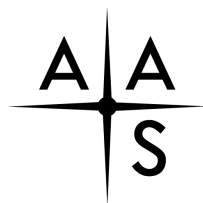


CENTER FOR **ASTROPHYSICS**  
HARVARD & SMITHSONIAN

# The LightSound Project

**Allyson Bieryla**

September 30, 2023



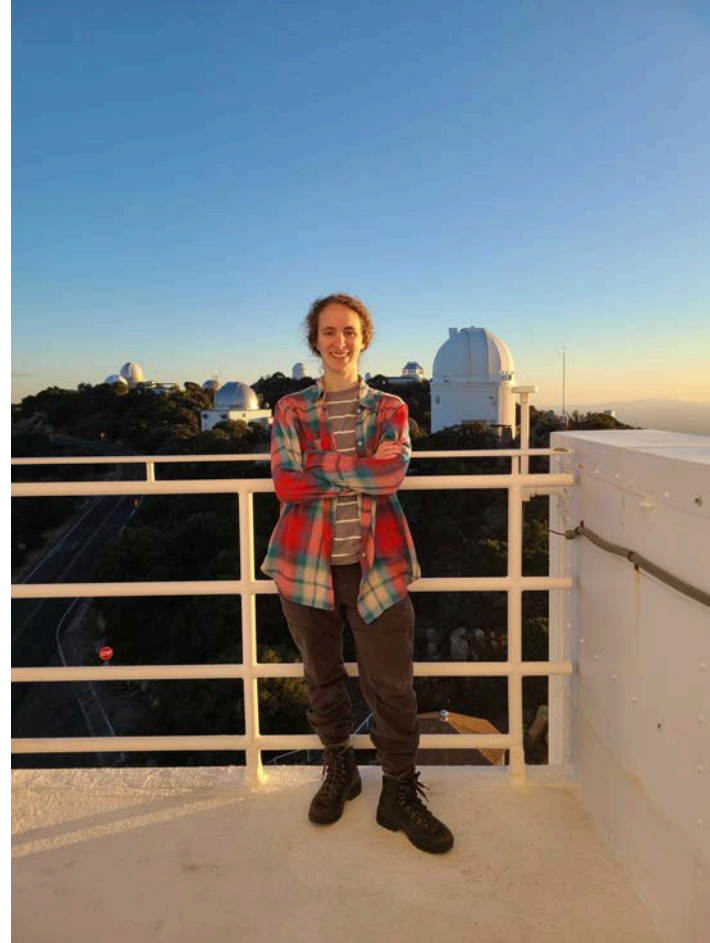
AMERICAN  
ASTRONOMICAL  
SOCIETY



# Team members



Allyson Bieryla  
Center for Astrophysics |  
Harvard & Smithsonian



Sóley Hyman  
Harvard '19  
U of AZ grad student



Wanda Diaz Merced



Daniel Davis  
Director of Harvard Natural  
Sciences Lecture  
Demonstrations



Elliot Richards  
Engineer  
Center for Astrophysics |  
Harvard & Smithsonian

# What is LightSound?

- ✓ Uses Arduino hardware
- ✓ High dynamic range light sensor allows a range of sensitivities
- ✓ Output sound through audio jack to headphones or speakers
- ✓ Runs on 9V battery, rechargeable Li-ion battery, or through computer power
- ✓ Inexpensive and easy to build!
- ✓ Request a pre-built device at no-cost!

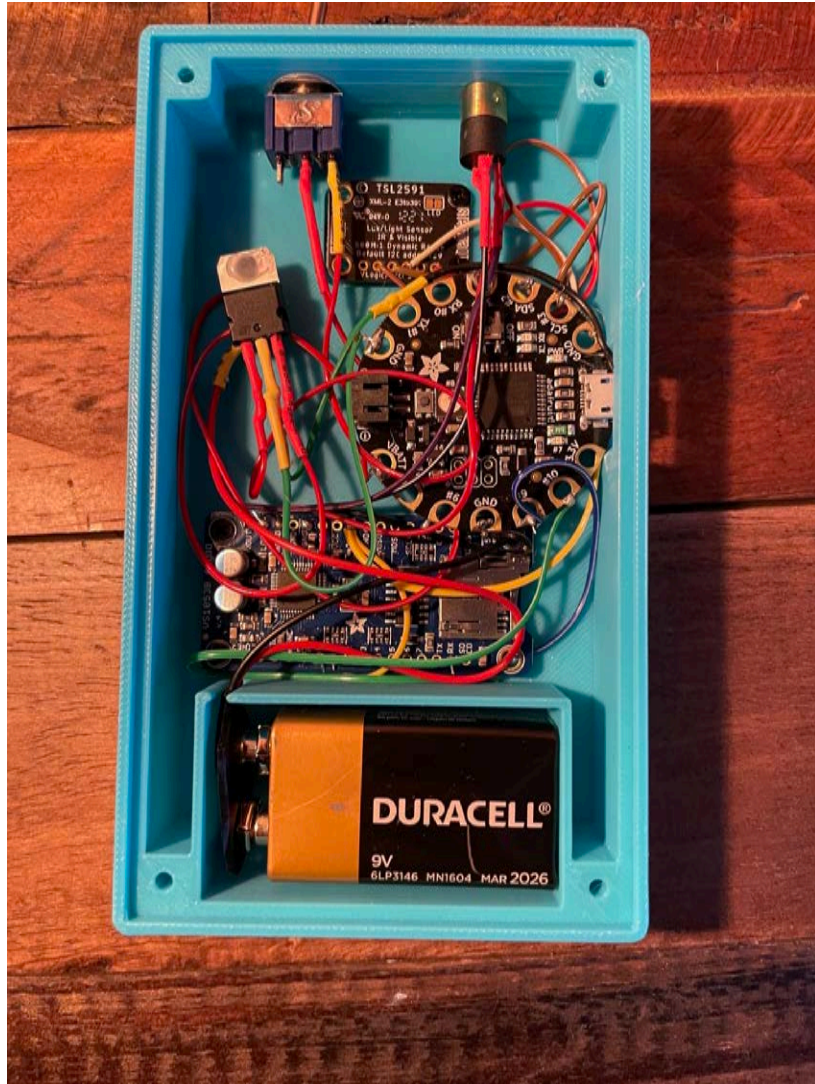
## Open Source

- ✓ Instructions to build your own (English, Spanish, and French)
- ✓ Software to collect and plot data

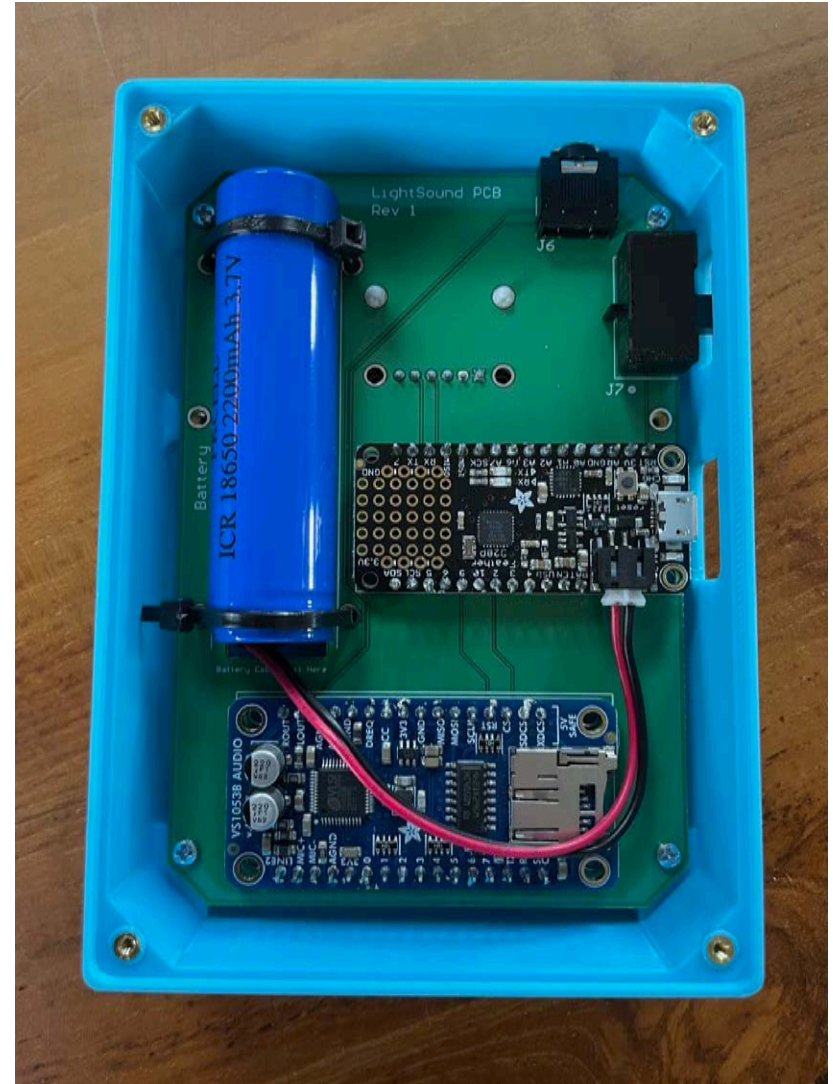




# The LightSound designs



Wired



PCB

# LightSound sound clip

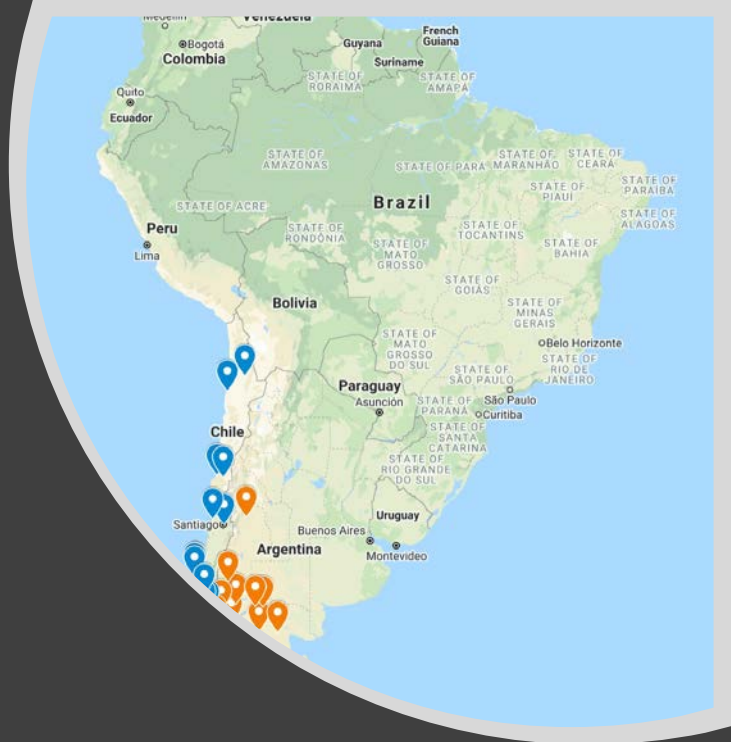


## Video demonstration of simulated eclipse

The sound starts as a high flute tone in the bright sunlight, and as the circle covers the sensor, the sound drops to a low clarinet before becoming clicks as the circle completely covers the opening. As it continues passing over, the low clarinet sound returns and the pitch rises until the flute sound returns.





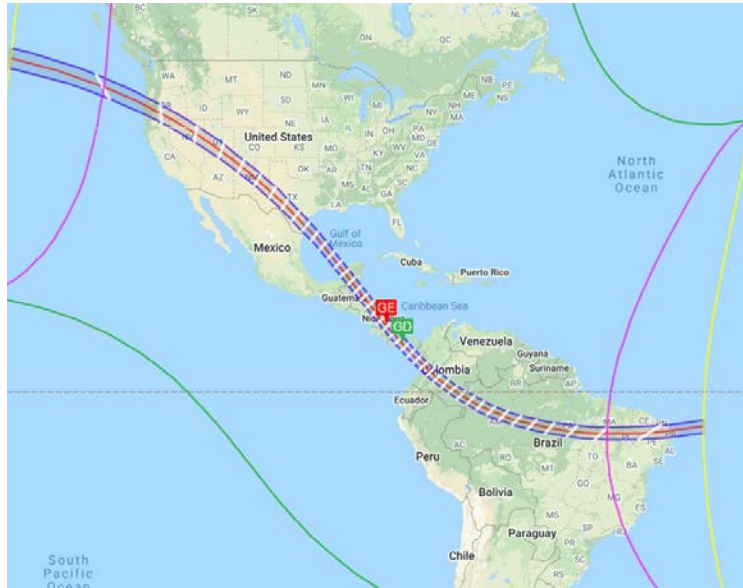


One LightSound device can impact thousands!!!

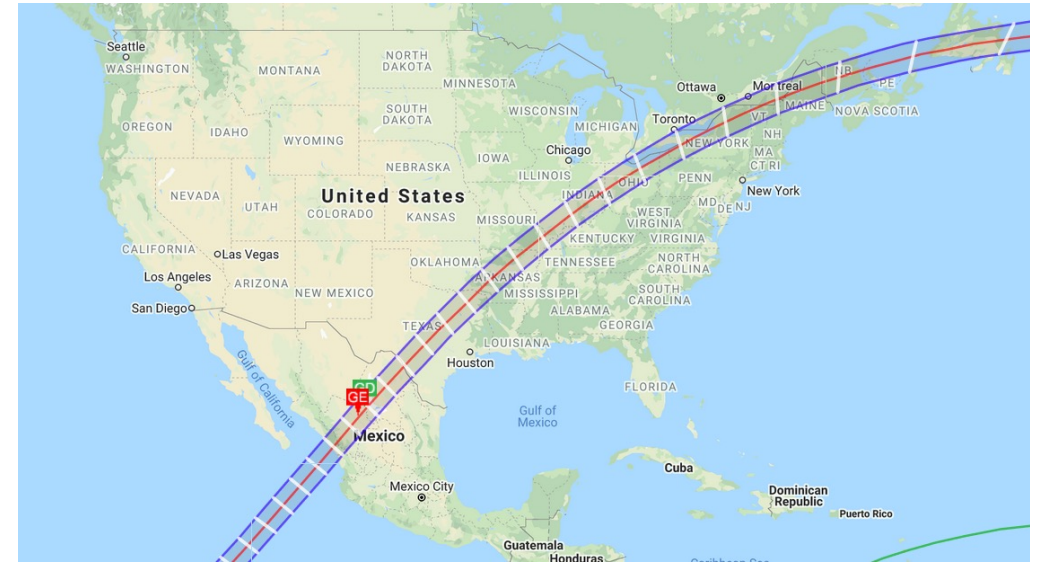




# North American Annular Eclipse October 14, 2023



# North American Total Eclipse April 8, 2024



## In Progress

Goal:  
500+ devices!!

We are ....

- ➔ Building LightSound devices
- ➔ Running Workshops
- ➔ Donating LightSounds



Scan to request  
a device!



# Workshops

**Teach**

Teach soldering and circuitry skills

**Build**

Build devices to be donated

**Transfer**

Transfer the knowledge



AAS 235 Workshop  
Photo credit: Todd Buchanan 2020



October 2022

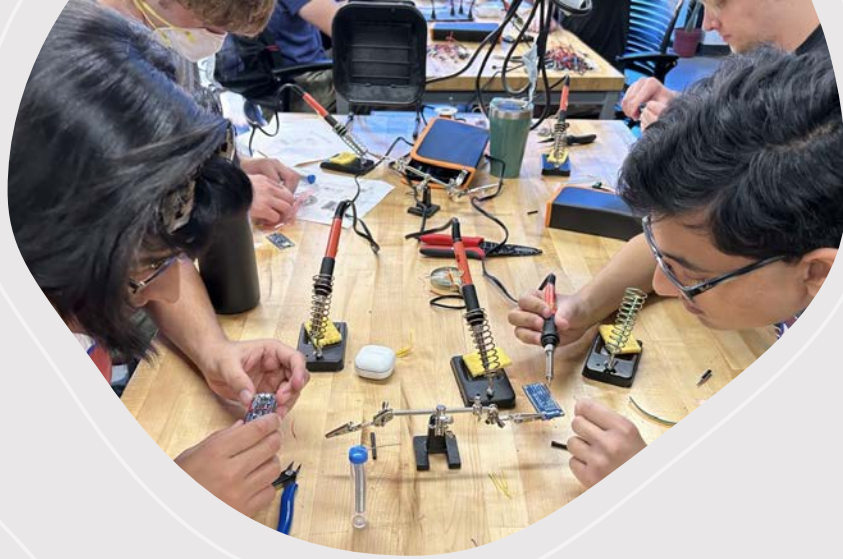


Rochester Museum SC





April 2023



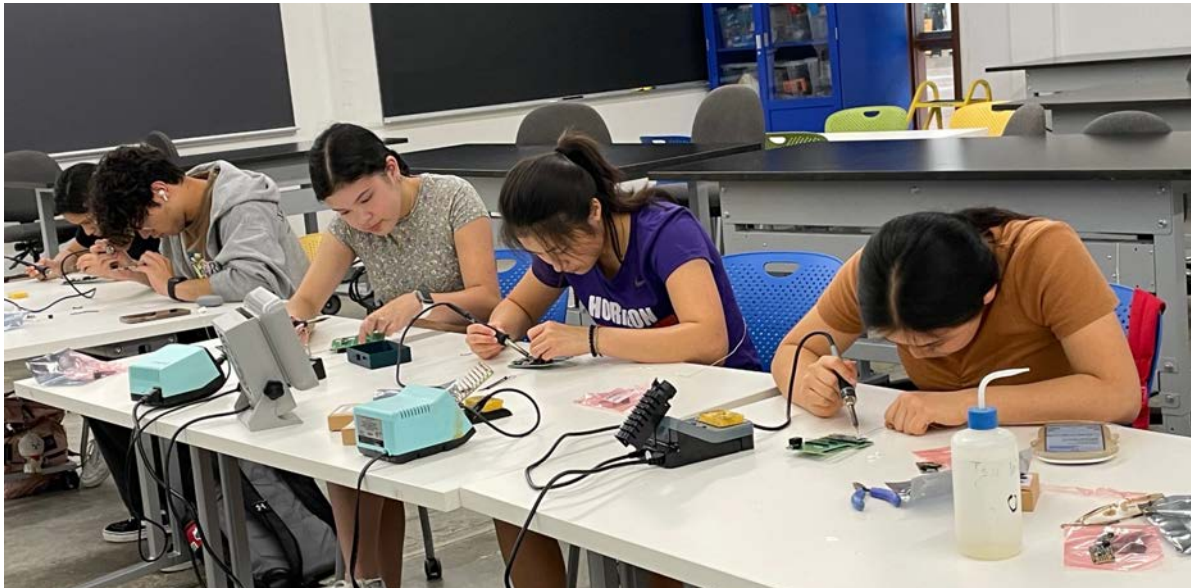
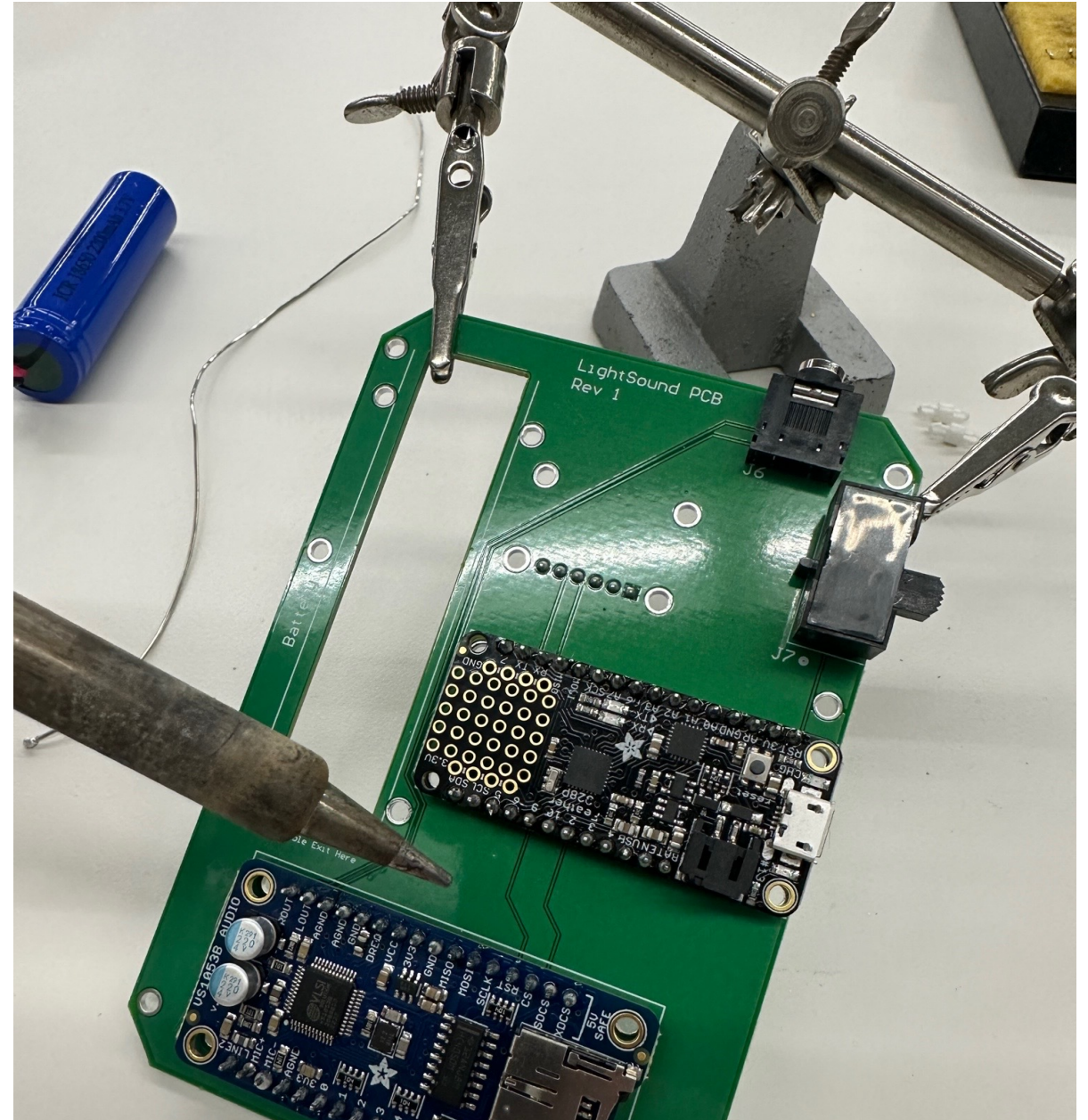
Tucson Initiative for  
Minoritized student  
Engagement in Science  
and Technology Program





UT Austin  
June 2023





Harvard University July 2023



# UT San Antonio



September 2023

# LightSound Website

- Detailed instructions for building and operating
- Wiring diagram
- Files for 3D case design
  - Mesh (.stl) files for direct printing
  - CAD files for editing/modifying
- GitHub link for code
- Request form for LightSounds (pre-built or supplies to build your own)



The LightSound was designed and developed at Harvard University as a tool for the Blind and Low Vision (BLV) community to experience the 2017 Great American Solar Eclipse with sound. The device uses a technique called sonification which is the process of converting light to sound. As the Moon eclipses the Sun during a Solar Eclipse the sunlight begins to dim and the LightSound device output will change in musical tone. The device can be attached to headphones or to a speaker to project the sound for a group. The device is powered by a 9V battery or by connecting it to a laptop via USB. Data can be collected and saved for later analysis or sonification when the device is connected to a computer.

The device was redesigned for the 2019/2020 South American Solar Eclipses to have a more sensitive light sensor and improved sound quality. Through an IAU 100 special project grant, we built and distributed 20 devices across Chile and Argentina. Chilean colleagues, through an ESO grant, distributed an additional 100+ devices.

Workshops to train users to build and use the LightSound devices were developed and run as part of AAS EPD, IAU OAD, and NSF grants. We aim to build several hundred devices for the upcoming 2023 Annular Solar Eclipse and the 2024 Total Solar Eclipse in North America. Please contact Allyson Bieryla (abieryla@cfa.harvard.edu) with questions or to collaborate.

## LightSound - Solar Eclipse Sonification tool

The LightSound is a device developed for the BLV community as a tool to experience the solar eclipse with sound. The device uses arduino technology and has a high dynamic range sensor. It also used midi capabilities to produce the sound. The device detects light through the light sensor and outputs sound based on the brightness. As the sun is eclipsed by the moon the observer will experience the dimming of light as the sound decreases. Instructions for building your own device are listed below along with the software code to upload to the device.

The LightSound device code and instructions to build are below. These are open source but they should not be used to build LightSounds for profit.



[Instructions to build](#)

[Operation Instructions](#)

[Wiring Diagram](#)

[3D case design](#)

[GitHub for device code and plotting code](#)

[Request a FREE pre-build LightSound device](#)



# GitHub Code

- Code for...
  - Arduino programming
  - Data logging
  - Data plotting
- Instructions for installing and using the Python code
- Documentation in English and Spanish, and soon to be in French!

The screenshot shows the GitHub repository page for 'solehyman / LightSound2.0'. The repository is public and has 1 star, 2 forks, and 1 issue. The 'Code' dropdown menu is open, showing options to clone the repository using HTTPS or GitHub CLI, open with GitHub Desktop, or download a ZIP file. The repository description is 'Python data logger, plotter, and Arduino code for LightSound 2.0'. The 'About' section provides more details about the project, including its purpose and funding. The 'Languages' section shows that the repository is primarily C++ (69.3%) with some Python (30.7%).

solehyman / LightSound2.0 Public

Notifications Fork 2 Star 1

<> Code Issues 1 Pull requests 2 Actions Projects Security Insights

master

solehyman Update README

- LightSound\_code\_v1...
- LightSound2\_data\_l...
- LightSound2\_data\_p...
- README.md

Go to file Code

Local Codespaces

Clone

HTTPS GitHub CLI

<https://github.com/solehyman/LightSound2.0>

Use Git or checkout with SVN using the web URL.

Open with GitHub Desktop

Download ZIP

About

Python data logger, plotter, and Arduino code for LightSound 2.0

Readme

1 star

0 watching

2 forks

Report repository

Releases

No releases published

Packages

No packages published

Languages

C++ 69.3% Python 30.7%

LightSound2.0

Python data logger, plotter, and Arduino code for LightSound 2.0 devices

About LightSound

LightSound is an Arduino-based device that converts light intensity to sound via a light sensor and MIDI board so that blind and visually impaired (BVI) individuals may experience astronomical events like solar eclipses. The original version (LightSound 1.0) was designed and used during the total solar eclipse on August 21, 2017. In preparation for the upcoming North and South American total solar eclipses (2019, 2020, and 2024), LightSound has been redesigned with higher sensitivities and an improved sound library. The project has received funding from IAU100 to build and distribute 20 LightSound 2.0 devices to schools in Chile and Argentina so that BVI students in the path of the 2019 and 2020 solar eclipses may experience the events.

The LightSound 2.0 devices can run on a 9-volt battery (portable mode) or off of computer power (logging mode). When in portable mode, the switch will turn the device on and off. In order to record data, LightSound must be connected to a computer. In this case, the device runs off of the computer power and will remain on as long as it is plugged in.

# Using the Arduino IDE

- Compile and upload code
- Serial Monitor and Serial Plotter for testing and quick looks (Tools menu)

```
LightSound_code_v1.5.0 | Arduino 1.8.19 (Windows Store 1.8.57.0)
File Edit Sketch Tools Help
LightSound_code_v1.5.0
/* Developed for the LightSound 2.0 */
/* Code developed by Soley Hyman, with help from Daniel Davis, Rob Hart, and
/* last updated: 2 May 2019 */

#include <Wire.h>
#include <Adafruit_Sensor.h>
#include <Adafruit_TSL2591.h>
#include <SoftwareSerial.h>

/*****
// define the pins used
#define VS1053_RX 10 // This is the pin that connects to the RX pin on VS1053
#define VS1053_RESET 9 // This is the pin that connects to the RESET pin on VS1053
// Don't forget to connect the GPIO #0 to GROUND and GPIO #1 pin to 3.3V

// define MIDI channel messages
// See http://www.vlsi.fi/fileadmin/datasheets/vs1053.pdf Pg 31
#define VS1053_BANK_DEFAULT 0x00 // default bank
#define VS1053_BANK_DRUMS1 0x78 // drums bank (unnecessary?)
#define VS1053_BANK_DRUMS2 0x7F // drums bank (unnecessary?)
#define VS1053_BANK_MELODY 0x79 // melodic bank
#define VS1053_RPN_MSB 0x06 // most sig. bit for bend/coarse tune
#define VS1053_RPN_LSB 0x26 // least sig. bit for bend
*****/

1 Adafuit Flora on COM5
```

```
COM7
[ 60616 ms ]
Visible (event.light): 805.43 Lux
Gain: 1x (Low)
Integration: 100 ms

[ 60866 ms ]
Visible (event.light): 798.11 Lux
Gain: 1x (Low)
Integration: 100 ms

[ 61116 ms ]
Visible (event.light): 800.11 Lux
Gain: 1x (Low)
Integration: 100 ms

[ 61366 ms ]
Visible (event.light): 803.42 Lux
Gain: 1x (Low)
Integration: 100 ms

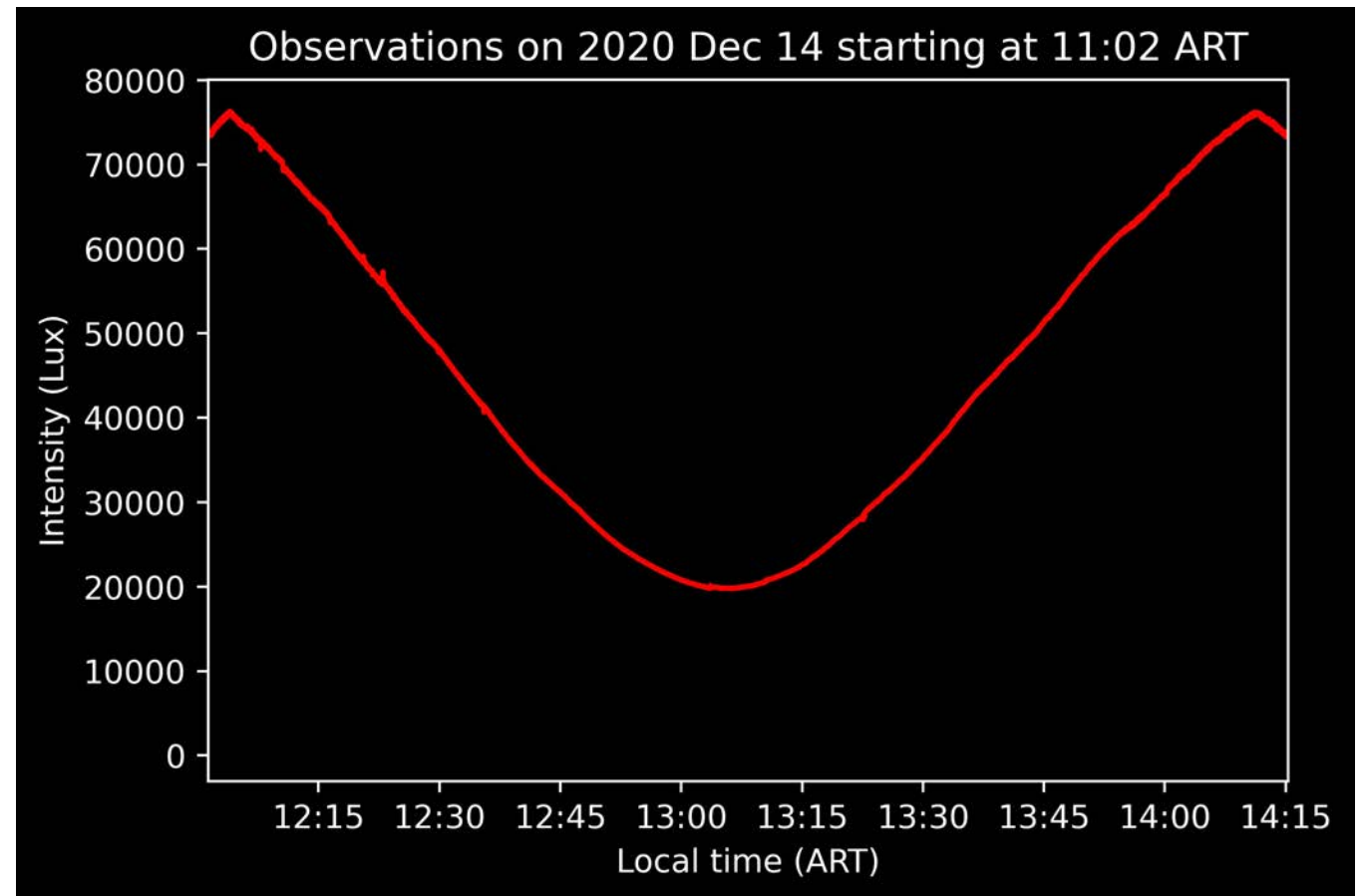
Autoscroll Show timestamp Newline 9600 baud Clear output
```



# Python logging and plotting code

Data from 2020 South American Eclipse,  
taken by Beatriz Garcia in Mendoza, Argentina

Computer + speaker + LightSound setup



# LightSound Project Discord Server

LightSound Project # welcome

GENERAL LIGHTSOUND

- # education NEW
- # outreach NEW
- # development NEW

2023 ECLIPSE PLANNING

- # eclipse-planning... NEW
- # data-sharing-2023 NEW
- # photos-2023 NEW

2024 ECLIPSE PLANNING

LIGHTSOUND HELP

PAST ECLIPSES

- # discussion-past-... NEW
- # data-sharing-pas... NEW
- # photos-past-ecli... NEW

VOICE CHANNELS

Sóley Hyman Today at 11:34 AM

Welcome to the LightSound Project community! This server is mean to connect LightSound users and developers, coordinate eclipse planning, share lesson plans and outreach ideas, share code/hardware improvements, and help troubleshoot software and hardware issues. The channel directory below lists all the channels on this server and their descriptions. If you'd like, head over to [#introductions](#) to introduce yourself to our community!

The LightSound team is comprised of [@Allyson Bieryla](#) (Harvard Univ./CfA) and [@Sóley Hyman](#) (Univ. of Arizona/Steward Observatory). Please feel free to reach out to us with any questions!

### USEFUL LINKS

LightSound Website: <https://astrolab.fas.harvard.edu/LightSound.html>  
LightSound GitHub (code updates will be shared in [#development](#)): <https://github.com/solehyman/LightSound2.0>

### Channel List

#### GENERAL

- [#welcome](#): This channel -- introduction to the LightSound Project Discord
- [#general](#): General discussion channel; ask non-topic specific questions here
- [#introductions](#): Introduce yourself when you join! Template provided in pinned message
- [#random](#): Channel for discussions that are not LightSound-specific
- [#server-discussions](#): Place to post ideas or suggestions about channels or the server

#### ECLIPSE PREP

- [#eclipse-planning-2023](#): Discuss and organize/coordinate plans involving LightSOUNDS for upcoming solar and lunar eclipses

Link for joining the discord server on the LightSound website





# LightSound

(eclipse sonification device)



<http://astrolab.fas.harvard.edu/LightSound.html>



Scan to request  
a device!



Allyson Bieryla ([abieryla@cfa.harvard.edu](mailto:abieryla@cfa.harvard.edu))  
Sóley Hyman ([soleyhyman@arizona.edu](mailto:soleyhyman@arizona.edu))