Optical Sciences Winter School for Enabling Future Students in Optics Society

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ABSTRACT

Optical Sciences and Photonics are areas of growing importance that are too often missing from traditional undergraduate science and engineering curricula. Often, aspects of optics and photonics are picked up as side topics in undergraduate and graduate courses along the way to obtaining more traditional STEM (Science, Technology, Engineering and Mathematics) degrees. Since 2016, the annual Optical Sciences Winter School has been held during the winter break of the University of Arizona's academic calendar. Its annual participants are now approximately 50 – 60 undergraduate students (mostly juniors and seniors) from US (United States) Universities who demonstrate an aptitude and talent for science and research. These students participate in a three- to five-day immersion experience, learning the many opportunities and benefits that choosing optics and photonics for their graduate studies can offer. The Optical Sciences Winter School (OSWS) brings together a motivated group of undergraduate students for a series of overview lectures teaching foundational topics in optics and their relation to current research. It also provides a forum for faculty, alumni, and invited guests to share results, approaches and methodologies in optics and photonics research and education that are unique to the undergraduate setting. This event is not focused on a specific school's program but tries to highlight the diverse optics programs in the US. Many sessions in the program are filled with various invited faculties and researchers' presentations from prominent optical physics and engineering undergraduate or graduate institutions.

Keywords: Optical Sciences Winter School, OSWS, Wyant College of Optical Sciences, Education, Outreach

1. INTRODUCTION

The field of Optics and Photonics is a crucial aspect of science and technology, yet it is frequently overlooked in traditional undergraduate curricula. Many students pursuing STEM (Science, Technology, Engineering and Mathematics) degrees may only briefly touch upon the subject or not even realize it exists, missing out on potential career opportunities. To address this lack of awareness and support for Optics and Photonics society, the Optical Sciences Winter School (OSWS) was created in 2016. This program strives to encourage and empower undergraduate students to engage with this field of study through interactive and educational experiences. By offering this opportunity, the program seeks to promote and strengthen Optics and Photonics education and research, inspiring a new generation of scientists and engineers to explore and innovate in this exciting area of science.

More specifically, the Optical Sciences Winter School is motivated by a desire to attract top talent to the field of Optics and Photonics. By bringing talented undergraduate students from leading colleges and universities, our community has early access to a promising talent pool from which we can recruit future PhD students. Furthermore, the Winter School provides an opportunity for these students to form lasting connections with their professors and peers. This connection allows us to foster a community of ambassadors for Optics and Photonics at their home institutions, promoting the importance and benefits of pursuing a career in the optics field. Ultimately, the goal is to recruit the best graduate students to the field, in the face of an increasingly competitive academic environment, and to build a strong network of professionals dedicated to advancing Optics and Photonics research and education.

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Note: All co-authors are the 2023 OSWS Committee members and listed in alphabetic (last name) order except the first author.

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2. OPTICAL SCIENCES WINTER SCHOOL PROGRAM

The Optical Sciences Winter School is usually planned as a three- to five-day program. The 2023 OSWS was scheduled as a four-days long event and offered exciting first two-days introductory lectures on core areas of optical sciences as presented in Figure 1. Through engaging and interactive sessions led by esteemed faculty and industry experts, participants will gain a strong foundation in the fundamental principles of optics and photonics. The Winter School's comprehensive overview of optical sciences is a tailored opportunity to enhance a student's understanding and skills. It is filled with two days of illuminating lectures and hands-on activities that will inspire and empower participating students to join the optics society, make meaningful contributions to the field of optics and photonics. The first two-days long lecture program of the 8th OSWS program in 2023 is shown in Figure 1 as an example.

Wednesday, Jan. 4, 2023
(All sessions at Optical Sciences 307)

8:00	Breakfast	
8:50	Welcome	Prof. Jason Jones
9:00	*Introduction to Image Science*	Prof. Lars Furenlid
10:00	Break	
10:20	*Low-cost, in vivo microscopy*	Prof. Dongkyun Kang
11:00	*Real-Time Modeling of Imaging Systems: The role of Modern Gaming Architectures in System Development, Analysis, and Optimization*	Prof. Matthew Kupinski
11:40	Lunch (Optical Sciences)	
1:00	*Introduction to Optical Physics*	Prof. Jason Jones
2:00	Lab tours	
3:30	*Radiation Pressure in Modern Physics*	Prof. Dalziel Wilson
4:10	Break	
4:30	*Quantum Optics*	Prof. Poul Jessen
5:10	Break	
6:30	Dinner (Gentle Ben's)	

Thursday, Jan. 5, 2023
(All sessions at Optical Sciences 307)

8:00	Breakfast	
9:00	*Introduction to Photonics*	Dean Thomas Koch
10:00	Break	
10:20	*Compact ultrafast fiber lasers and applications*	Prof. Khanh Kieu
11:00	*Nanophotonics*	Prof. Euan McLeod
11:40	Lunch (Optical Sciences)	
1:00	*Introduction to Optical Engineering*	Prof. Meredith Kupinski
2:00	Lab tours (including the Richard F. Caris Mirror Lab)	
3:40	*Ultrafast lasers as tools for optical fabrication and alignment*	Prof. Brandon Chalifoux
4:20	Break	
4:40	*Adventures during the Pandemic: Engineering a Remote Imaging Telescope*	Prof. John Hayes
5:20	Break	
6:30	Dinner and Poster Session (The Graduate Hotel)	

Figure 1. The first two-days long optical sciences lecture sessions (out of the total four-days long program in 2023) covers the introductory topics on the core areas of optics and photonics during the 8th Optical Sciences Winter School program in January 2023.

During the following two days of 2023 OSWS (Note: This can be changed depending on the total days of the OSWS program accommodating the number of students, participating schools, and the year's academic calendar.), for students interested in pursuing a graduate degree in optics, there are sessions introducing and promoting diverse optics and photonics programs available across the United States. These programs (shown in the red boxes in Figure 2 and 3) offer a wide range of opportunities for students to explore the field of optics and photonics, from fundamental research to practical applications in areas such as physical/quantum optics, optical communications, bio-medical optics, lasers, imaging science, and optical engineering.

Friday, Jan. 6, 2023

(All sessions at Optical Sciences 307)

8:00 Breakfast

8:45 Euan McLeod, University of Arizona
Welcome, Introduction to Optical Sciences at the UA

9:00 Keynote: Marcia Rieke and George Rieke, University of Arizona
JWST - triumph of engineering and science

9:50 Break

10:20 Session Chair: Euan McLeod
Katie Schwertz, Edmund Optics (UA Optics Alumna)
Forging a Career in the Optics & Photonics Industry

10:40 Kyle Myers, Former U.S. Food and Drug Administration Official (UA Optics Alumna)
How an Optical Sciences grad can impact medical device evaluation and regulation

11:00 Panel discussion: K. Schwertz, K. Myers, N. Lima, T. Sawyer

12:00 Lunch (Optical Sciences)

1:10 Session Chair: Masud Mansuripur
Arash Mafi, University of New Mexico
Laser Cooling of Yb-Doped Silica Glass

1:35 Thomas Brown, University of Rochester
East and West: How Rochester and Tucson Together Led the World in Defining Optics

2:00 Lab tours (including the Richard F. Caris Mirror Lab)

3:40 Session Chair: Brandon Chalifoux
Maxim Sukharev, Arizona State University
Computational nano-optics

4:05 Selim Unlu, Boston University
Commercialization of Interferometric Reflectance Imaging Sensor – A journey of innovation and entrepreneurship in and academic laboratory

4:30 Break

4:50 Session Chair: Brandon Chalifoux
Hong Hua, University of Arizona
Optics in Virtual and Augmented Reality Displays

5:15 Joe Shaw, Montana State University
Advancing the Optics and Photonics Frontier in Montana

5:40 Break

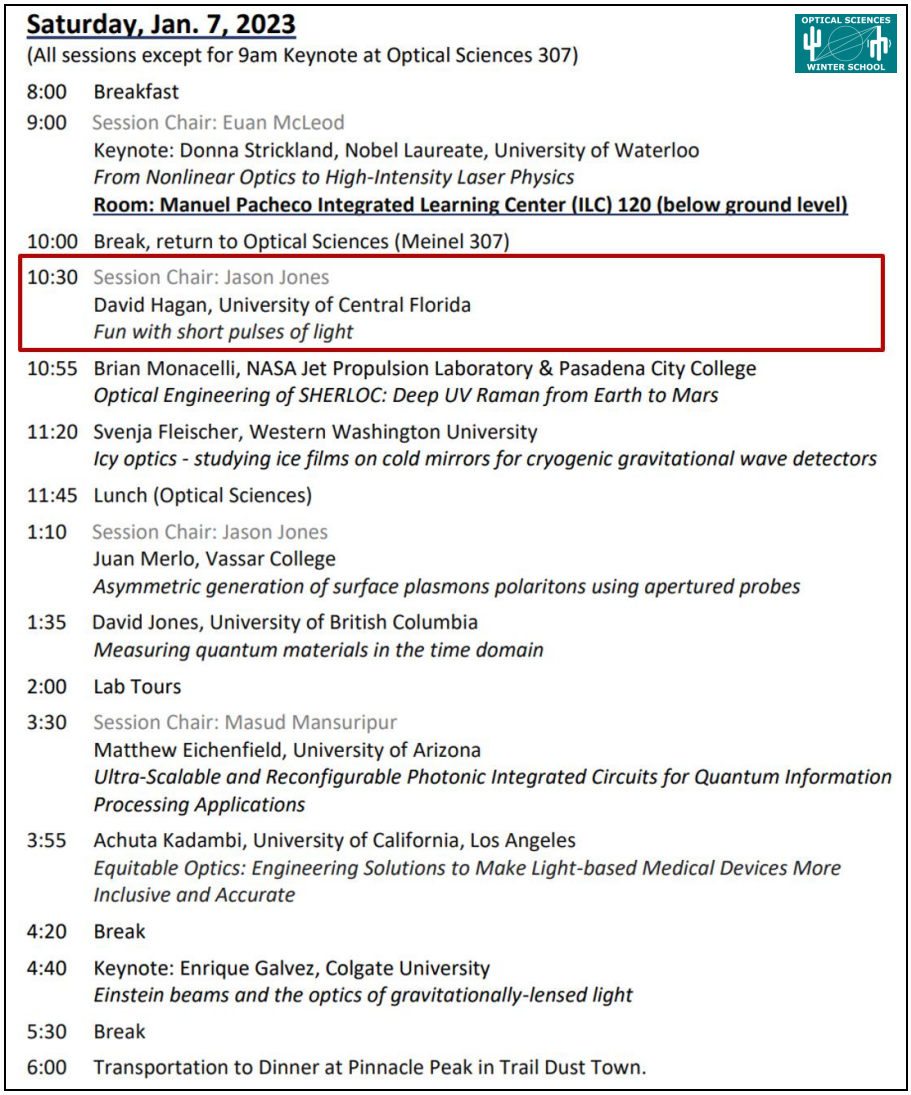
6:30 Banquet (Bear Down Gymnasium)

8:30 (or earlier) Session Chair: Lars Furenlid. After-dinner talk, Center for Creative Photography
John Schaefer, University of Arizona
Putting Optics to Use

Figure 2. The third day program (out of the total four-days long program) includes the introduction of various excellent graduate optics programs in US (red boxes) and the panel discussion with the former graduates for career path questions and answers (blue box) during the 8th Optical Sciences Winter School in 2023.

Each of these programs boasts distinguished faculty members, state-of-the-art facilities, and a rich history of groundbreaking research in the field. Whether students are interested in pursuing a career in academia, industry, or government, these graduate programs offer an excellent platform to gain the knowledge, skills, and experience necessary to succeed in their future career. With a wealth of resources and opportunities available through the various educational programs in US, a graduate degree in optics can open doors to a world of exciting possibilities for the students.

Also, the Optical Sciences Winter School offers a unique opportunity for students to engage with successful former graduates from the optics and photonics programs in the US. During the Winter School's panel discussion (e.g., blue box in Figure 2), attendees will have the chance to ask questions and learn about different career paths in the field of optics and photonics. The panel will feature graduates who have gone on to exemplary careers in academia, industry, and/or government, sharing their experiences and insights on what it takes to succeed in each of these areas. Participants will have the opportunity to hear about the realistic challenges and rewards of pursuing a career in optics, as well as tips for navigating the job market and finding the right fit for their skills and interests. The panel discussion provides an invaluable opportunity to gain practical advice and guidance from those who have walked the same path.



Saturday, Jan. 7, 2023

(All sessions except for 9am Keynote at Optical Sciences 307)

OPTICAL SCIENCES WINTER SCHOOL

8:00 Breakfast

9:00 Session Chair: Euan McLeod
Keynote: Donna Strickland, Nobel Laureate, University of Waterloo
From Nonlinear Optics to High-Intensity Laser Physics
Room: Manuel Pacheco Integrated Learning Center (ILC) 120 (below ground level)

10:00 Break, return to Optical Sciences (Meinel 307)

10:30 Session Chair: Jason Jones
David Hagan, University of Central Florida
Fun with short pulses of light

10:55 Brian Monacelli, NASA Jet Propulsion Laboratory & Pasadena City College
Optical Engineering of SHERLOC: Deep UV Raman from Earth to Mars

11:20 Svenja Fleischer, Western Washington University
Icy optics - studying ice films on cold mirrors for cryogenic gravitational wave detectors

11:45 Lunch (Optical Sciences)

1:10 Session Chair: Jason Jones
Juan Merlo, Vassar College
Asymmetric generation of surface plasmons polaritons using apertured probes

1:35 David Jones, University of British Columbia
Measuring quantum materials in the time domain

2:00 Lab Tours

3:30 Session Chair: Masud Mansuripur
Matthew Eichenfield, University of Arizona
Ultra-Scalable and Reconfigurable Photonic Integrated Circuits for Quantum Information Processing Applications

3:55 Achuta Kadambi, University of California, Los Angeles
Equitable Optics: Engineering Solutions to Make Light-based Medical Devices More Inclusive and Accurate

4:20 Break

4:40 Keynote: Enrique Galvez, Colgate University
Einstein beams and the optics of gravitationally-lensed light

5:30 Break

6:00 Transportation to Dinner at Pinnacle Peak in Trail Dust Town.

Figure 3. The last day program (out of the total four-days long program) includes the introduction of more graduate optics program in US (red box), lab tours, and the final day dinner gathering during the 8th Optical Sciences Winter School in 2023.

3. OUTREACHING FURTHER AND FURTHER

3.1 Continuing Episodes of Optical Sciences Winter School with Thankful Supports

Since the first Optical Sciences Winter School in 2016, the annual OSWS event has been a continuous success and achievement as shown in the series of group photos (Figure 4) of the educational outreaching event.

Figure 4. The Optical Sciences Winter School group photos from the first 2016 event (top left) to the 8th event in 2023 (bottom right). The virtual group photos for the two digital OSWS events during the COVID-19 pandemic in 2021 and 2022 are shown in the third and fourth rows.

The continuing success is largely thanks to all the motivated participating students, supporting schools across US, contributing faculties, and the sponsoring foundations, societies, and sponsors including the National Science Foundation, Gretler Foundation, SPIE [2], DeMund Foundation, Alfred P. Sloan Foundation, TRIF, OPTICA, and Wyant College of Optical Sciences at the University of Arizona.

3.2 Outreaching beyond COVID-19 via Hands-On Experiment Kits

The Optical Sciences Winter School has been continuously growing since its first successful event in January in 2016. Until the 2020 OSWS event, the OSWS have reached out to various schools and programs across the United Stated as marked in Figure 5 and the OSWS committee was planning to reach out to even more optics programs and schools.

Figure 5. The accumulated Optical Sciences Winter School outreach map marking the participated schools as of January 2020 just before the major COVID-19 pandemic storm hits the world and limits all in-person activities. The OSWS committee had to plan a digital OSWS for the 6th Optical Sciences Winter School event in 2021.

Soon after the 5th Optical Sciences Winter School in January 2020, the COVID-19 pandemic changed the world once forever. The OSWS committee had to rethink the format of the event and decided to switch to a digital event to follow the rapidly changing public health safety regulations.

One of the biggest concerns of a digital event was the lack of hands-on experiments due to the virtual nature of the program. The committee came up with a solution creating more than 50 boxes of Hands-On Experiment Kits (shown in Figure 6) with an excellent help from the OSWS student committee members who were the previous OSWS attendees and were the graduate students (Gregory Nero, Jenna Montague, Clarissa DeLeon, and Charles Condos) in the optics program in 2020 at the Wyant College of Optical Sciences, University of Arizona. Also, a local high school intern student Victoria Franco at the San Miguel High School helped the packaging of the boxes with the graduate students. This is a wonderful story highlighting the educational value of the OSWS serving our future generations through evolving education chains.

Figure 6. The 2021 OSWS student committee team prepared more than 50 boxes of Hands-On Experiment Kits for the digital Optical Sciences Winter School event during the COVID-19 pandemic in 2020 – 2021. (Time-lapse Video 1: http://dx.doi.org/doi.number.goes.here)

Thanks to the Hands-On Experiment Kits the OSWS students were able to experience hands-on learning through virtual lectures. As one of the lecture sessions utilizing the Hands-On Experiment Kits, Prof. Euan McLeod provided each student with a kit containing various optical components that they could use to follow along with his lectures from the comfort of their own homes as shown in Figure 7. Through this unique approach, students were able to gain practical experience in optics and photonics, without the need for in-person laboratory sessions. The virtual hands-on lectures were a resounding success, providing students with a rich learning experience that was engaging, interactive, and effective. By overcoming the challenges posed by the pandemic, the Optical Sciences Winter School team and partners demonstrated their commitment to providing high-quality education and training in optics and photonics, no matter the circumstances.

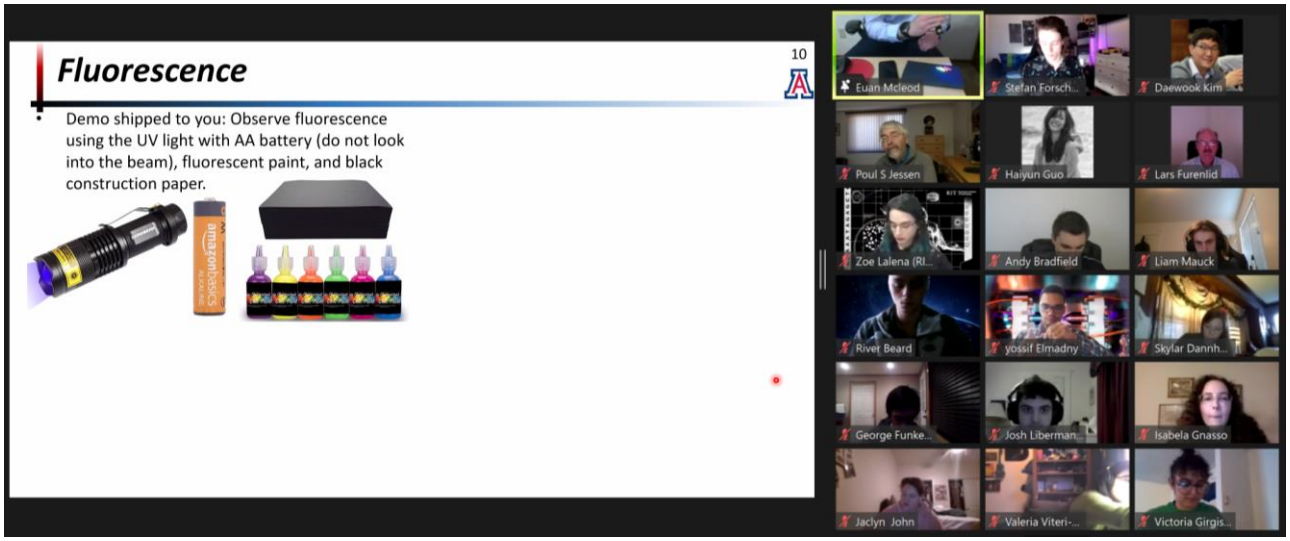


Figure 7. Prof. Euan McLeod (his hands are shown in the highlighted green box) provided a virtual hands-on lecture using various optical components in the Hands-On Experiment Kits delivered to each student's home for the digital Optical Sciences Winter School in 2021. This approach greatly enhanced the participating students' educational experience interacting with actual materials and components during the challenging pandemic period.

As a result, the digital Optical Sciences Winter School in 2021 in the middle of COVID-19 storm made another meaningful success with more than 51 students from more than 26 participating schools including Pomona College, Rose-Hulman Institute of Technology, University of Rochester, College of Charleston, Bethel University, Colgate University, Greenville University, Illinois Wesleyan University, University of Nevada - Reno, Georgia Institute of Technology, Rochester Institute of Technology, Boston University, College of William & Mary, University of Wisconsin - River Falls, Harvey Mudd College, Elon University, Northern Arizona University, California State Polytechnic University – Pomona, University of Dayton, Denison University, Vassar College, Case Western Reserve University, UCLA, University of New Mexico, Carleton College, University of Central Florida (CREOL), and more.

4. FUTURE VISION AS A COMMUNITY

Optical Science and Photonics are critical and emerging fields that are often overlooked in traditional undergraduate science and engineering curricula. Although aspects of optics and photonics may be covered as side topics in undergraduate and graduate courses, they are not given the full attention they deserve in the era of light and photons. This Optical Sciences Winter School aims to reach out to future generations to provide a comprehensive overview of foundational topics in optics and their relevance to current research.

Figure 8. The success of the Optical Sciences Winter School and Workshop is due in no small part to the generosity and dedication of the scientists who participated in the event. These kind-hearted individuals volunteer their time, expertise, and resources to share their knowledge and inspire the next generation of leaders in the field of optics and photonics. The photos show Dr. Marcia Rieke, Dr. Donna Strickland, Dr. George Rieke, and Dr. Eric Mazur (clockwise from the top-left) who gave inspiring talks to the students. There are many other excellent speakers who gave priceless talks at the OSWS events whom the OSWS committee gives endless thanks to their contribution to this educational outreaching mission.

Most of all, we must do this as a scientific society, as a supporting team, and as a caring society. The annual event has been bringing and will bring together an excellent and highly motivated group of undergraduate students for a unique and interactive experience. This mission is never about a specific school's program. Instead, we try to highlight the diverse optics programs in the United States. The Optical Sciences Winter School has been featuring distinguished faculties and industry professionals who generously shared their time, knowledge, and expertise on the latest advancements in optics and photonics. There are so many kind minds helping to enable future students in our optics society and four of them are shown in Figure 8. We hope to educate our next generations, and they will educate their next generations. By caring and reaching out to our students, the future of our society will be even brighter. We invite our optical sciences community to join us for this exceptional opportunity to share, teach, and engage in the field of optics and photonics.

ACKNOWLEDGEMENT

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[2] Daewook Kim, "Optical Sciences Winter School," SPIE Community Development Showcase, SPIE Photonics West, San Francisco, 2023