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

Marsh W. White Award Proposal

Project Proposal Title	The Power of Light: Increasing Interest in Physics Through Optics
Name of School	University of Dayton
SPS Chapter Number	1500
Total Amount Requested	$500.00

Abstract

We will design and build three new optics-based physics demonstrations to increase interest in physics in local high school students. We have identified two high schools connected to the university, including one that focuses on underrepresented minorities. We will also use the demonstrations at our other outreach events.

Proposal Statement

Overview of Proposed Project/Activity/Event

This project aims to increase interest in physics among high school students who are potential physics majors and may consider attending the University of Dayton (UD). The students we will target include underrepresented minorities from the Dayton area.

The UD SPS chapter has a long history of outreach to the children in the Dayton area, focusing on K-6 students. Our chapter has participated in TechFest, a large-scale STEM demonstration event that sees thousands of student participants, every year for over a decade. We received the 2018-19 Marsh White award for designing and building demonstrations to promote interest in physics in elementary school-aged children. That award enabled us to increase our outreach, and we found new opportunities for interacting with students. Based on these successful efforts, we would now like to extend our outreach to high school students, especially those in the area surrounding the UD campus.

We plan to recreate three experiments that changed our understanding of light: Thomas Young's double-slit experiment, a demonstration of the quantum Venn diagram paradox, and a demonstration of the photoelectric effect. We chose these to challenge the intuition developed in students' earlier experiences and encourage them to think deeply about how light works and how it interacts with the world as they know it.

The demos will allow us to conduct outreach aimed at a more mature set of students than our existing equipment, which is geared more towards elementary school students. Once we have our new demos built, we plan on initially working with two area high schools: Chaminade Julienne High School (Chaminade) and Dayton Early College Academy (DECA). UD is a Catholic, Marianist institution, and it often recruits incoming undergraduates from Marianist high schools. Chaminade is one such school that is located only a mile from the UD campus. Our Physics department has had several Chaminade alumni graduate from our program, so there is a natural connection to this school. DECA is a program for minority students in the Dayton area where they attend high school and college courses at a UD campus facility. One of the physics teachers there is a recent graduate of the UD physics program, and he is excited about having our chapter interact with his students.

How Proposed Activity Promotes Interest in Physics

This project aims to develop a more profound interest in physics among students who will soon attend college. We hope to go beyond ideas that high school students have seen before and inspire excitement and curiosity in an age group of students that we have not previously targeted. The Marsh W. White Award will allow us to expand our current scope to increase interest in physics for students who are about to attend college.

The hope is that by showing these students some aspects of college-level physics in an accessible way, we can increase their likelihood of choosing a STEM major in college. Since these topics are typically not covered in a high school setting, these demonstrations may pique interest in quantum physics. The presentation will include details of how the original experiments were conducted and the potential of the initial study results to give an overarching understanding of the importance of the experiment. Supplementary and perhaps, more importantly, the presentation will link the experiment to current real-world applications of the physical effects that were uncovered in order to stimulate an interest in the concept being displayed. With relevant connections to real-world use, it becomes more likely that students would be inclined to care about the concepts being demonstrated instead of just short-term observance of a foreign concept. As an older audience is being targeted, it is more relevant to include sustenance to the presentations instead of pure shock and awe demonstrations that are

commonly used on younger children. Being that the goal is to stir among this group of students to consider STEM careers, it is imperative to demonstrate how work in related fields is beneficial and rewarding to both themselves and others and can positively change the world.

Another benefit of these experiments is that they can easily be explained in terms of concepts that students find familiar. A brief explanation of the Bohr model will allow students to understand the concept of quantized energy and why these discrete states allow the photoelectric effect to occur. An explanation of wave interference in everyday life will allow students to understand why the double-slit experiment proves that light behaves as a wave. Finally, an explanation of light polarization will, along with the demonstration, further drive the point that there is a world of complexity in everyday interactions that can be described by physics.

A key element to our project is outreach to underrepresented minorities in physics. We are at a pivotal moment in history where institutional and systemic racism barriers are being exposed, examined, and torn down. This moment is vital for the field of physics, as is evidenced by the recent focus by SPS, American Physical Society (APS), the Optical Society (OSA), the American Institute of Physics (AIP), and other organizations on examining systemic racism. For example, the AIP National Task Force to Elevate African American Representation in Undergraduate Physics & Astronomy (TEAM-UP) recently released a report for recommendations for change in physics departments across the nation. OSA has formed a new Diversity Equity & Inclusion Rapid Action Committee (of which our faculty advisor is a member) for addressing systemic issues in its organization. This project aims to increase the representation of underrepresented minorities in physics and break down system racism barriers in physics.

Plan for Carrying Out Proposed Project/Activity/Event

SPS members and officers will be in charge of planning the event, collaborating with other student groups, and communicating with high school administration. The faculty advisor for this chapter will monitor our progress. We will communicate with the schools' faculty through our alumni to help plan our demonstration into their curriculum. We will design the demos to be presented to a class of high school students or at a convention booth. The presentation will cover how Young and Einstein made these discoveries and how they violated the classical laws of physics. The audience will interact with the experiments and observe the quantum aspects of light for themselves. At least two SPS members will be in charge of transporting the demonstrations and doing the presentations. We are considering collaboration with other student organizations that focus on outreach to students in the Dayton area.

Project/Activity/Event Timeline

The project has been broken into several individual tasks, as shown in Table 1. Contacting area high school teachers through our alumni network will begin immediately so that we can find suitable days and times for the classroom visits. We will also begin the design of the individual demos at that time. Once we have the demos designed, we will purchase all of the necessary materials. When we have all of the required materials, we will build and test the demos. The three demos may be built and tested at different times, but we anticipate they will all be done in this time frame. Once we have the demos built, we will design a lesson plan for our demonstration activities. Finally, when our plan is complete, we will give demonstrations at the two schools we indicated previously. Once our activities are complete, we will

Task	Time frame
Contact high schools	Dec-Jan 2021
Design demos	Dec-Jan 2021
Purchase materials	Jan-Feb 2021
Build and test demos	Feb 2021
Design lesson plans	Feb-March 2021
Give demonstrations	March-May 2021
Submit final report	May 2021

Table 1. Breakdown of tasks and time frames in which they will be completed.

complete and submit our final report by the due date of May 15th, 2021.

Activity Evaluation Plan

We will evaluate the effectiveness of our demonstration through surveying. Before giving our presentation to students, we will provide a survey gauging their interest in physics on a scale of 1-10. After our presentation, students will take another survey to measure the enjoyability, their understanding, and their interest in physics afterward. The surveys will be given over Google Survey for ease of analysis. Furthermore, we will ask that the teacher give their feedback on our presentation through email communication. With these two ways of evaluation, we will modify our presentation to make it more effective in generating enthusiasm for physics.

Budget Justification

All of the costs listed in the budget are for the construction of the three demonstrations. For the diffraction experiment, the laser and some other materials will come from our physics department, but will still need to buy some of our materials. This plan includes an optical breadboard and appropriate optomechanics for the placement of optical elements, which is our highest cost. We estimate that we will spend $350 for these parts, based on published prices from Thorlabs. The double-slit and electroscope experiments will require the construction of secure boxes with a glass window in them. The glass is necessary for the electroscope because the inside needs to be viewed and kept airtight. The glass window is necessary for safety reasons in the double-slit experiment. To avoid the need for a large number of safety glasses while we operate lasers, the box will be closed, and the laser will be secured in place to ensure it does not shine in anyone's eyes. We estimate the construction of these boxes to be $100, based on prices at local hardware stores. We will also need to purchase a UV lamp for the photoelectric experiment to show how differing wavelengths will affect the electroscope and a few miscellaneous other items, for which we estimate an additional cost of $50. This brings the total amount requested to $500.

Additional funding and support will be provided by the University of Dayton's physics department to cover any expenses that cannot be handled through the award budget. Our SPS chapter will also be using funds allotted for usual club activities to cover any additional needs.