



# SOCIETY OF PHYSICS STUDENTS

An organization of the American Institute of Physics

## Marsh W. White Award Proposal

Project Proposal Title	The Year of Light: Inspiring Kids with the Beauty of Physics
Name of School	Cleveland State University
SPS Chapter Number	1247
Total Amount Requested	\$500.00

### Abstract

Inspired by our departmental focus on optics and imaging, Cleveland State University's SPS will develop a set of monthly interactive lessons for K-7 school students about light. These lessons will be carried out through our established physics outreach ("Physics Fridays") with Campus International School, a public school in downtown Cleveland.

### Proposal Statement

#### Overview of Proposed Project/Activity/Event

Cleveland State University's chapter of SPS will continue our established physics outreach program ("Physics Fridays") for the students at Campus International School, a public K-7 school located in downtown Cleveland. Inspired by our department's strong emphasis on optics and imaging, we will develop a semester-long program to teach students about light. Our hands on lessons will walk students through the fundamentals of the physics behind light. Starting with demos and activities to illustrate the wave nature of light and its interaction with different materials, we will first teach the students about refraction, diffraction, and interference using monochromatic light. Next we will introduce the concepts of light's wavelengths and energy and help the students discover how color changes the way light interacts with materials. After establishing this foundation we will try out some new applications-based lessons, starting with conducting some basic experiments with lenses and mirrors and using this knowledge to explore cameras. We will also discuss some optics-based technologies, like optical fibers, solar panels, and LED. We will conclude the semester by designing a highly-interactive final lesson ("Optics Olympics") in which the students will have to use their knowledge of light in physics team competitions. Teams will race to complete in tasks like building mirror mazes, color mixing, design of spy optics (periscopes and fibers), in correctly answering light and optics trivia questions, in using reasoning to answer questions about colors of crystals in a chemical garden. We hope that using light, which kids interact with and experience every day, will help students to strengthen their already blossoming physics intuition.

Each specific lesson will be delivered via interactive activities and demos taught within the 1-1.5 hour timeframe that is the Campus International School (CIS) afterschool care program. The program—ran by

YMCA—is ever growing and caters to students from kindergarten to 7<sup>th</sup> grade. This presents a bit of a challenge for us, since the maturity, interest, and intellectual levels of our group are as widely diverse as the students’ ages. In recent years, in particular, we have been struggling to make the outreach accessible and exciting to everyone in the wide range of students. Focusing on optics will allow us to meet this goal, since we have already developed optics foundations lessons for the younger students (thanks to past Marsh White awards) and we can adapt those with more detailed information and new supplies for the older students who have already mastered the basics. Using optics and light, we hope to grab the attentions of both Kindergarteners and 7<sup>th</sup> graders, as well as learn (or remember!) something about physics ourselves!

### How Proposed Activity Promotes Interest in Physics

Our goal is to promote an interest in science (particularly physics) by cultivating inquiry-based discovery and development of science/physics intuition. We hope that through this set of lessons, where we will attempt to take the “hands-on” approach to a whole new level, we will bring out the scientific inquirer within all of the students. Moreover, we hope to inspire them to look at everyday objects and phenomena under a new “light”, seeing the physics behind them. By teaching the students about light, which they interact with and observe countless times each day, we hope to give them pieces of knowledge that they will think of often and recall in the future. One great illustration of this effect came the last time we taught students optics. We passed out diffraction glasses for part of the lesson and when the lesson was finished and the students were going home, we overheard one student excitedly telling his dad that white light is actually ALL of the colors of light together. His fascination with that “simple” idea, and the fact that he will likely think of this fact many times when he sees white light, is proof enough that even the simplest of concepts can have a lasting effect on a child’s curiosity about the world.

### Plan for Carrying Out Proposed Project/Activity/Event

- **Key Personnel**
  - Christian Gunder, CSU CME Major/Physics Minor; SPS Treasurer & Outreach Coordinator
  - Dan Terrano, Chem/Math/Physics major; SPS Vice President
  - Ilona Tsuper, Chem/Math/Physics major; SPS Secretary
  - Dr. Kiril Streletzky, advisor to CSU SPS, SPS National Zone Counselor, and CIS father
- **Marketing** – Identical to the previous year, afterschool staff will be notified of events two weeks prior to the event. Staff will continue to communicate with parents so that they may pick up their children later on physics days.
- **SPS member participation** – In addition to key personnel, 5-10 other students (physics, math, engineering majors/minors) will join us in our efforts. Many are national SPS members as our chapter rewards a semester long outreach with paid SPS membership.
- **Expertise** – Several members of the earlier outreach team will aid us in our efforts:
  - Krista Freeman, 2011 CSU Physics Graduate, PhD candidate at Carnegie Mellon University, outreach program co-founder, outreach program advisor
  - Jim Pitchford, 2011 CSU Math Graduate, science writer, past outreach coordinator
  - Janna Mino, 2015 CSU Chemistry & Physics Graduate, previous SPS vice presidentThe expertise offered from these previous members give current outreach members valuable insight and added experience to the core of the group.

### Project/Activity/Event Timeline

- I. **Wave Nature of Light (January 2016)**  
Refraction, diffraction, interference with monochromatic light
- II. **Energy and Wavelength (February 2016)**  
Refraction, diffraction, interference and dispersion with polychromatic light
- III. **Lenses, Mirrors, and Cameras (March 2016)**  
Experiments with lenses and mirrors, pinhole & SLR cameras, and film
- IV. **Light-Based Technologies (April 2016)**  
Fiber optics, neon signs, solar panels, light scattering
- V. **Optics Olympics (May 2016)**  
Mirror maze races, color mixing competition, spy optics design clinic, optics trivia, deductive reasoning competitions

For each of these planned outreach events, we will develop detailed lesson plans to ensure the students get as much out of the experience as possible. After each event, students will receive an educational take-away gift related to the topic of the day (e.g. diffraction glasses, glow sticks, etc). When feasible (for example, during the first two lessons where we build a foundation of optics and during the Optics Olympics) we will tailor activities and demonstrations to the diverse ages of students in our group.

## Activity Evaluation Plan

The outreach events will be carefully documented via: 1) lesson plan outlined and detailed for every outreach event; 2) photo-reports with multiple rehearsals from CSU and subsequent activities at CIS; 3) careful archiving of each of the activity's selection of equipment; 4) recorded number of kids and their respective grades for each activity; 5) surveys will be handed out to students, parents, and afterschool instructors to assess the overall effectiveness of our efforts. Moreover, outreach members will also be given a quick survey to assess the impact of the activities on themselves.

## Budget Justification

The SPS outreach team has already developed some optics demos with the aid of previous Marsh White awards. We also enjoy a collaboration with CSU's Physics Department, which provides a wealth of optics-based equipment. However, we would like to have the dedicated outreach optics equipment. Also, we have several new applications-based lessons to develop. In particular, we would love to have supplies to effectively teach about the workings of cameras, solar panels, LEDs and fiber optics. In addition, we want to realize a long-standing dream to create an "Optics Olympics" –complete with mirror mazes, which we have struggled with in the past.

We request funds for tools dedicated to our applications-based lesson plans and Optics Olympics:

- I. **Wave Nature of Light (January)**  
[Eisco Lab Complete Optics Bench and Attachment Set](#) to help explore a variety of Optics phenomena
- II. **Energy and Wavelength (February)**  
[Eisco Lab Complete Optics Bench and Attachment Set](#) to help explore a variety of Optics phenomena  
[4M Illusion Science Kit](#) – a great set of the optical illusions with explanations  
Neon Paper Pack
- III. **Lenses, Mirrors, and Cameras (March)**  
[Eisco Lab Complete Optics Bench and Attachment Set](#) to help explore a variety of Optics phenomena

[Bigshot Camera](#) to teach about the optics within cameras.

IV. **Light-Based Technologies (April)**

[Eisco Lab Complete Optics Bench and Attachment Set](#) to help explore a variety of Optics phenomena

[Solar panel educational kit](#) would help to show how light can be converted to energy;  
[LED Bracelet](#)

V. **Optics Olympics (May)**

“[Laser Maze Logic Game](#)” for the mirror maze competition with 60 different Challenges to tailor the competition difficulty according to age groups

We hope that, with these funds, we can utilize these materials to help these children grow intellectually, and come out with a newfound affinity for light and physics.