

## SURF application Qualifications and Research Interest

Please list the titles of courses (not just the course number) in your major that you have taken or will take prior to Summer 2025.

Ph 12a Waves

Ph 12b Quantum Physics

Ph 12c Statistical Mechanics

ph 5 Analog Electronics for Physicists

ph 6 Physics laboratory

ph 7 physics laboratory

Work Experience (including research experience):

### **Prof. J. Kirschvink's Geophysics Lab: Caltech - Research Assistant**

- Researched magnetic sense in planarians (flatworms).
- Conducted pipetting of chemical fixatives to create biological samples and maintained aquariums.
- Developed essential lab work ethics, such as stringent cleaning procedures.

### **Prof. S. Shimojo's Cognitive Neuroscience Lab: Caltech - Research Assistant**

- Conducted independent research on planarians/flatworms to test their memory abilities.
- Submitted a paper manuscript to a peer-reviewed journal, currently under revision.
- Presented findings to the Vision Science Society annual conference for 3 consecutive years.

Skills or experience which would be helpful in a research project in this field (i.e., programming, photography, building equipment or models, etc.):

- Proficiency physical lab equipment such as DAQs, signal generators, and oscilloscope: I've used these research-grade equipment in physics experiments to collect various physical data readings such as analog circuits behavior, soundwave intensity, light intensity and other sensor data. This will be helpful when collecting data on the polycatenated ring chain behavior with methods such as the laser vibrometer or load/tension sensor.
- Computer vision: My research project at Shimojo lab involved tracking planarian movement using AI computer vision, which can be applied to detecting the positions of each ring in the polycatenated ring chain to gather data on its motions.
- Experience studying coupled oscillator systems, wave equations, and Fourier analysis: Having studied the theory in these topics, I will have a more solid understanding of chain's behavior and how I can quantitatively analyze it, especially as wave propagation behavior in the polycatenated ring chain is a major aspect of this project.
- Programming with MATLAB, Python, Java, C++, Mathematica: These will definitely help in data analysis, running the experiment, and more.

- Photography/video recording: I know the basic parameters of a camera's optical settings and know how each of them affects the quality of the recorded image, which will be useful for getting quality data.
- 3D Modeling, 3D printing, and machining parts: These will be useful when fabricating possible prototypes of the polycatenated rings and modifying the setup by designing any parts I need.
- Wiring, designing electronic circuits, and working with linear actuators: The experimental setup on the polycatenated ring chains will likely require setup of several electronic devices linked with each other, such as being able to drive a linear actuator to apply pulses on the chain. Familiarity with electronically setting up and controlling devices such as this will significantly speed up the setup process.
- Raspberry Pi and Arduino usage experience: Microcontrollers may be used to control experimental setup, especially involving physical actuation and electronic sensory devices like this one.

Extracurricular activities, awards and honors, hobbies, interests, etc. (You may include awards and honors received while you were attending high school):

- Won 6th place internationally at URC University Rover Challenge as science/mechanical team member of Yonder Dynamics in UCSD: designed, 3D modeled, and machined mechanical parts; worked with setting up biochemical tests for rover's life detection mechanism
- Worked in Yonder Deep robotics club at UCSD: 3D modeled and printed parts for underwater drone for research, learned basic wiring setup and waterproofing procedure
- Qualified for World Championships in VEX Robotics Competition 2021-2023, designed and built hardware and used C++ for autonomous code
- Competed in Science Olympiad as Build and Physics Captain, leading physics hybrid events and build events: team qualified for states 2022-2024 and won several individual event medals
- Graduated with Cum Laude (within top 20 percentile GPA) from Harvard-Westlake high school

How does your proposed project for this SURF relate to your professional goals?

This project exactly encompasses the research direction I want to pursue in the future as an experimentalist in physics. The Daraio lab explores an amazing intersection of physics and engineering: to find new ways to apply physical concepts to investigate new materials with new properties. Understanding and discovering new properties, I believe, carries the potential to form the basis of several new inventions and technology that can help people in new ways.

This project can allow me to develop my skills even further and significantly expand the range of experiments I can conduct: an ability I need to achieve such goals. By working for an experiment such as this one where theory and physical experimentation intersect, I can develop a deeper understanding of how they work in tandem to improve our understanding of complex structures. It would make for an amazing opportunity to see how seemingly unpredictable behaviors can be observed and modeled in complex systems such as this one, going far beyond what we learn in class or do in labs, by taking part in cutting edge research. Getting to explore a relatively less-understood system excites me, as does the experience I can gain from this project as I improve as an experimentalist. I'd love nothing more than to join Daraio Lab's endeavor of exploring unique structures and materials using the tools of physics.

Is there any other pertinent information you would like the committee to consider?