimensional subwavelength gratings and selective suppression. We show that using the sub-wavelength grating a broadband filter with the same layer structure and thickness can be created, which enables monolithic integration of the filter bank with the imaging sensor. This technology has the potential to transform hyperspectral imaging for applications that range from telecommunications to imaging spectroscopy.

Yang Xu – Physics PhD

Title: Measuring Spiral Bandwidth with Stimulated Emission Tomography
Abstract: The technique of stimulated emission tomography (SET) provides an excellent characterization of SPDC sources of bi-photon states since it increases the average number of photons detected by several orders of magnitude than the traditional coincidence count method. In this experiment, we apply SET to investigate the orbital angular momentum (OAM) modes of entangled photons of an SPDC source. We measure the OAM spectrum of a bi-photon state of an SPDC source generated using a Gaussian pump beam with a purely classical process, namely the difference frequency generation. In particular, we scan through allowed values of orbital angular momentum, l, and radial mode number, p, of the seed beam and measure the OAM distribution of down-converted Laguerre-Gaussian beams in the output. We expect that this experiment will pave way for the precise and efficient characterization of bi-photon states produced by weak SPDC sources.

Dong Xue – Physics PhD

Title: Chirped-pulsed Kerr solitons in the Lugiato-Lefever equation with spectral filtering

Abstract: High energy ultrashort pulses have a wide range of applications including material processing, imaging, and eye surgery. A powerful new ultrashort pulse generating platform known as a “Kerr resonator” supports wavelength and repetition-rate versatile ultrashort solitons. However, the energy of Kerr solitons is lower than traditional mode-locked laser sources. Recently, chirped pulse Kerr solitons have demonstrated the potential to generate high energy pulses. Here we investigate the equations underlying chirped pulse Kerr solitons. The appropriate mean-field equation, the Lugiato-Lefever equation with a filter (LLE-F) is new and almost no literature exists investigating its properties.

We find that the approximate LLE-F model deviates from the complete experimental model over a large range of relevant parameters. As a consequence, in contrast to other Kerr solitons modeled well with mean-field approaches, the chirped pulses are found to be unusually insensitive to loss. This study therefore reveals new opportunities for Kerr resonators including frequency comb generation from low-quality-factor cavities.

For more information on hiring Co-op students, contact Kai Davies (Graduate Program Coordinator) at kai.davies@rochester.edu

Professional Organizations: Student Chapters

SPIE

SPIE is the International Society for Optics and Photonics. The University of Rochester Student Chapter was established in 2009 and has since grown to be the largest student chapter in North America, with over 70 registered student and alumni chapter members. We promote optical science and engineering while supporting the professional development of our chapter members. To accomplish this, we regularly engage in optics outreach in the Rochester community, invite speakers to visit with students on campus, and schedule tours of local optics companies.

Current Officers:

President: Kaitlin Dunn
Vice President: Saleem Iqbal
Secretary: Ben Moon
Treasurer: Wooyoun Kim
Web Administrator: Janet Tang
Communications Officer: Rob Holcomb
Outreach Chair: Tyler Howard
Faculty Advisor: Greg Schmidt
Senior Faculty Advisor: Jannick Rolland

If you would like to host a company tour or collaborate with us on outreach or professional development events, please contact urspie@gmail.com.

Optica

The University of Rochester's Optical Society (Optica) Student Chapter is a pre-professional organization and academic club. Our mission is to promote and advance the science of light amongst the student body of the University of Rochester. One of our largest goals each year is to provide students with professional development workshops aimed at giving them the skills they need to succeed. We have been working to find creative ways to engage with and teach optics to the campus and community at large, as well as host social events to promote interaction between students. Our biggest event of the year, bringing together Institute undergraduates, graduates, and faculty, is our annual Photon Cup soccer match with the Physics department.

Current Officers:

President: Antony Georgiadis
Professional Development Chair: Dwight Fairchild
Social Chair: Icel Sukovaty
Outreach Chair: Kendall Smith
Secretary: Lukas Ladas
Business Manager: Gabriel Medina

Please contact Antony Georgiadis at ageorgi2@u.rochester.edu with any questions, comments, or ideas.

Optics Summer Short-Course Series
June 2022

In 2022, The Institute of Optics will hold the 61st annual Summer Short-Course Series. Course dates and registration are set for June 6th-June 22rd, 2022. Registration will be available March 1. All courses will be remote.

The courses listed below are being offered**:**

Applied Concepts: Colorimetry and vision, wave guide photonics, and more.

Fundamental Concepts: Covering lenses, aberrations, principles of diffraction, optical systems, polarization, birefringence and crystal optics, and radiometry and detection.

Integrated Photonics Circuits: Targeted for students, researchers, and engineers in industry, who want to learn the fundamental aspects of integrated photonics circuits.

Introduction to Computational Imaging and Information Essentials: Introduces computational imaging, a modern paradigm in imaging in which the burden of image formation is no longer borne solely by optical physics.

Modern Optical Engineering: Covering optical testing and instrumentation, optical manufacturing, optical thin film coatings, diffractive optics, and glass in modern optics.

Optical System Design: Introduces participants to both fundamental and advanced concepts in optical system design by integrating classroom lectures with software training labs. The course can be taken as a full week course or as one of two three-day course options depending on interest/skill level. *Introduction to Optical System Design* covers first order layout, image quality evaluation, aberration theory, optimization, and refractive/reflective design forms. *Advanced topics in optical system design* begins with refractive/reflective design forms and then covers advanced optimization techniques, zoom lenses, aspheres, stray light analysis, tolerancing, and illumination design.

Optical Thin Film Coating Technology: Covers all aspects of optical interference devices including thin-film design, digital design methods, and coating and characterization.

Opto-Mechanical Analysis: Introduces optics measures, modeling optics, surface errors, stress, optic mounts & bonds, thermal effects, vibrations, system analysis, adaptive mirrors, assembly, testing, and optimization.

Ultrafast Optics and Petawatt Laser Systems: This course serves as an introduction to ultrafast laser systems with an emphasis on chirped pulse amplification and the generation of ultrahigh peak powers and irradiances.

IA Members

Industrial Associate members are listed alphabetically within membership levels: Strategic, Society & Trade Associations, Select, Standard and Associate.

Strategic IA Members

	**ASML** www.asml.com
	**Corning Incorporated** www.corning.com
	**Danbury Mission Technologies** *(formerly Collins Aerospace)* www.dmtllc.org
	**Edmund Optics** *www.edmundoptics.com*
	**L3Harris Technologies (NY)** www.l3harris.com
	**Newport Corp | MKS Instruments** www.newport.com | www.mksinst.com
	**OptiPro Systems, Inc.** www.optipro.com/index.html
	**Synopsys** www.synopsys.com
	**Zemax** www.zemax.com
	**Zygo** www.zygo.com

Society, Trade, & Academic Association IA Members

Monroe Community College STATE UNIVERSITY OF NEW YORK	**Monroe Community College** ***www.monroecc.edu***
NEW YORK PHOTONICS PHOTONICS ROCHESTER	**New York Photonics** ***www.newyorkphotonics.org*** ***www.rrpc-ny.org***
nextcorps LUMINATE	**NextCorps | Luminate** ***www.nextcorps.org*** ***www.luminate.org***
OPTICA | Formerly OSA Advancing Optics and Photonics Worldwide	**The Optical Society** ***www.osa.org***
SPIE.	**The International Society for Optics and Photonics** ***www.spie.org***

Select IA Members

AFRL THE AIR FORCE RESEARCH LABORATORY	**Air Force Research Lab (AFRL)** ***www.wpafb.af.mil/afrl/***
	Apple ***www.apple.com***

Select IA Members (Continued)

	II-VI Inc. ***www.ii-vi.com***
	L3Harris Technologies (CA) ***www.l3harris.com***
	Lawrence Livermore National Lab ***www.llnl.gov***
	Lockheed Martin ***(Missile & Fire Control and Space Systems)*** ***www.lockheedmartin.com***
	MIT Lincoln Laboratory ***www.ll.mit.edu***
	Microsoft ***www.microsoft.com***
	Raytheon ***www.raytheon.com***
	Snap Inc. ***www.snap.com***
	Sunny Optical Technology Group Co., Ltd. ***www.sunnyoptical.com***
	Viavi Solutions ***www.sunnyoptical.com***

Standard IA Members

Avo Photonics	**Avo Photonics** ***avophotonics.com***
facebook Reality Labs	**Facebook Reality Labs** ***www.facebook.com/careers/areas-of-work/facebookrealitylabs***
JANOS TECHNOLOGY	**JANOS Technology** ***www.janostech.com***
JENOPTIK Optical Systems	**JENOPTIK Optical Systems** ***www.jenoptik-inc.com***
NAVITAR	**Navitar** ***www.navitar.com***
Optikos The Optical Engineering Experts®	**Optikos** ***www.optikos.com***
OPTIMAX®	**OPTIMAX Systems, Inc.** ***www.optimaxsl.com***
QVI Quality Vision International Precision for People®	**Quality Vision International, Inc.** ***www.qvii.com***
SAFRAN Optics 1	**Safran | Optics 1** ***www.optics1.com***
SONY®	**SONY Electronics Inc.** ***www.sony.com***

Associate IA Members

	**Bristol Instruments, Incorporated** ***www.bristol-inst.com***
	**Gray Optics** ***www.grayoptics.com***
	**Johns Hopkins Applied Physics Lab** ***www.jhuapl.edu***
	**OptoSigma Corporation** ***www.america.optosigma.com/***
	**Plymouth Grating Laboratory** ***www.plymouthgrating.com***
	**Spica Technologies** ***www.toptica.com***
	**TOPTICA Photonics, Inc.** ***www.toptica.com***
	**Wavefront Research, Inc.** ***www.wavefrontresearch.com***