SOCIETY OF PHYSICS STUDENTS
An organization of the American Institute of Physics

Marsh W. White Award Proposal

Project Proposal Title	Fabulous Light Waves and their Applications
Name of School	Cleveland State University (CSU)
SPS Chapter Number	1247
Total Amount Requested	$500.00

Abstract

The CSU's SPS *Physics Fridays* outreach program would like to expand its outreach from middle school kids to high school. We will work with CSU alumna and former *Physics Fridays* coordinator who is currently a high school science teacher. This school is a public, choice STEM-designated K-12 school that serves over 1000 students from over 45 school districts in eight Ohio counties. The school maintains grades 7-12 on the Northeast Ohio Medical University's campus and has a strong biology, health, and medicine focus. Our outreach program will provide important physics fundamentals and advance basic understanding of physics behind common optical tools used in biology and medicine. "Fabulous Light Waves and their Applications" proposes a half day trip of the CSU SPS outreach team to the school in early spring to engage the students in interactive lesson with optical demonstrations. The high school students will then come to CSU to visit its Advanced Optics and Modern Physics teaching labs, and optics and biophysics research labs.

Proposal Statement

Overview of Proposed Project/Activity/Event

In 2011 CSU's chapter of SPS established an outreach program called *Physics Fridays* at the Campus International School (CIS), a local K-8 Cleveland public school located right next to CSU. Since then, physics students, CSU alumni, and Dr. Streletzky visited CIS several times throughout the academic year for an interactive physics exploration session with CIS students. The outreach program, which typically serves 30-50 kids in the CIS afterschool program, has won several Marsh W. White Awards from the National SPS.

This effort has been recently slowed down by COVID challenges (in particular, by strict restrictions during the afterschool program at CIS). As a result, we have started a collaboration with a high school science teacher, Ms. Janna Mino, at BioMed Science Academy in Rootstown OH. The school has a biomedical focus and strongly advocates for its graduates to continue into college after graduation, though largely into Biology, Premed, Biotechnology fields. *Physics Friday* recently visited seniors in the school with an interactive lesson on waves. The seniors were engaged by the demonstrations and curiously asked questions throughout the explanations of physical phenomena.

Ms. Mino, who was 2013-2014 coordinator of the *Physics Fridays* and the co-author of the 2014 CSU's Marsh White proposal, together with several other science teachers at BioMed Science Academy feels that their students would benefit from a stronger foundation in and greater exposure to physical science. According to Ms. Mino, such foundation should not only prepare students better for careers in Biology, Medicine and Bioengineering but could also open other possibilities for student to other fields such as physics and math. She also points out that, despite the connection to a medical school campus, a portion of students are more interested in fields like engineering or technology than medicine, which require physics knowledge as well. BioMed seniors reflected that they were particularly impressed by the passion and level of depth our SPS officers presented during our visit. The CSU students (who until this trip had only experience of outreach in middle school) in turn really appreciated the challenge of presenting to high school seniors.

This trip brought up a discussion of doing a focused Spring semester program with BioMed Science Academy focused on light waves and their common applications in biomedical and bioengineering fields. The SPS students of the *Physics Fridays* program, after consultation with Ms. Mino and their SPS advisor Dr. S, decided to propose two half day outreach events for the BioMed high school students. First, we will again visit BioMed Science Academy in the early spring to bring an interactive demonstration-based lesson ("Fabulous Light Waves and their Applications ") on light waves and their applications in biomedical/bioengineering fields. The lesson will be followed by informal discussion between high school students and CSU students about waves, optics, college, and various career paths. Second, the same students of BioMed Science Academy will come to CSU in late spring. During this trip, high school students will get to visit Advanced Optics and Modern Physics teaching labs at CSU, where they will be introduced by Dr. S to more advanced optical phenomena usually studied by college students. The trip will also include visit by BioMed students to several CSU research labs that focus on optics, followed by a social hour with student researchers from these labs. Finally, students will be guided by two SPS officers, Patrick and Jordan, in a Hologram making session in the Optics lab of CSU.

How Proposed Activity Promotes Interest in Physics

Many high schools do not require physics courses or prioritize integrating authentic physical science curriculum into their scope and sequence. Particularly in an environment with a strong life science focus and access to impressive biomedical technology, a foundational understanding of basic physics is crucial and can help those students more deeply understand these biological processes and tools. More importantly, this kind of exposure may be the first deep dive into pure physics that some of these students ever receive, which may open doors for them to pursue further physics education. Being able to intervene with engaging physics demonstrations from passionate, experienced physicists and students at this level, when students have a stronger math background than younger students may be the perfect timing to convince them of the possibilities in physics before they choose a college and career path.

Plan for Carrying Out Proposed Project/Activity/Event

- **Key Personnel**
  - Andrew Scherer, physics and environmental science major, SPS President and Outreach Coordinator
  - Patrick Herron, physics major, SPS secretary
  - Jordan Miller, physics major, SPS treasurer
  - Jim Pitchford, 2011 math alum from CSU, one of the co-founders of SPS *Physics Fridays*
  - Dr. Kiril Streletzky, SPS Advisor and Outreach Supervisor
- **Marketing**
  - Similar to the previous year, school staff will be notified of events a least two weeks prior to the event. Staff will continue to communicate this info to students and parents. In addition, Ms. Janna Mino (Science Teacher, BioMed Academy, Rootstown OH) will help to coordinate our activities.
- **SPS Member Participation**
  - In addition to key personnel, 3-6 other students (physics, math, engineering majors) will join us in our efforts. Many are national SPS members, as our chapter rewards a yearlong outreach with a paid SPS membership.
- **Expertise** – Several members of the earlier outreach team will help us:
  - Ms. Janna Mino, 2015 physics alum, *Physics Fridays* outreach coordinator 2013-2014, science teacher at BioMed Science Academy, Rootstown OH
  - Dr. Krista Freeman, 2011 physics alum, *Physics Fridays* outreach co-founder and coordinator 2011-2012, postdoctoral fellow, University of Pittsburgh PA
  - Ms. Tara Peppard, CSU Lab Manager

Project/Activity/Event Timeline

Two events are planned under proposal:

I. **Visit by CSU SPS outreach team of BioMed Science Academy in Rootstown (late January-early March):** The half day visit on a Friday by the group of CSU students will include a set of hands-on optics demonstrations with a focus on explaining to BioMed students how physics is essential in understanding optical phenomena used in Biology, Bioengineering, and Medicine. The Fabulous Light Waves lesson will consist of:
   - **a.** Introductory Demo (~20min) for BioMed students on wave properties of light with
     - **i.** Spring demo-based discussion of light wavelength, amplitude, phase, polarization

ii. Giant concave/convex mirror and lenses discussion of light reflection and refraction
iii. Giant grating and prism discussion of light dispersion and color addition
iv. Ripple-tank discussion of light interference and diffraction
v. Fluorescent dye, colored solutions and solar panel discussion of light absorption

b. Four student stations for closer hands-on examinations of optical phenomena by smaller groups of BioMed students (~15 mins each).
   i. Reflection/Refraction station with Ray Optics Demonstration set, mirror mirages, and several demos of the total internal reflection (including introduction of fibers).
   ii. Optical devices station with an Eye model, microscope and telescope models, and pinhole and SLR cameras.
   iii. Polarization/Absorption station with simple linear polarizers, 3D glasses, calcite crystals and other birefringence examples and gammy bears and light sources of different colors (lasers and LEDs). Solar panel kit will also be used.
   iv. Dispersion station with a simple prism set up, gratings glasses, gas lamps of different sources and various model spectrometers including a hand made one.
c. A quick summary to all students about learned concepts.
d. The optics lesson will be followed with college student round table where CSU students from the outreach team will answer additional questions about Optics lesson and share their experience at CSU in academics, research, and SPS.

II. **Visit by BioMed Science Academy to CSU (Late April-May):** As a highlight of the program, BioMed students will visit CSU on a Friday for another half-day Optics emersion. The visit will consist of:

a. Advanced optics lab demos on light interference and diffraction through laser demos on slits and apertures, Fresnel spot, Fresnel lenses, white light interference in Michelson interferometer, Monochromator and FTIR demos, and holography demos (~20min).
b. Modern Physics lab demos on X-ray transmission and diffraction, X-ray CT (~20min).
c. Visits to CSU research labs on Optical Trapping of Cilia, Laser Light scattering, electron microscopy (~60min).
d. A completion by BioMed students of a group Holography project in the Optics Lab under guidance of CSU physics students and Dr. Streletzky (~40min).
e. Social Hour with CSU student researchers and faculty (~40min).

Activity Evaluation Plan

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

Budget Justification

The budget for the proposal includes several items that the *Physics Fridays* outreach program would need for successful implementation of this proposal. Some of the demos are already in the library of Physics

Fridays, other have been borrowed repeatedly from the Physics Dept at CSU. For this proposal we would like to request the following: 1) Ray Optics Demonstration Set - while we borrowed it from the Physics Dept before we recently run into a difficulty of scheduling conflict, therefore we would like to get our own *Physics Fridays* set up for the demos at the BioMed Academy (~$110); 2) 6 Quantitative Spectroscopes so that we could easily take them with us to the BioMed Academy (~$60); 3) 20-pack Hologram Kit to be used by BioMed students when they come to CSU (~$130); 4) 3 Hand Build Microscope kits ($200).