



# SOCIETY OF PHYSICS STUDENTS

An organization of the American Institute of Physics

## SPS Chapter Research Award Proposal

<b>Project Proposal Title</b>	Reaching new heights: A low-cost stratospheric microbial sampler.
<b>Name of School</b>	College of the Canyons
<b>SPS Chapter Number</b>	1274
<b>Total Amount Requested</b>	\$2,000

### Abstract

The Society of Physics and Engineering Students at College of the Canyons is developing a low cost, 3D-printed stratospheric balloon payload to sample atmospheric microbial life. This project aims to make aero-microbiology research more accessible by combining affordable electronics and open-source design to explore microbial life in high altitude environments.

### Proposal Statement

#### **Overview of Proposed Project**

Studying microbial life in the upper atmosphere poses several problems regarding high cost, engineering know how, reusability and reproducibility for sampling. Our project aims to fill this gap in atmospheric and aero microbiology science by creating a low cost, easy to build, open-sourced 3D printed balloon payload that can be reused and provides a platform for sampling results that have low to no contamination.

Our club is working with a PhD student and adjunct professor at our college who was interested in sampling the mid to lower stratosphere looking for methane related organisms in those areas. To be able to do this repeatedly was a problem as current methods up to this point were more or less very expensive, requiring large balloons or aircraft which are out of reach for most research budgets. To mend this issue the club has designed and created a prototype small balloon payload that is low cost and easy to assemble and used to sample specific parts of the atmosphere. This will be open sourced, meaning that all of our 3D printing files, instructions, programs and electronics diagrams will be free for anyone interested, thus lowering the cost of entry into the aero microbiology space.

The main continuing goal of the project is to reduce complexity and cost of the current payload prototype so that it is accessible to the widest variety of groups as possible. This will help create many more data

points for types of microbial life at different levels of the atmosphere, and at different times of the year so that a greater understanding of the living part of our atmosphere on earth can be had.

This project has given many opportunities to bring physics and hands on research together for our club members. Aspects of understanding how balloons work, how air densities effect air flow, how to deal with extremities of the atmosphere such as low temperature and UV exposure and how our choice of materials will affect reusability and resistance to these extremes. These types of problems have brought our group together to work as a team to solve problems and has made us reach out to other disciplines to help understand materials and biology as well as brought in students of all backgrounds to work on the project from the greater school population. We hope to use this to also connect to other SPS chapters as they may be a great test bed for seeing if our project truly is easy to use, easy to assemble and launch. As this is a novel system, the club is also writing a paper for publishing about the technical aspects for the system and could present the research and design at conferences.

This project has two main goals. The first is trying to find methane related microbes in the lower stratosphere. The second goal is to create a payload for a weather balloon that can do this, while keeping it low cost and easily reproducible for other groups to try and expand the ability to take samples. The two goals are linked as we need to create a payload to sample the microbes. However, we are really interested in getting the project into other groups' hands to try and get more data points.

Microbial life travels across the world via winds and jet streams in higher parts of the atmosphere due to their low weight. While there is some data on what microbes go where, there is really little data on this in total, leaving a gap on understanding how and which microbes move around. It's possible as well that some microbes also live in these areas, being able to withstand extreme environments of the upper atmosphere as well while metabolizing gases like methane.

Our project is set to see if it's possible to create a low cost, open source, easily accessible platform for sampling microbes, or bio aerosols, at high altitudes in the atmosphere. Finding what and where lives are in the atmosphere can help us understand how they move around the world, and even possibly observe how diseases move around for humans, animals, and plants. As 3-D printers have fallen in cost and electronics and microcontrollers are easy and cheap to obtain, our group thinks that it will be possible to create a project where we can fill a blank space in the atmospheric sciences so that groups have a very low bar of entry to be able to contribute to the science as a whole.

## **Background for Proposed Project**

Being able to sample tropospheric and stratospheric microbial communities can help lead scientists to better understand how microbes of all types move around the world via various winds and jet streams that can move massive amounts of particles, including small life, around the world. Sampling this high is an obvious challenge, as the altitudes are generally accessible only to large payload ballons, sounding rockets or aircraft due to altitude. To further this problem, getting one or a few data points at one time in one small area does not help solve the problem of understanding upper-level atmospheric transport processes as a whole.

As microbes have many roles in our world and understanding the movement of microbes through the atmosphere could help better predict and prevent problems of all types. Movement of disease-causing microbes for agricultural crops could help predict and prevent outbreaks of disease, keeping our food supply more stable. The microbes and density of microbes also play a role in cloud formation and

possibly precipitation as well, so understanding patterns in how and when they move may also impact weather prediction.

To mitigate this issue of accessibility our club has created a novel, open access bio aerosol sampling platform that is easy to build and modify for specific needs. We have successfully launched the platform once; however, we are now working to develop a more streamlined second version of it, cutting weight, removing unnecessary electronics and making it even cheaper and easier for other groups or clubs etc. to get their hands on it and up into the air.

## **Expected Results**

By the end of this project we aim to establish whether or not microbes can live in the stratosphere, if so what types of microbes, and in what climates. We expect to capture biological samples on the payload through the use of bioaerosol filters. Post launch, the data will be processed in a lab allowing us to determine what microbes were present during our flight. From the data we will be able to profile what taxa appear consistently as we continue to perform launches into the foreseeable future. In addition, as our organization, or others, perform more launches we will be able to profile just what types of microbes can be found in different locations throughout the globe.

## **Description of Proposed Research - Methods, Design, and Procedures**

The parameter we focused on the most was altitude. To do this we sterilized the payload and use special protocols to prevent contamination within the payload before, during and after flight. "Based on systematic optimization results, 33-34 PCR cycles were selected as optimal amplification parameters for atmospheric bioaerosol samples. This cycle number represents a carefully balanced compromise that provides substantial taxonomic resolution enhancement over standard protocols while maintaining negative control contamination within acceptable limits for low-biomass sample analysis" (Kim). In addition to our constraint of microbes within the payload, we focused on capturing three different samples to compare against. We had the 2 controls and the experiment. The first control would begin collecting microbes once it reached a minimum altitude of 50m, and end collection once the second control began collection. This second control began collecting at approximately 5,000m and would end collection once the experiment began. The third chamber, or the experiment, began collection at approximately 15,000m and would remain open for 3 minutes before being commanded to close before descent.

## **Plan for Carrying Out Proposed Project**

We have approximately 5 current SPS members actively working on the project in addition to 2 Professors. We aim to have approximately 10 SPS members working on this project so it may be carried on into the future once current team members graduate. We have members on our team who already have extensive experience with undergraduate research as well as engineering. With the team's future expansion, we will have these current team members guide the new team members so they may contribute to and continue the project. Most of the engineering of the project happens in a classroom or at students' homes with the processing of the data occurring in a lab, and the sterilization of the payload occurring within a clean room present at our community college. The physics department contributes a space for the project, and one of our advisors is heavily involved in the direction of the project, and all of the lab analysis.

## **Project Timeline**

Currently we are working on the second iteration of the bioaerosol sampler experiment, the first iteration yielded successful results. We plan to finish design revisions for the second iteration of the experiment by the end of the second week of December 2025, then begin production of the second iteration immediately after, with a launch date for the second iteration of January 30<sup>th</sup>. Then we plan to have the third iteration designed, produced, and documented by the end of May 2026. Along with the third iteration we plan to start having other groups in other schools produce their own versions of the Bioaerosol Sampler Experiment using instruction from our organization.

## **Budget Justification**

The highest cost item for the project, regardless of what iteration we are on, will be the helium. For every launch we require helium and high-altitude balloons. Without getting the payload into the stratosphere, there is no point to this project, so it is both the most integral and most expensive portion of the project. We are asking for multiple balloons since it is possible that on site a balloon may be damaged and pop, and in addition since we plan to do continual launches, more balloons would be helpful. In addition to funding from this grant, this project is also receiving funding from the College of the Canyons ASG grant, and a UCLA grant. The project has received \$500 from the College of the Canyons ASG grant, and \$2500 from the UCLA grant.

## **Bibliography**

Berthet, K., Feany, M., Peraza, D., Jambe, L., Shahla, A., Hammond, S., (2025). *Breaking Barriers in Aeromicrobiology: Making Stratospheric Sampling Accessible, Affordable, and Reproducible for STEM Education*. Unpublished manuscript.