

CLUSTER 5: Photonics: Light-based Technologies in Everyday Life

Only one week into the COSMOS program and it's already been a wonderfully exciting and rich learning experience for everyone. After an eventful Opening Day and introduction to COSMOS, our first day as a group in Cluster 5 began with an interesting Laboratory Safety Training session where we learned about proper eye protection when working with lasers. With many types of lasers that operate at different wavelengths, it is very important to use protective glasses that correspond to the proper wavelengths to ensure safety. Immediately after the safety training, we were able to get started with a lecture from Dr. Charles Tu on some of the amazing ways light contributes to technological advancement in communications, energy production, health and biomedical applications, and nearly every aspect of science and life in general. After lunch, we went to the Photonics Lab in the Jacobs Engineering Building to learn about light refraction, prisms, and Snell's Law from Dr. Peter Ilinykh. Students then had the chance to conduct a lab with a Helium-Neon (HeNe) laser and a prism to verify Snell's Law experimentally and find the critical angle of the prism.

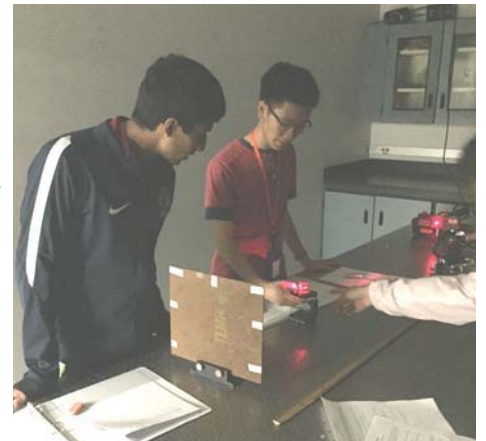
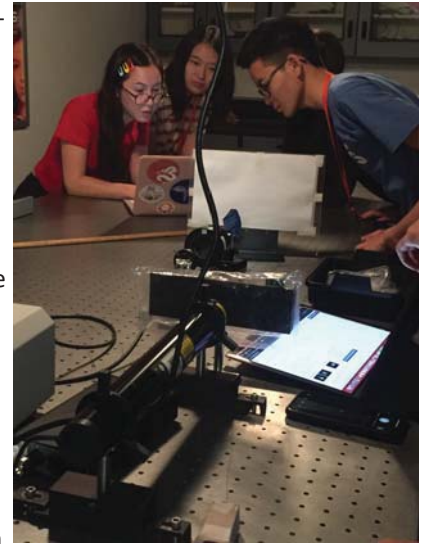
Tuesday began with the first Discovery Lecture of the program, from Dr. Nicole Steinmetz, a professor of Nanoengineering here at UCSD. She explained her exciting research on plant viruses being used to construct targeted and effective cancer treatments. Her research looks incredibly promising, and we will all likely be hearing about her work in the news in the years to come. After a look at our Science Communications curriculum and lunch, we tackled another lab with Dr. Ilinykh, this time involving prism refraction and diffraction grating spectrometry. Students took data to calculate the resolving power of the prism and the line spacing of the diffraction grating.

On Wednesday, the day started with an in-depth lecture from Dr. Tu on semi-conductor physics, n- and p-type doping, quantum numbers and energy levels, LEDs, and refraction and diffraction of light. Our laboratory work on this day involved a fun mini-project on mobile spectrometers. Each student had the opportunity to build their own spectrometer out of cardstock and a piece of a compact disc (CD) to use as the diffraction grating. Students took data using their mobile phone and uploaded the spectra to a great website called Spectral Workbench in order to analyze the data in detail. Students even

got to take their spectrometer with them to keep.

On Thursday, students got some helpful training on how to utilize the vast library resources online at UCSD before continuing work on their Ethics Essays. Students chose their topics and started researching relevant sources. In the afternoon lab session, students worked with LEDs and analyzed different wavelengths of light through various methods. It is becoming very evident that nearly every aspect of physics and engineering that relate to optics will be addressed throughout our lecture and lab sessions, and students will continue learning a lot!

We will be sure to keep you updated on Friday's happenings in the next newsletter, which will be written by the students. Please know that your students are learning, growing, and enjoying COSMOS and the beautiful San Diego weather!



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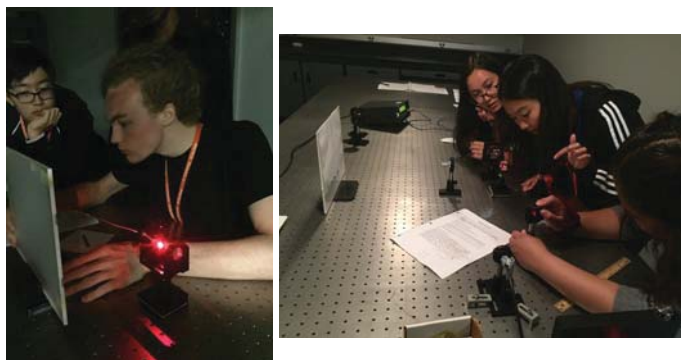


Somehow, we are already finishing up our second week of COSMOS! It sure is going fast, but that's what happens when you're having fun! Students in Cluster 5 are really settling in and getting comfortable with the morning lectures and afternoon labs, while still finding time to work on their Ethics Essays and have fun with their fellow COSMO-nauts. ;)



During the lectures with Dr. Charles Tu and Dr. Sarnaz Bagdadchi, students have been exploring some really interesting and high level physics and engineering topics. Just some of the topics include how semiconductor physics allows for LEDs, laser diodes, photodetectors, and solar cells, and how all of these ideas relate to fundamental geometric optics and enhance our technological society. Additionally, students saw some great optics demonstrations on chromatic and spherical aberrations from Dr. Janet Pan, with lights and lasers.

In the lab, students created their own solar cells using conductive glass plates, titanium dioxide, and berry juice as a dye to see which group could get the most current to flow from their cell. Also, they experimented with polarization, fiber optics, and interferometry as they started brainstorming and planning their Final Projects.



During the week, we were treated to a great Discovery Lecture by Dr. Rob Knight on how the Microbiome interacts with human and environmental health. Additionally, Eric

Takeuchi from Daylight Solutions stopped by to explain the work his company is doing with Quantum Cascade Laser technology. On Monday next week, we will take a field trip to Daylight Solutions and tour their amazing facility!

Another busy week full of interesting, exciting, and fun science! Here's what some of the students have to say about their experience with COSMOS so far:

"Being able to work in a team on the labs every afternoon taught me a lot about photonics. It was great experiencing the concepts we learned in class while also collaborating with my teammates." - Joy L.

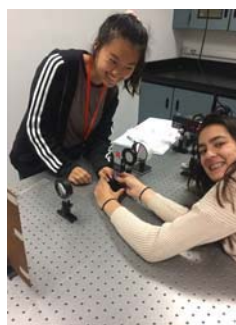
"I'm looking forward to making fun sounds with the holes in the tables everyday. And eating more mango popsicles :)" - Phoebe W.

"Working in a professional lab is very exciting and our experiments have opened up my interest in photonics! It is also really fun getting to know people in my cluster and making inside jokes with them." - Anne S.



"The best part of COSMOS would have to be interacting with the people here. I especially enjoy my suite time where I am able to just have a blast with the people in my hall playing games or just sharing stories." - Kevin C.

"I finally get to assimilate into this family two weeks into the program. Being a member in COSMOS encouraged me to step out of my tiny group to meet all the awesome individuals who enjoy the same principles as I do. I feel lucky to be part of this group." - Steven H.



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brand new facility so students could see their QCL infrared microscope (used to advance cutting-edge cancer-detection) and CAD software techniques, before finishing with a great discussion with one of the company's founders about optics, astronomy, and spectroscopy and Daylight's connections to all areas of science. It was a truly great trip!

Students in Cluster 5 have been tackling some great physics and engineering problems and seen some wonderful and interesting labs over the past week. In our lectures, students had the chance to learn about quantum cascade lasers (QCLs), quantum dots, LCDs, polarization of light, and holography from Dr. Tu, and biosensor science and applications from Dr. Baghdadchi. In the afternoon, students started planning and working on their group final project that will become their main focus for the remainder of the program. Many students also had the opportunity to go home or leave UCSD with their family for the Family Weekend – hopefully everyone enjoyed that time together!

On Monday this week, we took our much-anticipated field trip to Daylight Solutions and had a great time learning from and interacting with numerous scientists and engineers in the field of photonics. The wonderful staff organized three rotating mini-tours of their

Tuesday began with a great Discovery Lecture from Dr. V. "Ram" Ramanathan on climate change, the dire consequences of inaction, and the great potential within every one of these amazing students to change the world. Later, students had a chance to visit the Fallen Star art installation on the top of the Jacobs Engineering Building, and continue making progress on their final projects. In the evening, students saw a great discussion panel on Women in STEM and learned a lot.

On Wednesday, after a great lecture from Dr. Charles Tu on more detailed solar cell technology and demonstrations from Dr. Janet Pan on light scattering and rainbows, students continued to develop plans for completing their final project by the middle of Week 4 in order to be prepared for their presentations at the end of the COSMOS program. We won't give anything away just yet, but student groups have come up with some very innovative and interesting ideas for investigating scientific

phenomena in the world of optics and photonics – it is sure to be fun!

Thursday began the second Cluster Exploration session, followed by our Science Communication course. There, students discussed some of the most effective techniques for presenting science ideas and starting working on presentations. Finally, students continued to make some great progress on their final projects. Here are a few more quotes from students as we head into the final week of COSMOS!

"My favorite part of COSMOS so far was finding out that there are so many people who share the same interests as me. Every time I meet someone new, I am always surprised to find things after things we have in common with each other." - Nabeel S.

"The best moments I had in COSMOS so far is all the laughter and inside jokes we share with each other. We also build our relationships through the labs and whenever we hang out together." - Lilyan M.

"The best part of COSMOS is the connection everyone forms with each other through the long periods of time we spend together. From lectures to labs, we always have a way to get a laugh out of one another!" - Austin P.

"I liked learning what time purple was and learning how the face ID on Apple iPhones works." - Kiana S.

"Our cluster is filled with geniuses and goofballs. Correction: geniuses that are also goofballs. It's been such a fun time so far learning and laughing with you all." -Don L.



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Somehow it's already over, but COSMOS 2019 was a huge success! Students in Cluster 5 learned so much from their time with professors, hands-on experiments, and activities with new friends that surely created lasting memories and will inspire future scientific endeavors. Right now, students are working diligently on the final touches of their projects as they prepare to present at the Research Expo on Saturday.

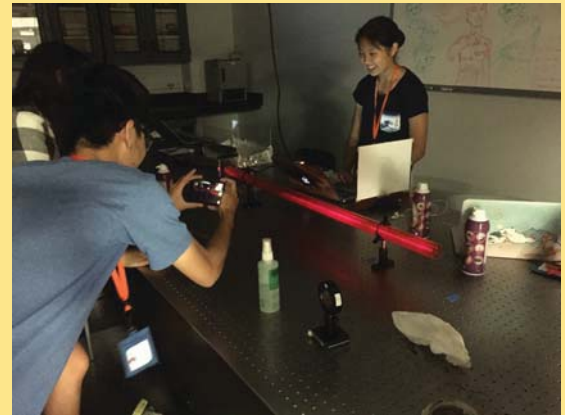
During lectures this week, students learned more about biosensors, optoelectronics, and how nanostructures influence color in nature and engineering. There was even a chance to discuss some solar spectroscopy and use a solar telescope to view the Sun. Finally, two of the most fun and interesting parts of the week were some hands-on activities. In the first, students built an electric circuit that converts sound (music from your cell phone) into a light signal from an LED that can be detected by a solar panel or photodiode and played through a speaker. In the second, students build a \$1 foldable microscope that could be used to magnify to an astounding degree. Students had a great time learning the circuitry, playing music with light, and learning about simple, yet powerful microscope technology!

The final Discovery Lecture of the program was a wonderfully interesting and engaging talk by Dr. Margaret Roberts on censorship in China and the Great Firewall. She explained her research and the impacts of internet censorship on citizens of autocratic countries as well as some potential effects around the world, and students were very interested and learned a lot.

Students are now working diligently on their projects; implementing plans, collecting and analyzing data, writing and practicing their

presentations, and preparing for the Research Expo on Saturday. Keep an eye out for the awesome Cluster 5 t-shirts

when you join us for the final day of COSMOS 2019! Here are a few send-offs from students.



"The time we spent in the photonics lab is by far the best academic activity our cluster provides. We have the opportunity to learn in a collaborative with like-minded peers while also being able to utilize lasers, lenses, and other various tools that we would have access to in a high school environment" - Austin P.

"I liked learning about how fiber optic cables worked in the lab because it is so cool how much information you can fit in just one fiber." - Nina H.

"I think that my favorite academic activity would actually be the lectures since a lot of the information was new to me and has taught me a lot about how semiconductors work in the molecular level and how lasers are made." - Emily C.

"What I enjoyed most about COSMOS was making tons of new friends with my cluster and roommates. During the first week, I didn't really enjoy the program, but my friends really made the next few weeks fly by, and now I'm really sad that we have to go back to our own separate lives in a few days. I loved complaining about Cafe V food with my cluster, listening to Prof. Peter's savage jokes, seeing Prof. Charles ride his bike every day, running under the beautiful morning sky (as exercise, definitely not because I was late to class haha), and more. Thanks for such a memorable month everyone!" - Rebecca M.

