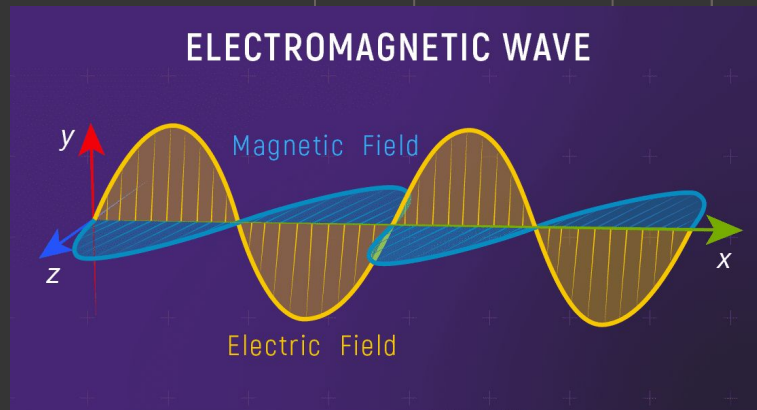


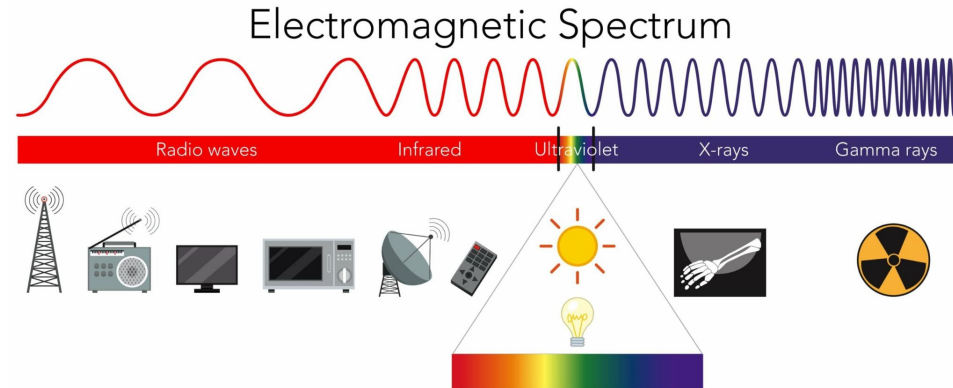
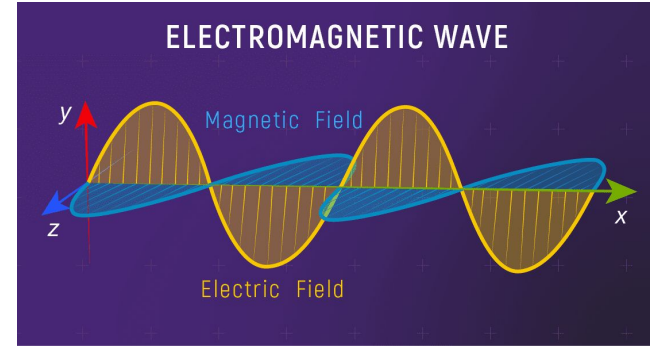
STELLA Spectrometers

Created By Inna Shapovalenko & Alexa Matson
Supervisors Dr. Sam Batzli and Alexa Ross



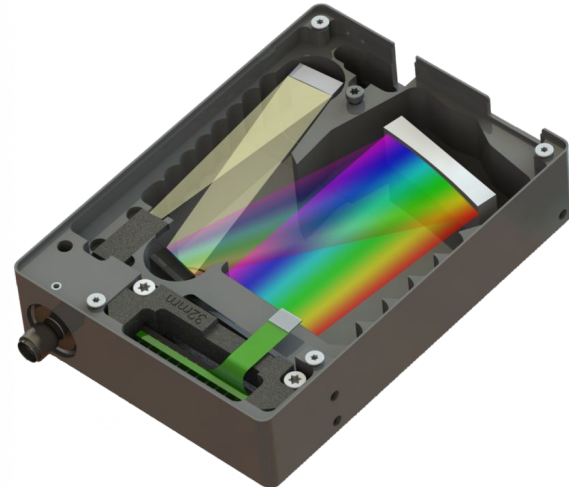
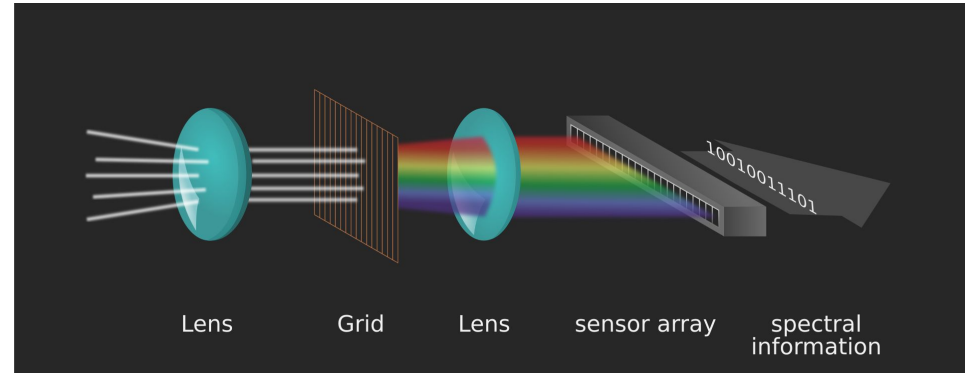
The Science of Spectroscopy

- **Light** is a form of energy that travels in waves
- Electromagnetic radiation can be broken into a range of different frequencies:
 - Radio
 - Microwave
 - Infrared
 - Visible
 - Ultraviolet
 - X-Ray
 - Gamma Ray
- Shorter Wavelengths = More Energy
- Longer Wavelength = Less Energy
- Visible light only makes up about **0.0035%** of the whole spectrum!!!

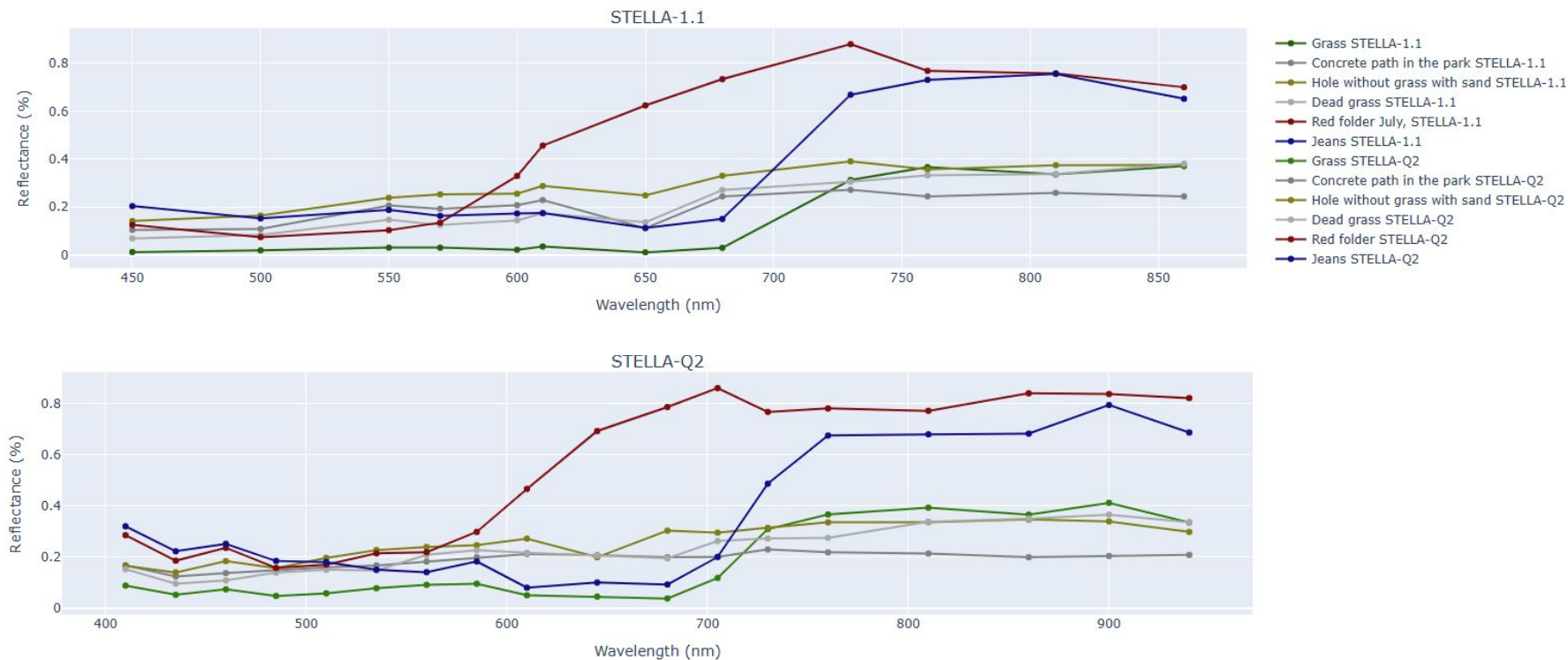


What is a spectrometer?

- Instruments that can separate and measure components of electromagnetic radiation
- Breaks light down into its different components (wavelengths) across the spectrum
- Able to measure...
 - Irradiance
 - Radiance
 - Reflectance
- **Many different types of spectrometers exist for a variety of applications!**

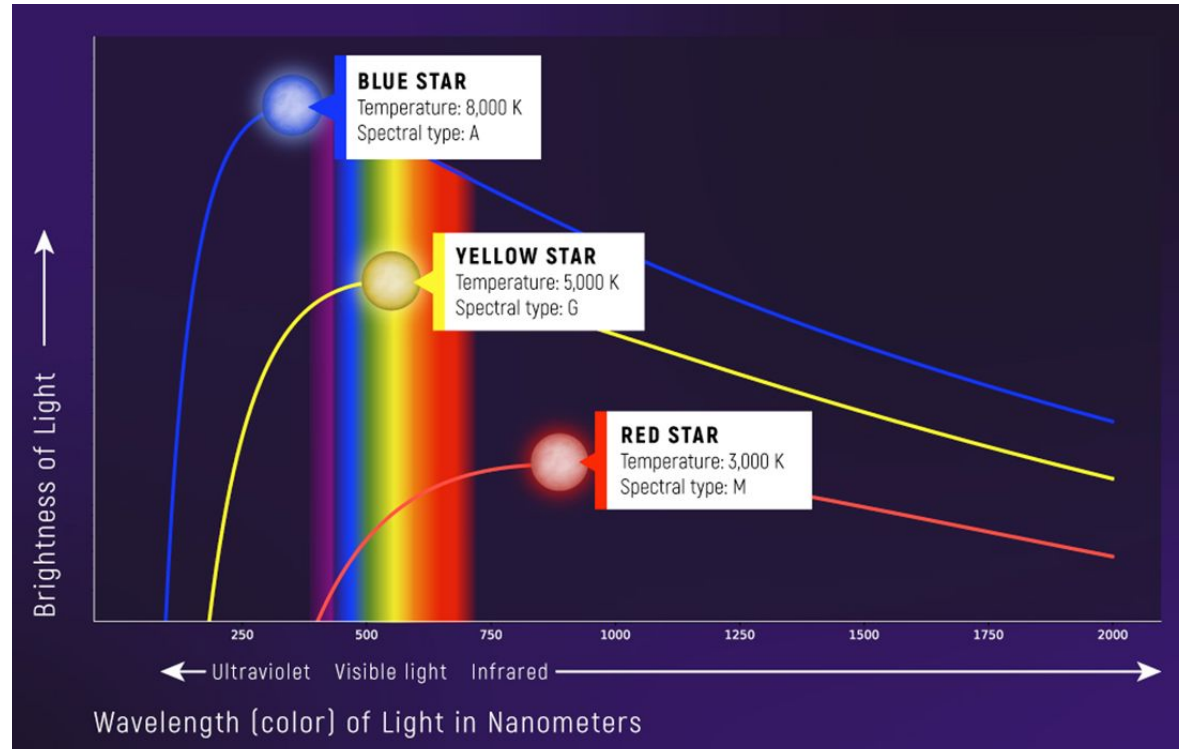


Spectral Data of Different Materials



Application: Astronomy

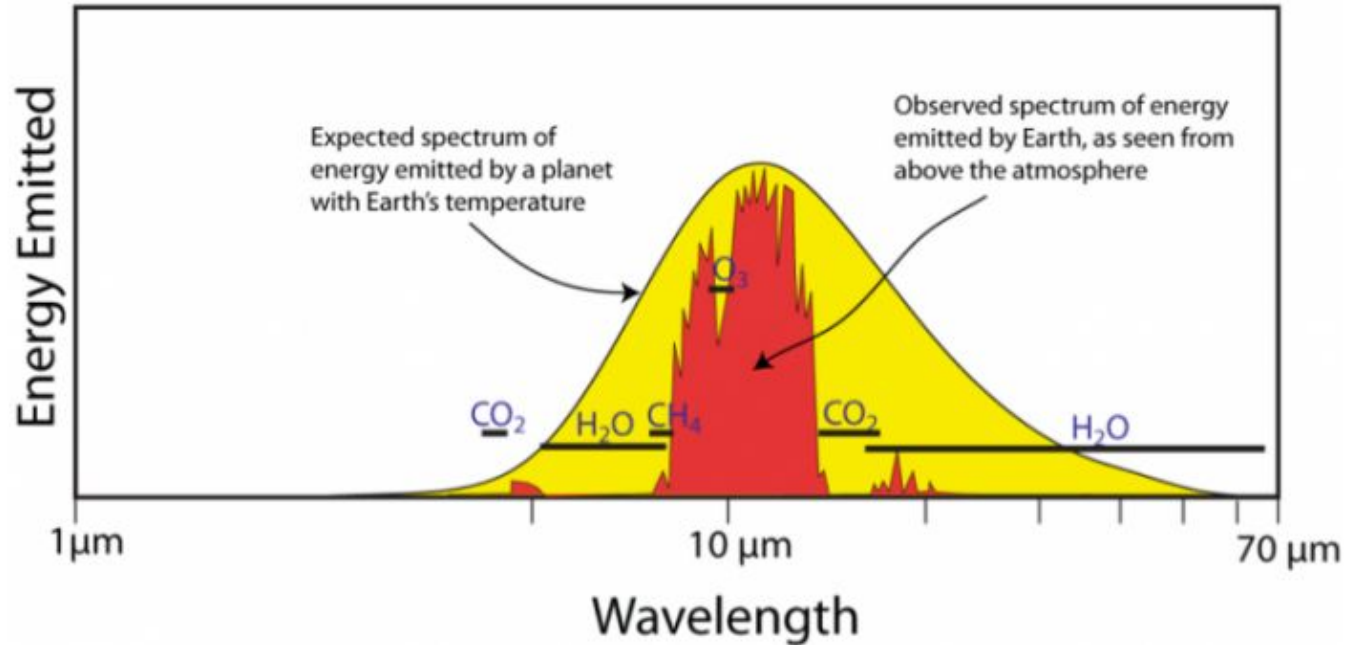
Spectrometers split light from stars or nebulae into colors to reveal which elements are present and help determine the gas's temperature, pressure, and motion.



<https://webbtelescope.org/contents/media/images/01F8GF8WYB-CQVKTGPX3MA58182?Type=Infographics&Tag=Spectroscopy>

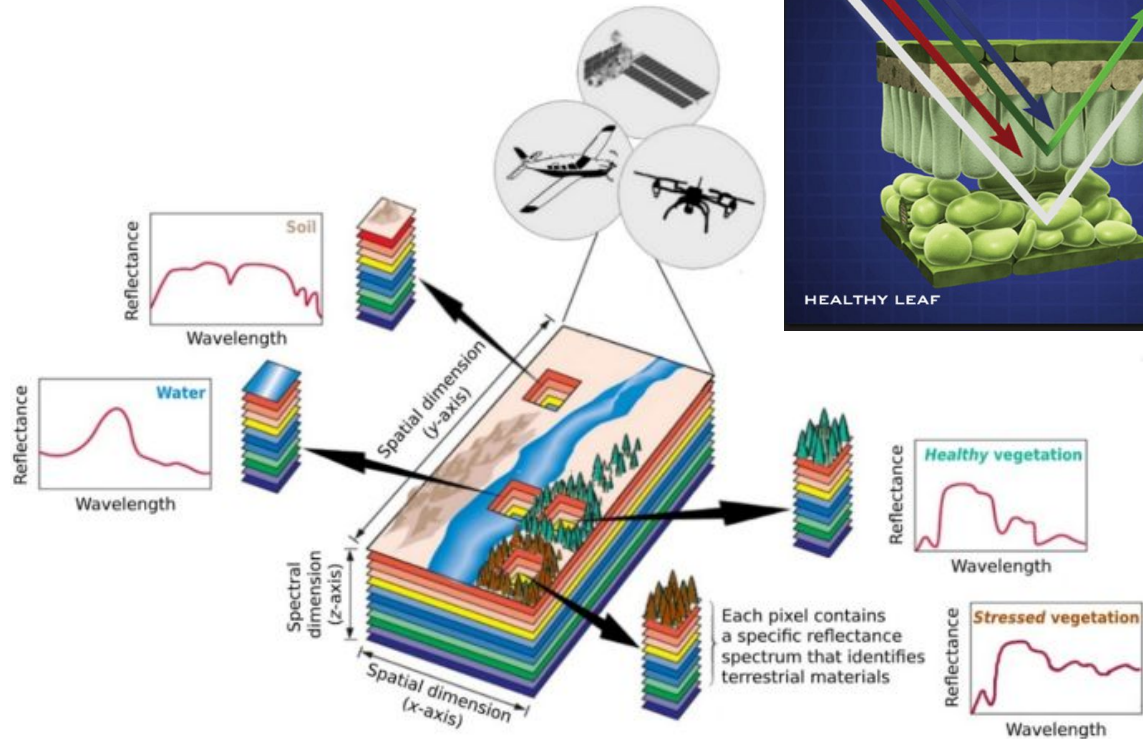
Application: Environmental monitoring

Spectrometers detect and measure light to identify pollutants in air or water and track changes in conditions like air quality, water quality, or greenhouse gas levels.



Application: Remote Sensing

Spectrometers measure sunlight reflected from Earth's surface to identify materials like soil, water, or vegetation and to monitor changes in the environment, such as pollution or deforestation.



Application: Remote Sensing

True Color:



False Color:



Composite imagery taken on 07/18/2025 by the Landsat-9 satellite
(Landsat Product ID: LC09_L1TP_024030_20250718_20250718_02_T1)

NASA & STELLA Program

The **STELLA (Science and Technology Education for Land/Life Assessment)** project uses spectrometers that can be built with low-cost components and 3D printed housings to introduce NASA Earth observation technologies and provide authentic hands-on learning experiences for remote sensing education.

STELLA devices measure:

- Light reflectance
- Solar radiation
- Air/surface temperature
- Methane & more



<https://landsat.gsfc.nasa.gov/stella/>

STELLA Instrument Versions



6 versions available to fit different needs and skill levels

- **No soldering required:**
 - **STELLA-Q2, Helio-STELLA, STELLA-AQ**
 - Ideal for students – plug & play with connectors
- **Soldering & 3D printing required:**
 - **STELLA-1.1, 1.2, 2.0**
- **Drone-compatible:**
 - **STELLA-1.1 & 2.0** (under 100g)
- **Features:**
 - **1.1 & 1.2:** Touchscreen display
 - **2.0:** Bluetooth to smartphone via Bluefruit Connect app
 - **1.2** will replace **1.1**

STELLA-1.1

Definition:

The STELLA-1.1 is a spectrometer that helps to study light by breaking it into different colors (wavelengths).

How It Works:

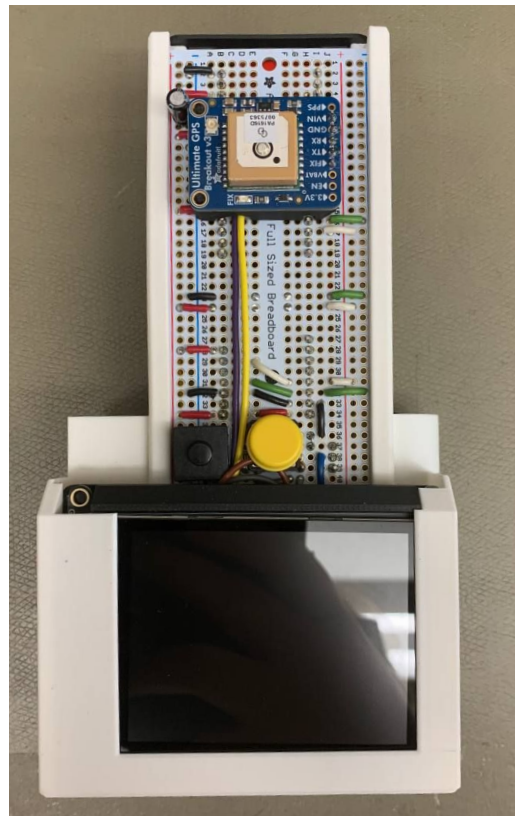
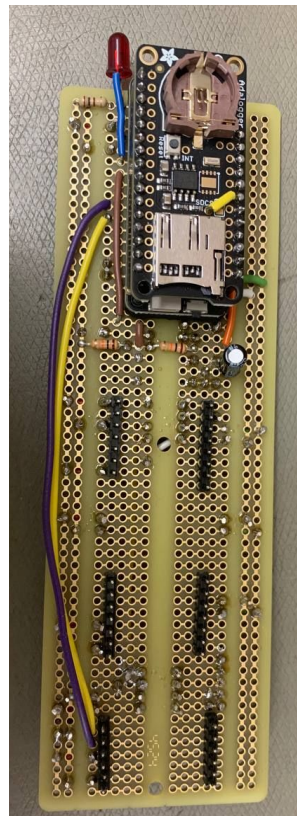
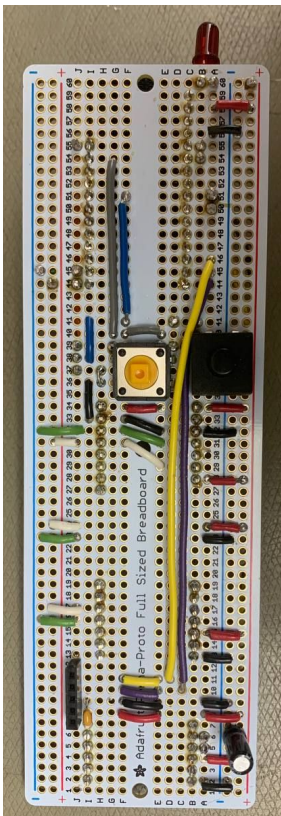
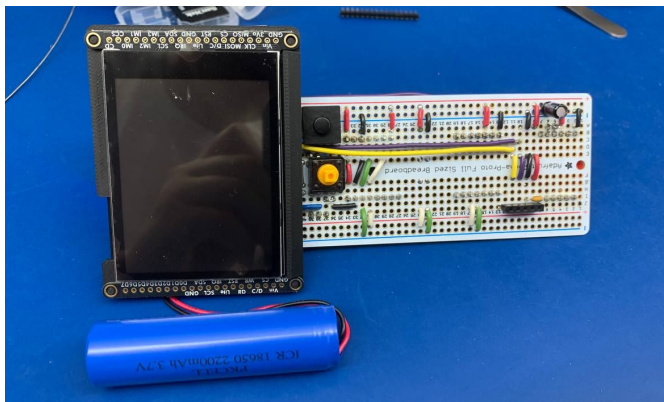
It measures light in 12 separate bands across a wavelength range from 450 to 860 nanometers - that covers light and a bit of near-infrared light

Extra features:

STELLA-1.1 also has:

- A surface temperature sensor to check how warm or cold things are
- Weather sensors to record things like air temperature and humidity



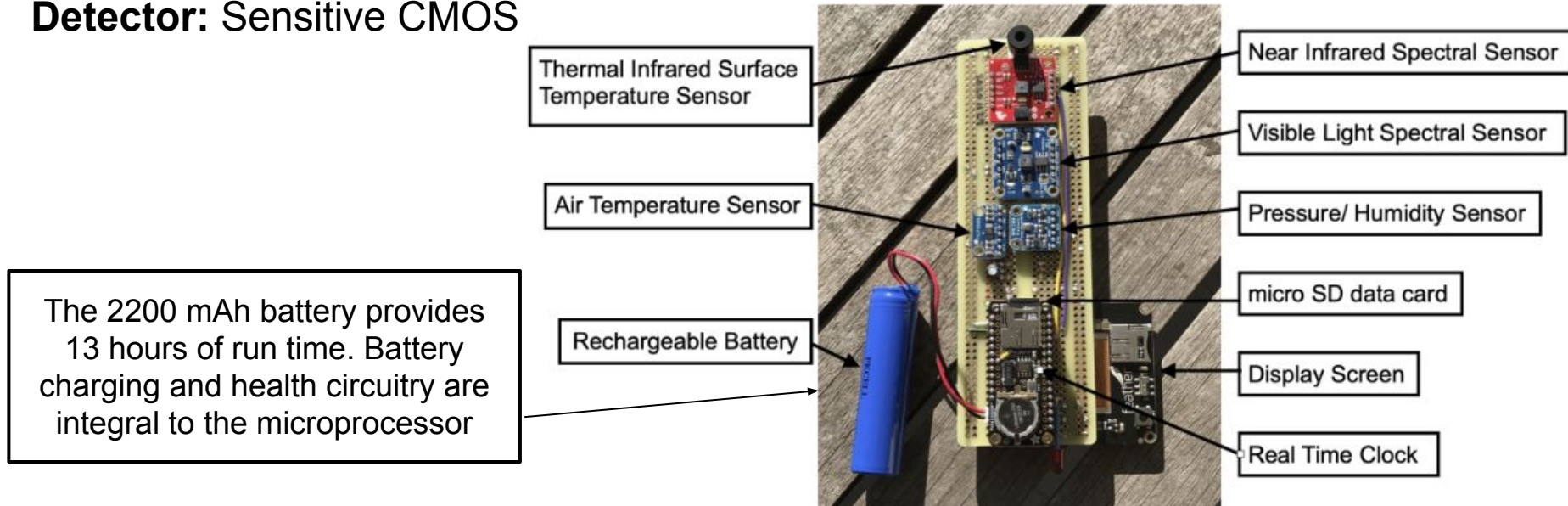


Technical Characteristics

Wavelength Range: 350-900 nm (covers visible light and near-infrared)

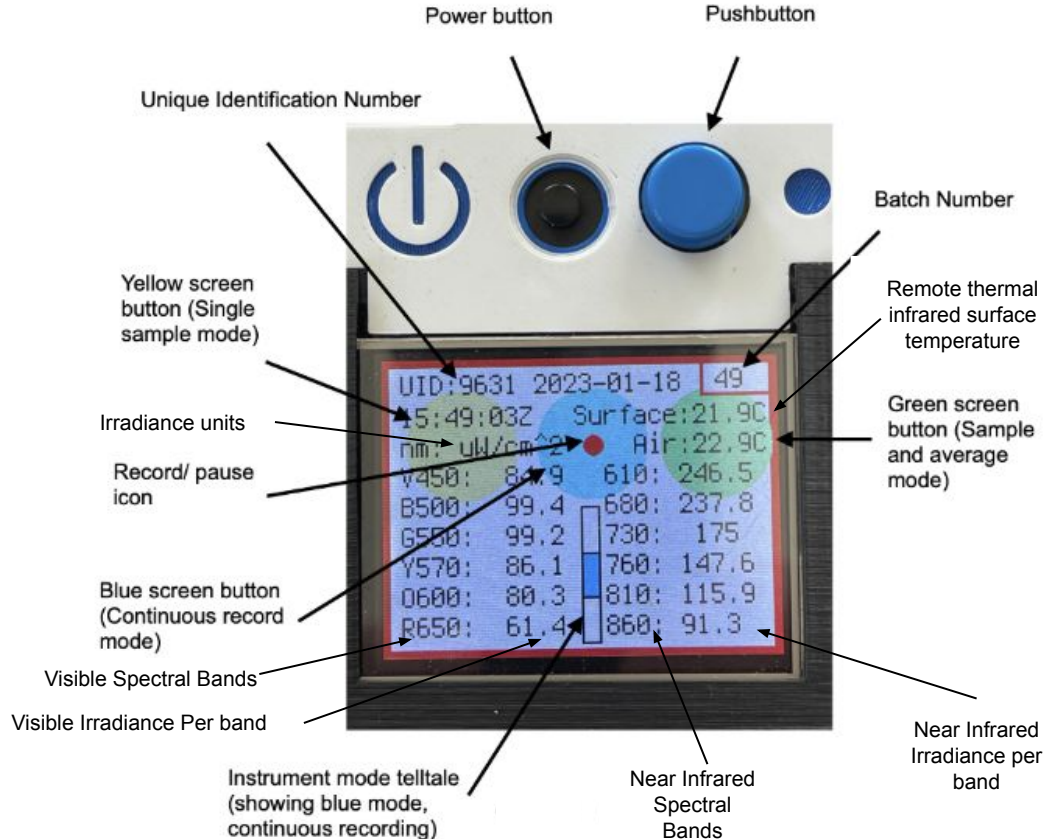
Spectral Resolution: 1-2 nm (can separate close wavelengths)

Detector: Sensitive CMOS



Modes of use

- Single sample mode (yellow color on screen)
- Continuous recording (blue color)
- Sample and average mode (green color)



STELLA-Q2

Definition:

STELLA-Q2 is another version of the STELLA spectrometer.

How It Works:

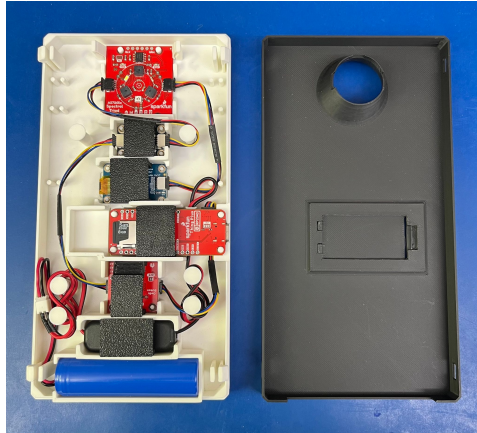
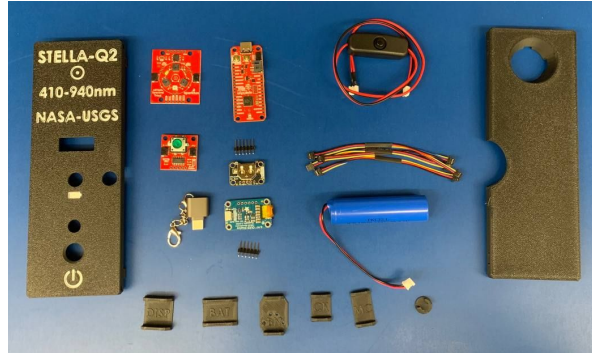
It measures light in 18 separate bands across a wavelength range from 410 to 940 nanometers - that covers light from violet to near-infrared light

Extra features:

- The wide range helps scientists see details that the eye can't
- This makes STELLA-Q2 useful for studying plants, sunlight, and the atmosphere



A little bit of building process



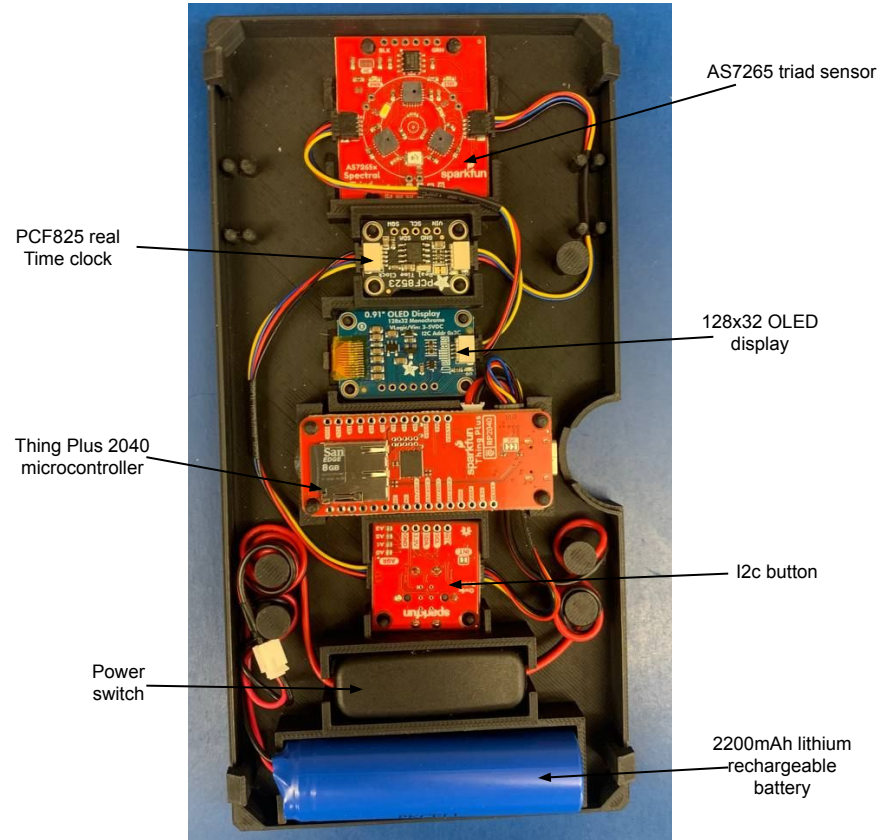
STELLA-Q2

Wavelength Range: 410-940 nm - covers visible light and near-infrared, so it can detect colors that our eyes can't see

Spectral Resolution: Spectral Resolution: 1-2 nm (can separate close wavelengths)

Detector:

- TRIAD spectral sensor
- Clock module
- Thing Plus 2040 microcontroller



Spectroscopic Mystery

- Lets see if we can identify different materials only by their spectral signatures!

Data Collection:

- 1.) Start by taking readings of the blank white sheet of paper. You will do this **BEFORE AND AFTER** each time you take data on a material
- 2.) Position the spectrometer over the target material. When collecting data make sure to:
 - a.) Keep the spectrometer steady
 - b.) Write down the batch number of each material and their calibration batch
 - c.) Q2 → LED light needs to be on and spectrometer can be flat against the material
 - d.) 1.1 → spectrometer should be held about 10 cm away from the material
- 3.) Repeat process until all materials have been measured

Spectroscopic Mystery

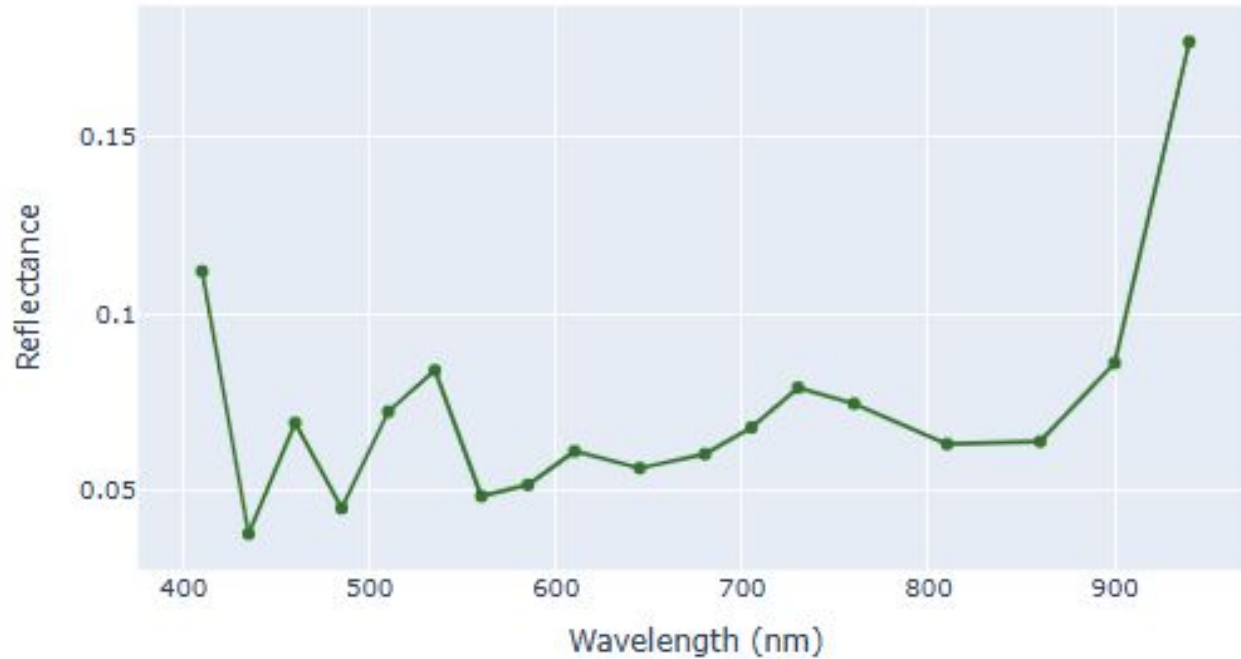
- Lets see if we can identify different materials only by their spectral signatures!

Data Analysis:

- 1.) Remove the SD card from the spectrometer and plug it into your computer using the given SD to USB-C converter.
- 2.) Go to <https://stella-data-viewer.onrender.com/>
- 3.) Make sure to fill in the section for the specific spectrometer you are using.
- 4.) Record the wavelength and corresponding reflectance values on the worksheet.
- 5.) Plot the reflectance values with respect to wavelength and connect each data point with a line.
- 6.) Repeat processes for all the materials

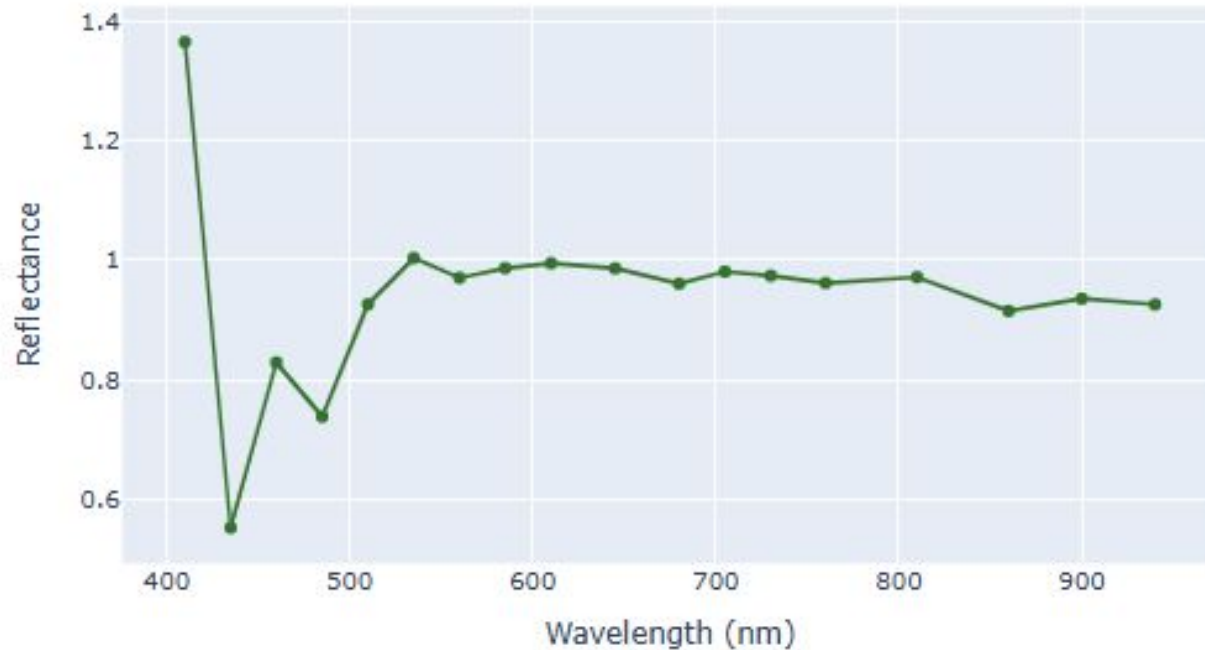
Mystery 1

STELLA-Q2 Reflectance Curve



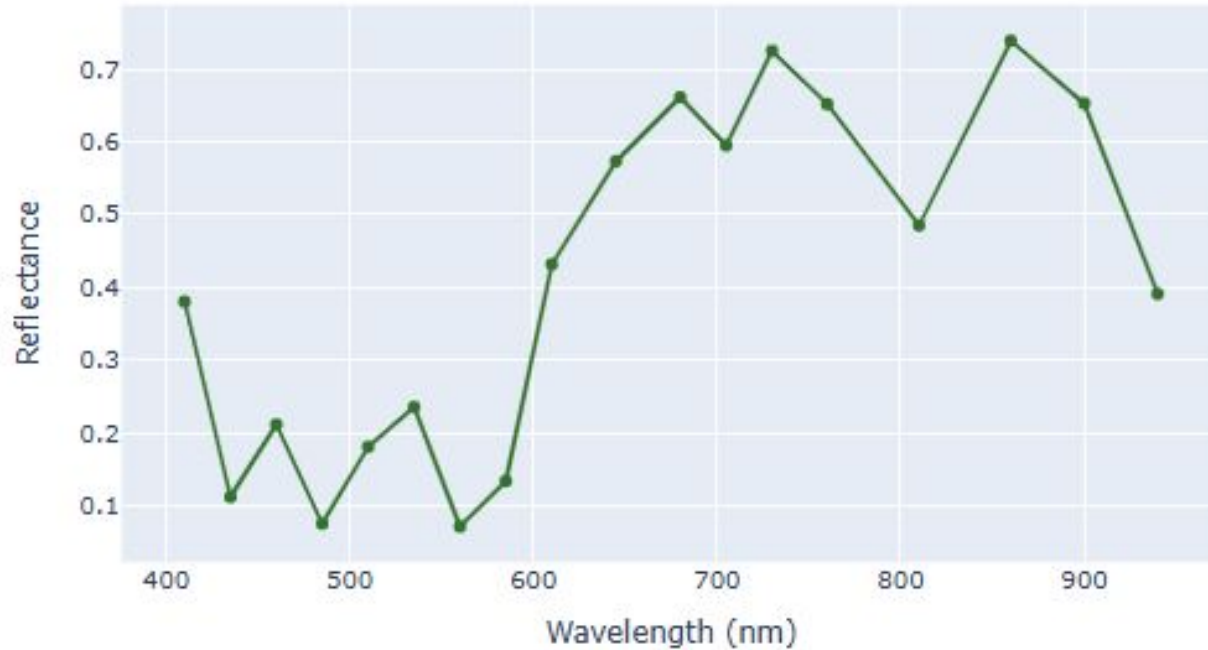
Mystery 2

STELLA-Q2 Reflectance Curve



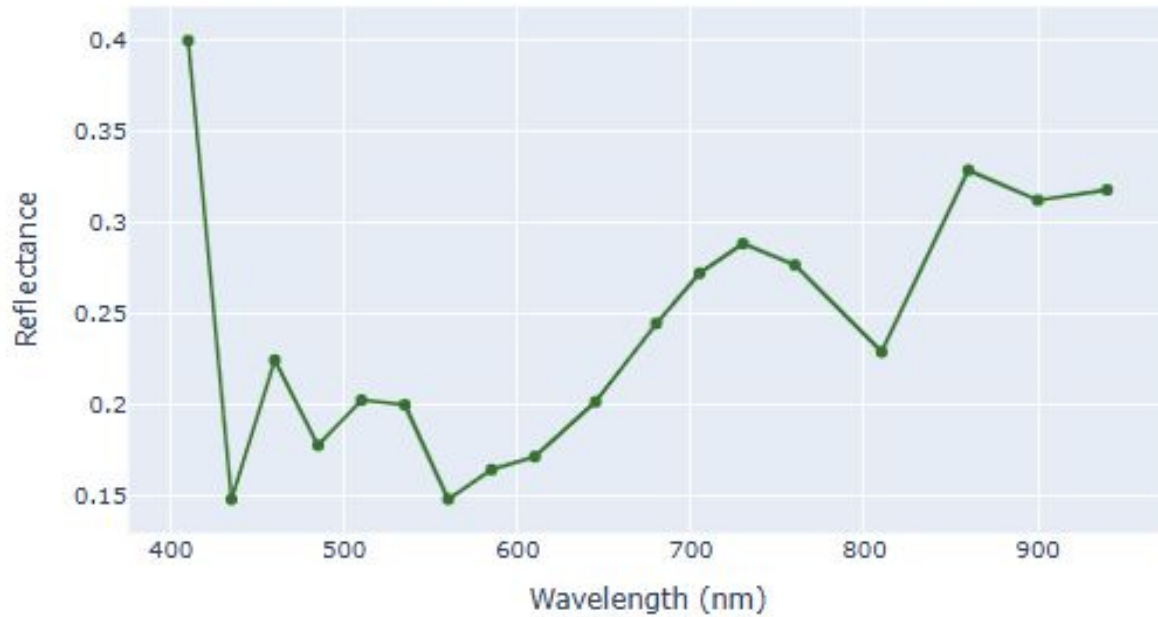
Mystery 3

STELLA-Q2 Reflectance Curve



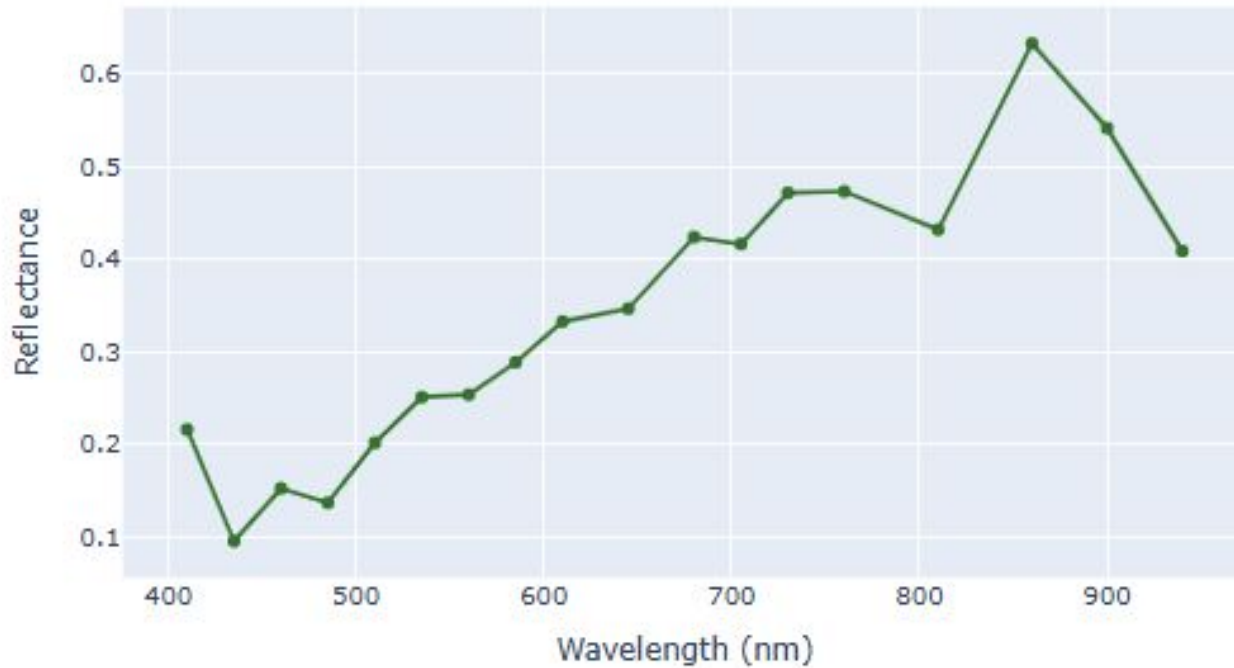
Mystery 4

STELLA-Q2 Reflectance Curve



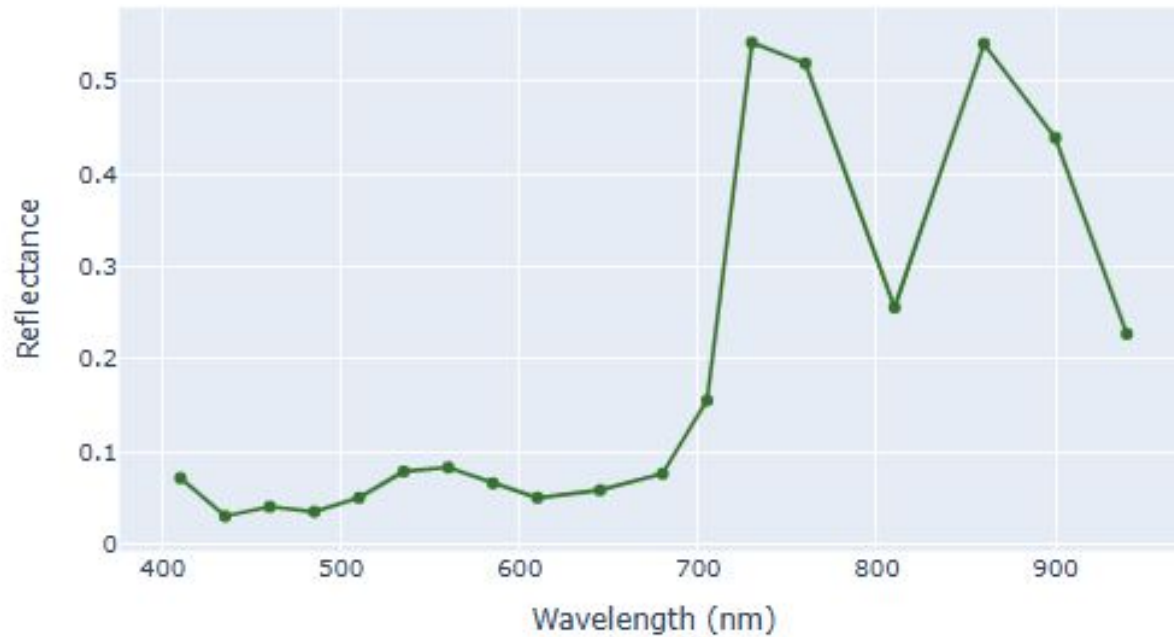
Mystery 5

STELLA-Q2 Reflectance Curve



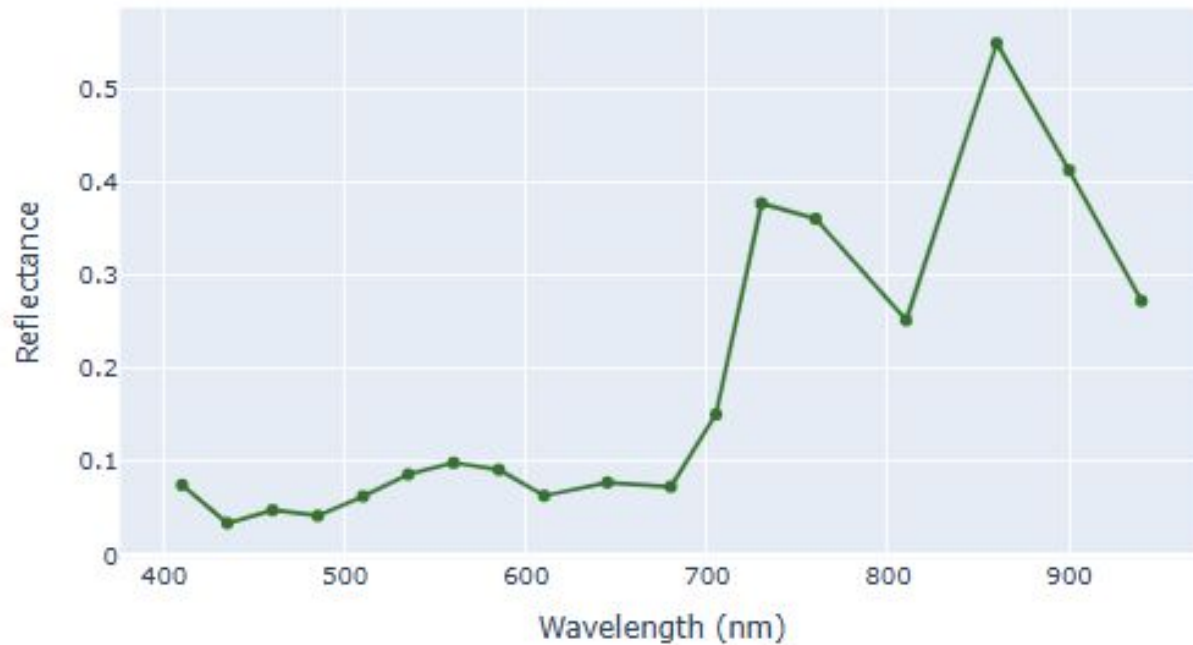
Mystery 6

STELLA-Q2 Reflectance Curve



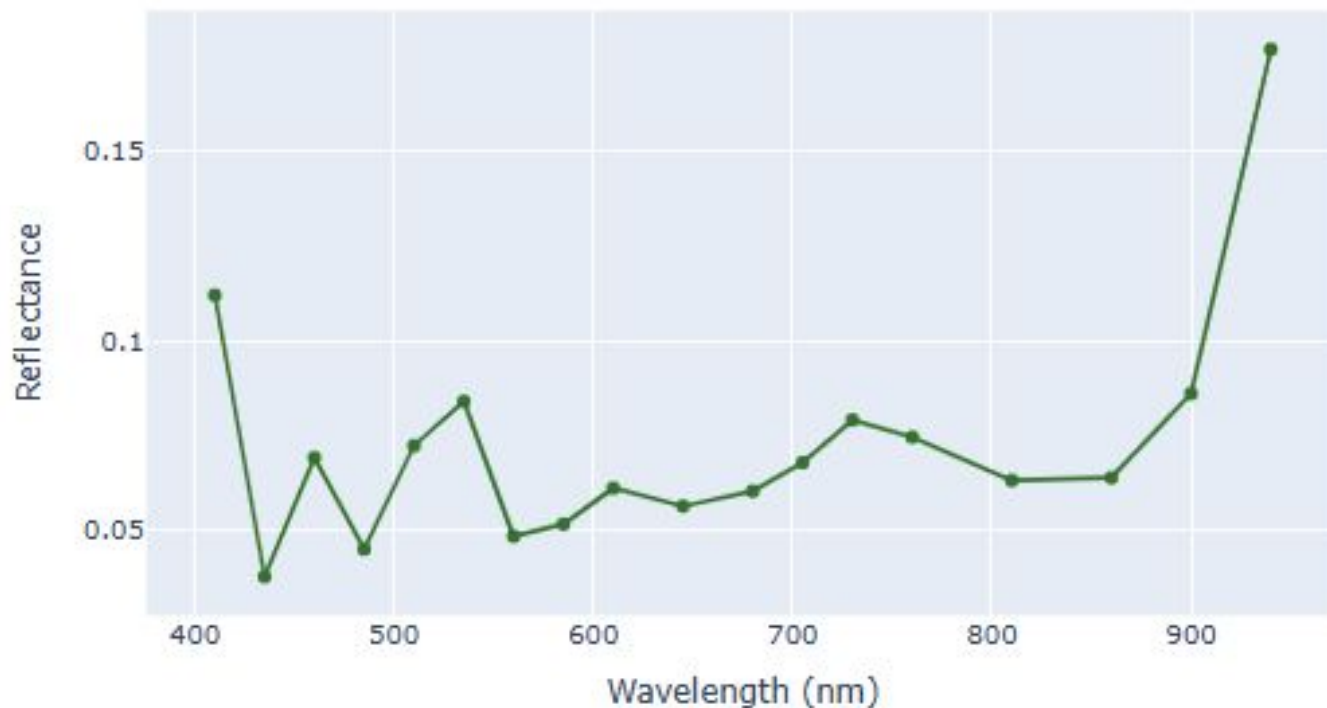
Mystery 7

STELLA-Q2 Reflectance Curve



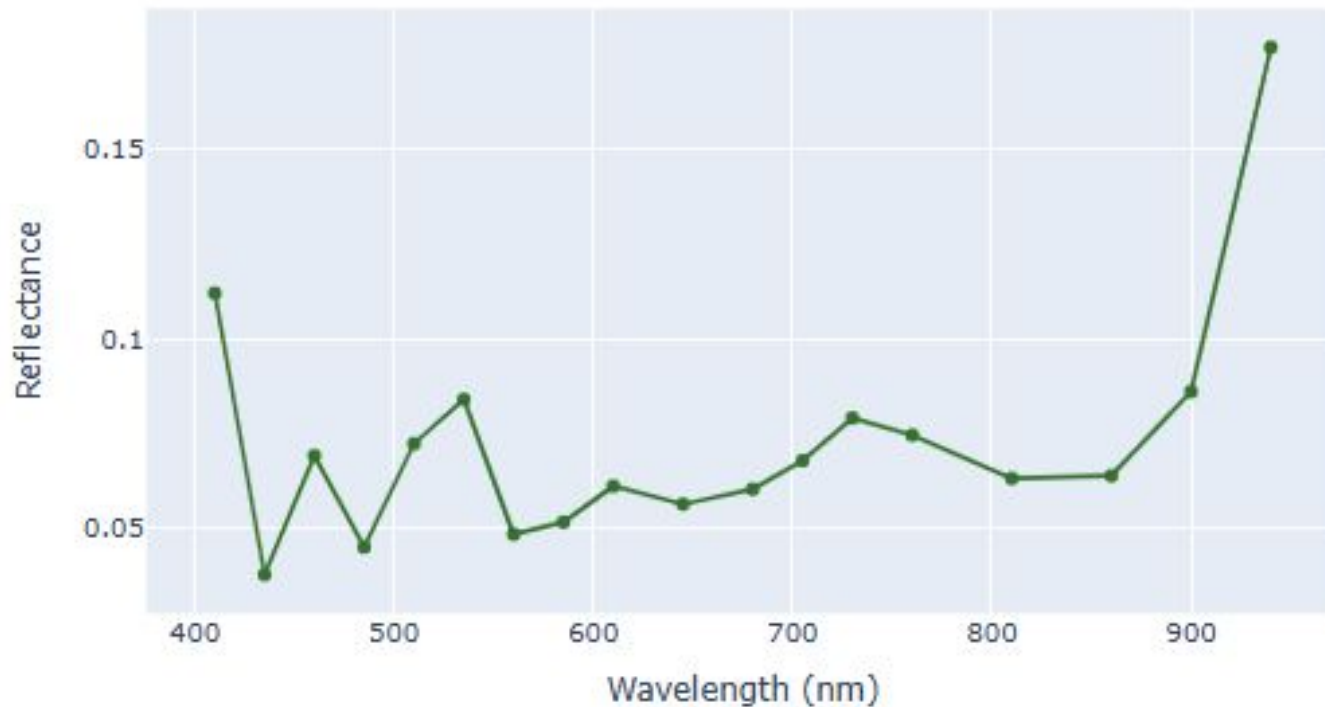
Mystery 1

STELLA-Q2 Reflectance Curve



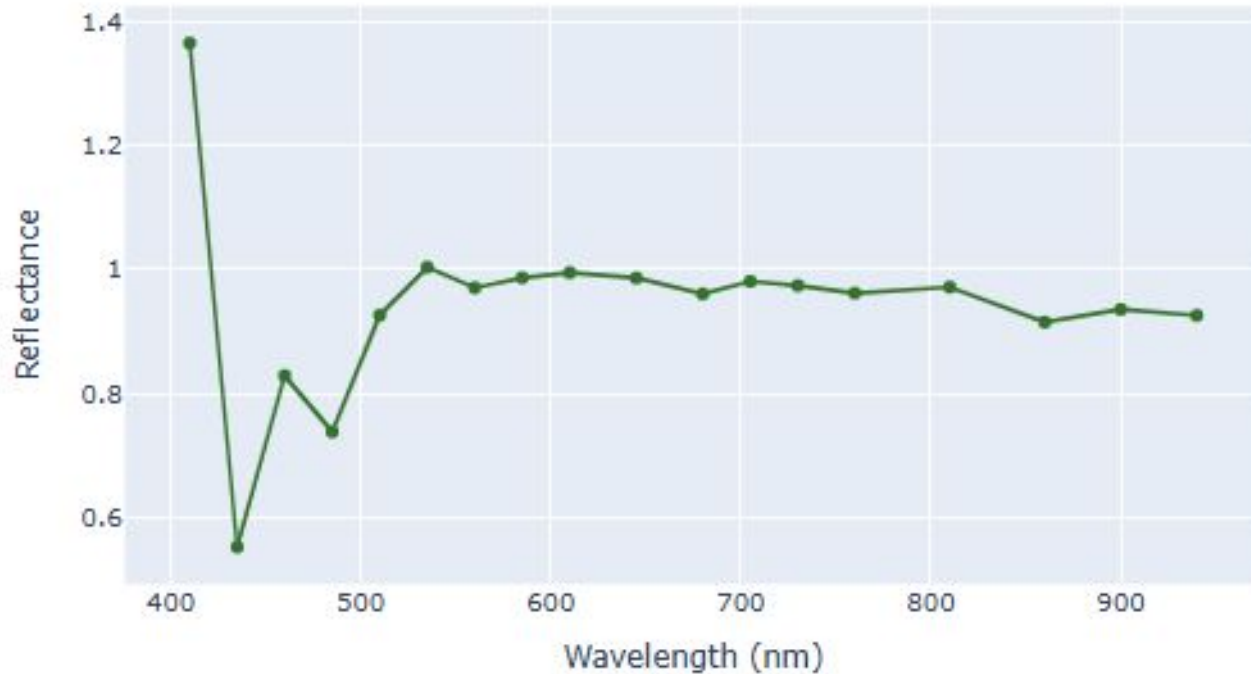
Mystery 1 - Black case

STELLA-Q2 Reflectance Curve



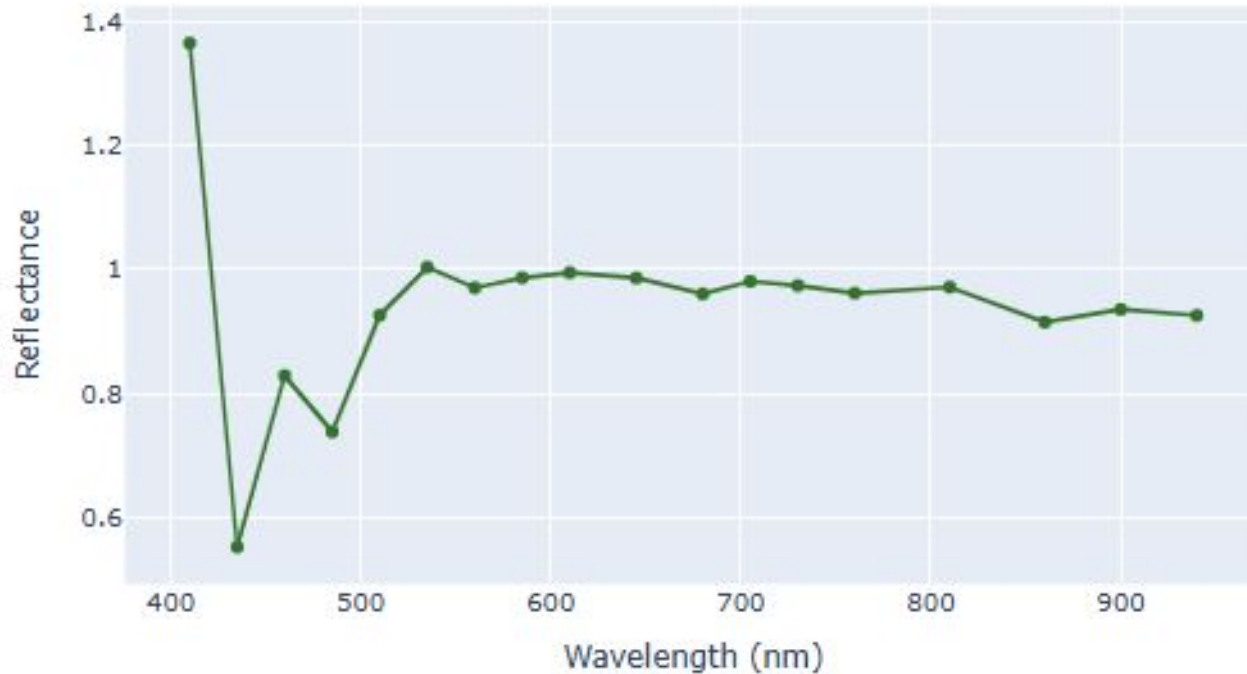
Mystery 2

STELLA-Q2 Reflectance Curve



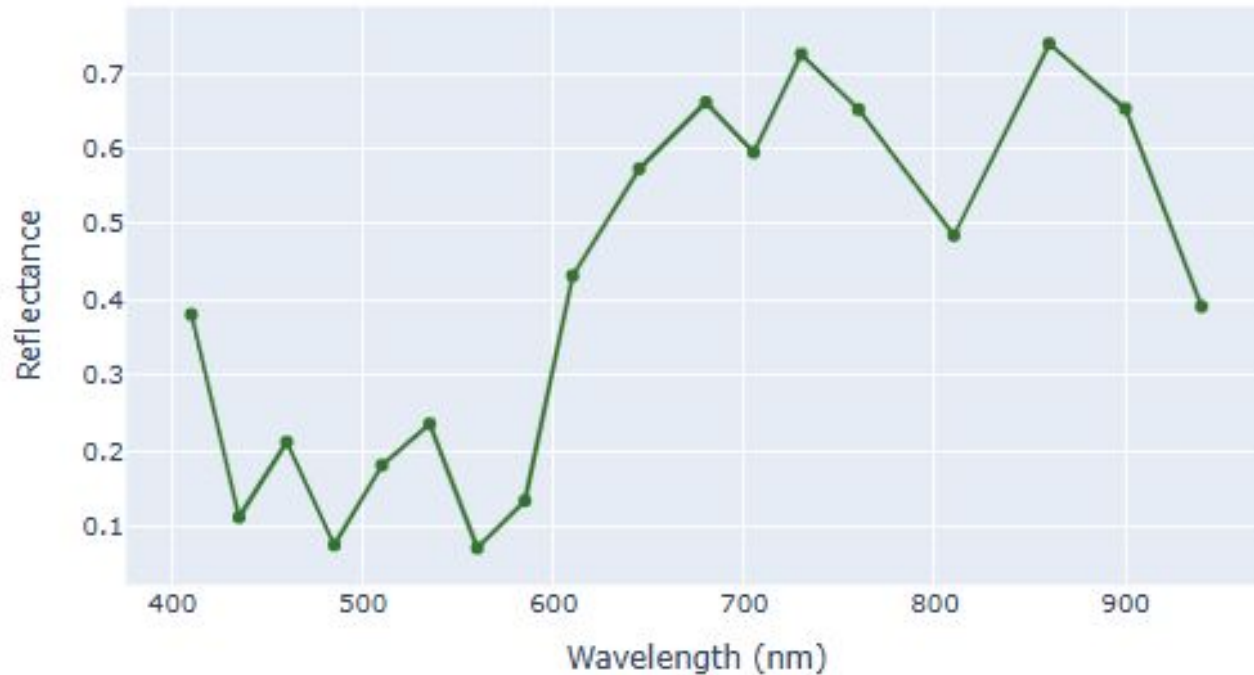
Mystery 2 - White case

STELLA-Q2 Reflectance Curve



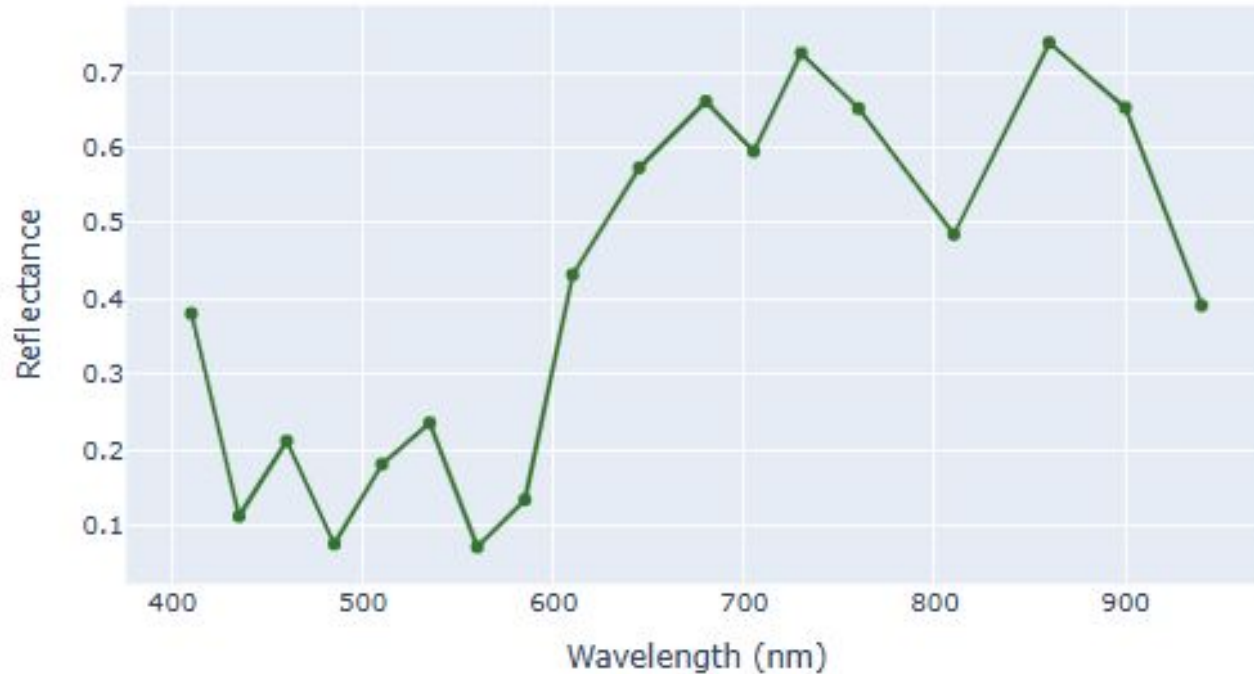
Mystery 3

STELLA-Q2 Reflectance Curve



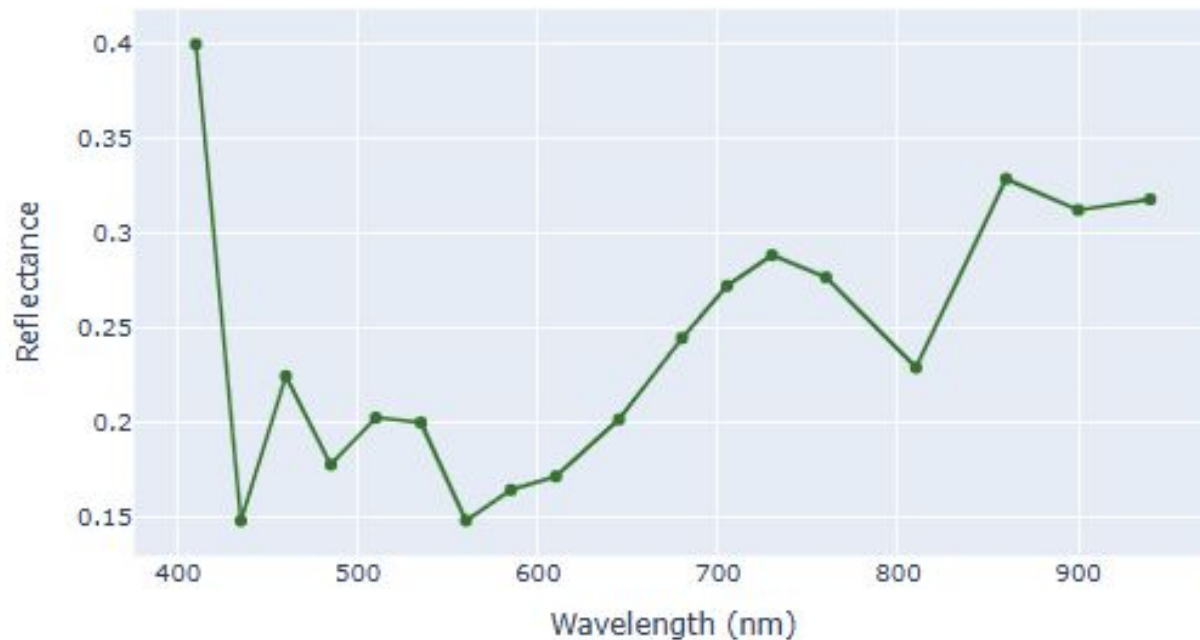
Mystery 3 - Red folder

STELLA-Q2 Reflectance Curve



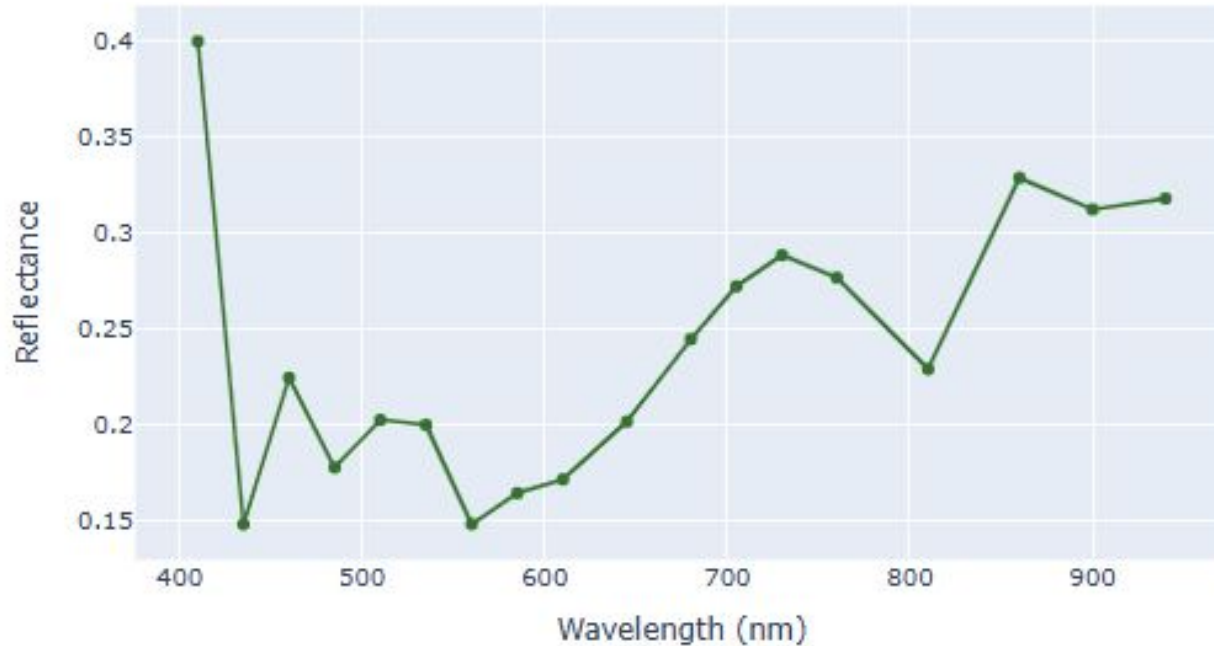
Mystery 4

STELLA-Q2 Reflectance Curve



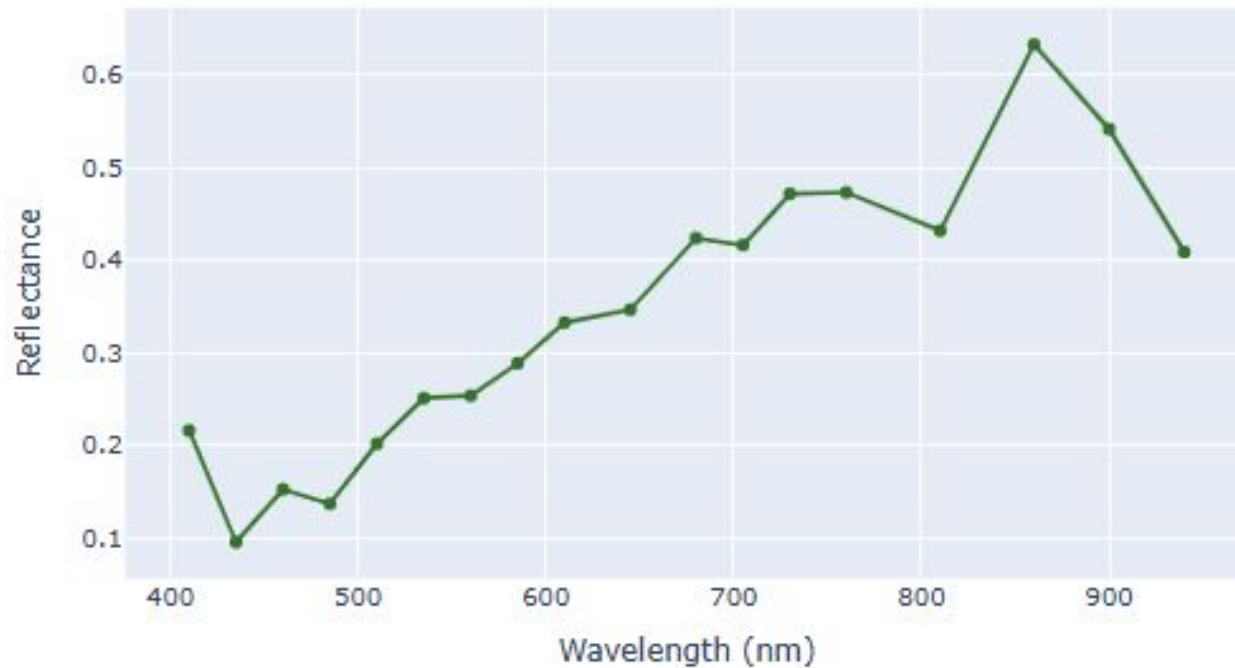
Mystery 4 - Purple folder

STELLA-Q2 Reflectance Curve



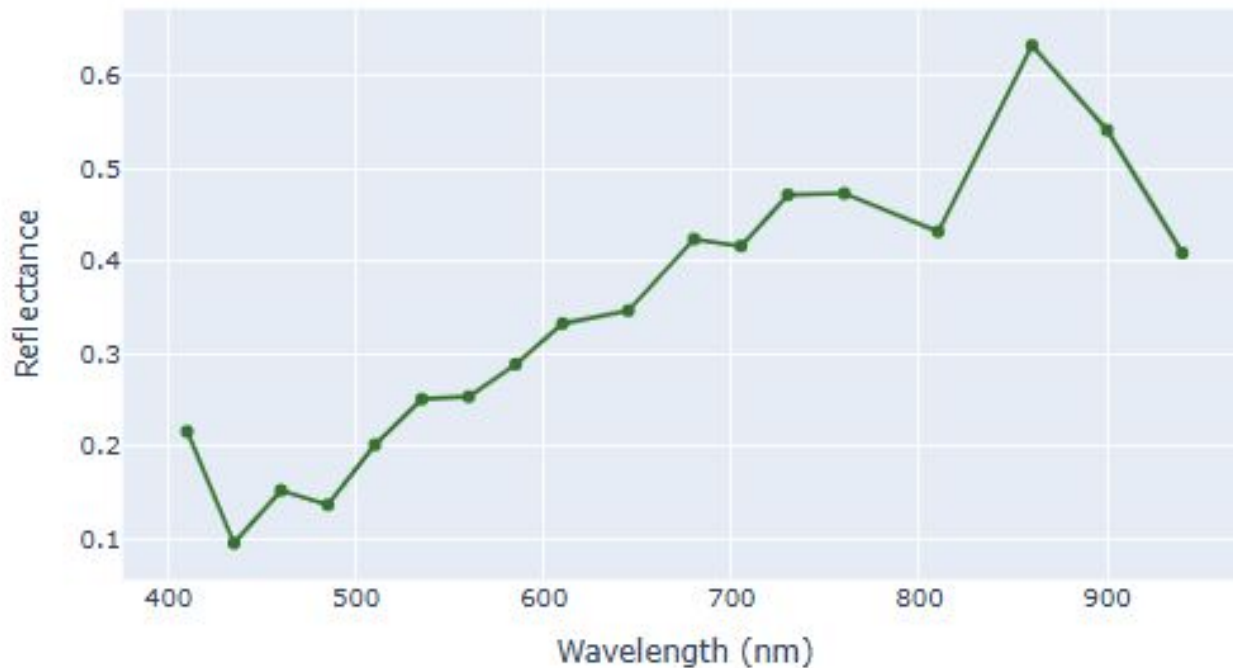
Mystery 5

STELLA-Q2 Reflectance Curve



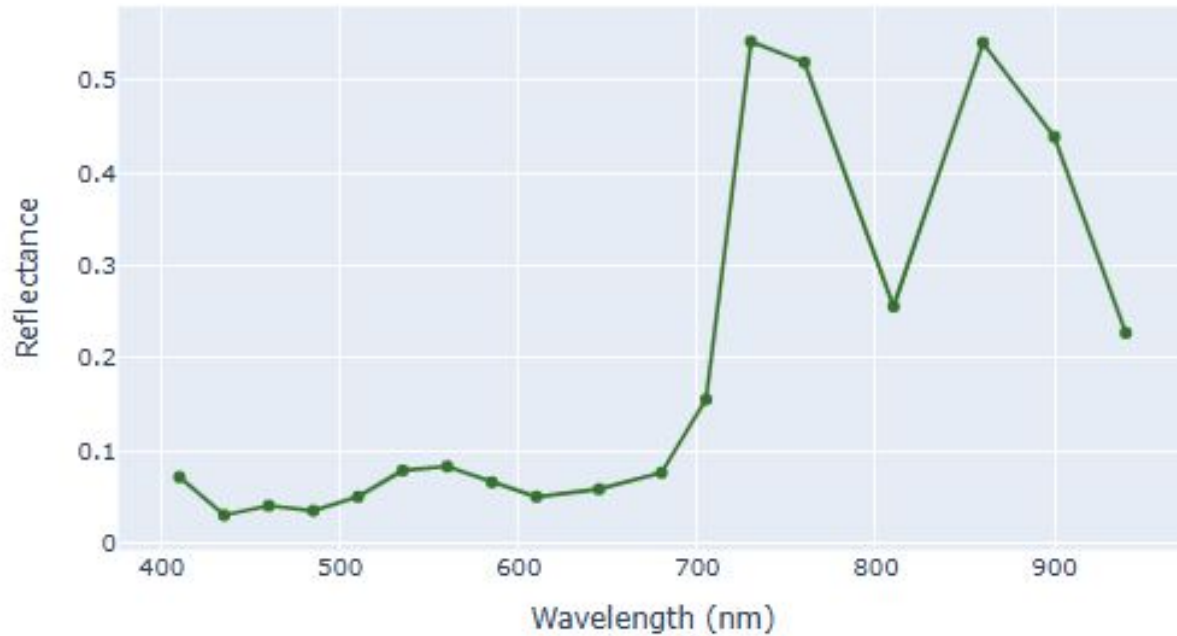
Mystery 5 - Light brown box

STELLA-Q2 Reflectance Curve



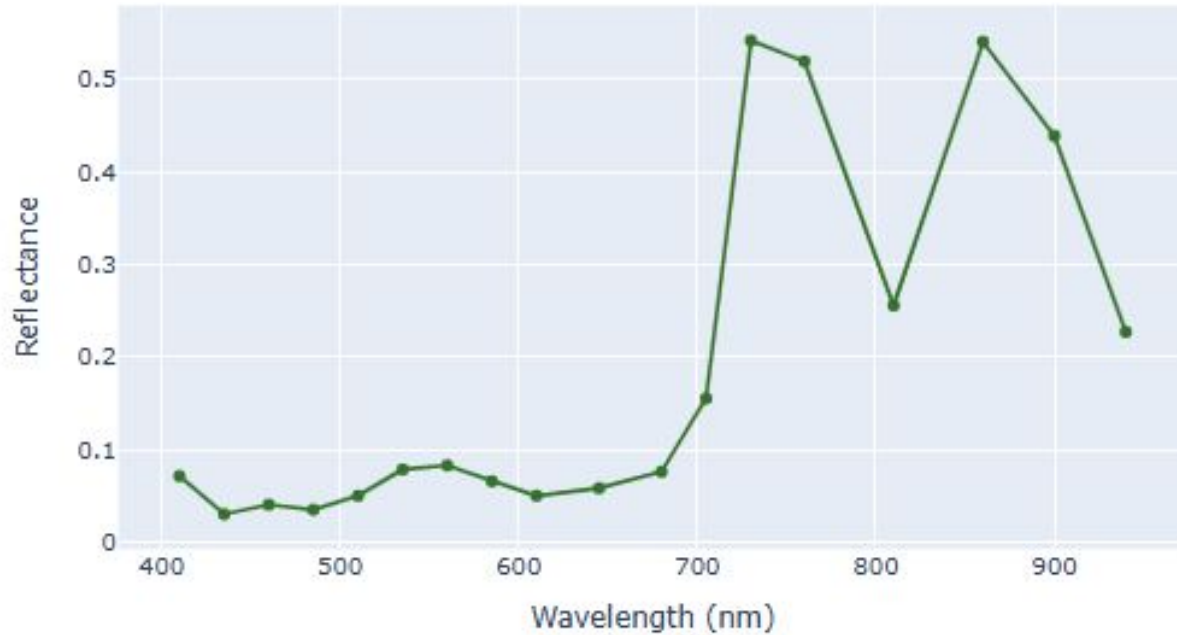
Mystery 6

STELLA-Q2 Reflectance Curve



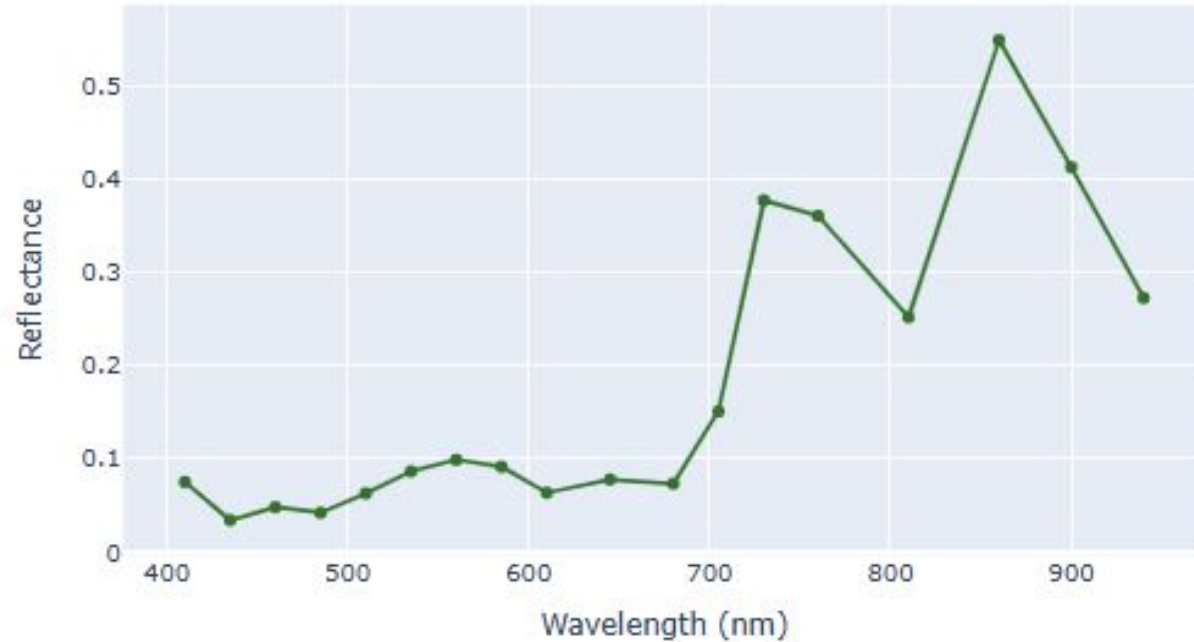
Mystery 6 - Healthy leaf

STELLA-Q2 Reflectance Curve



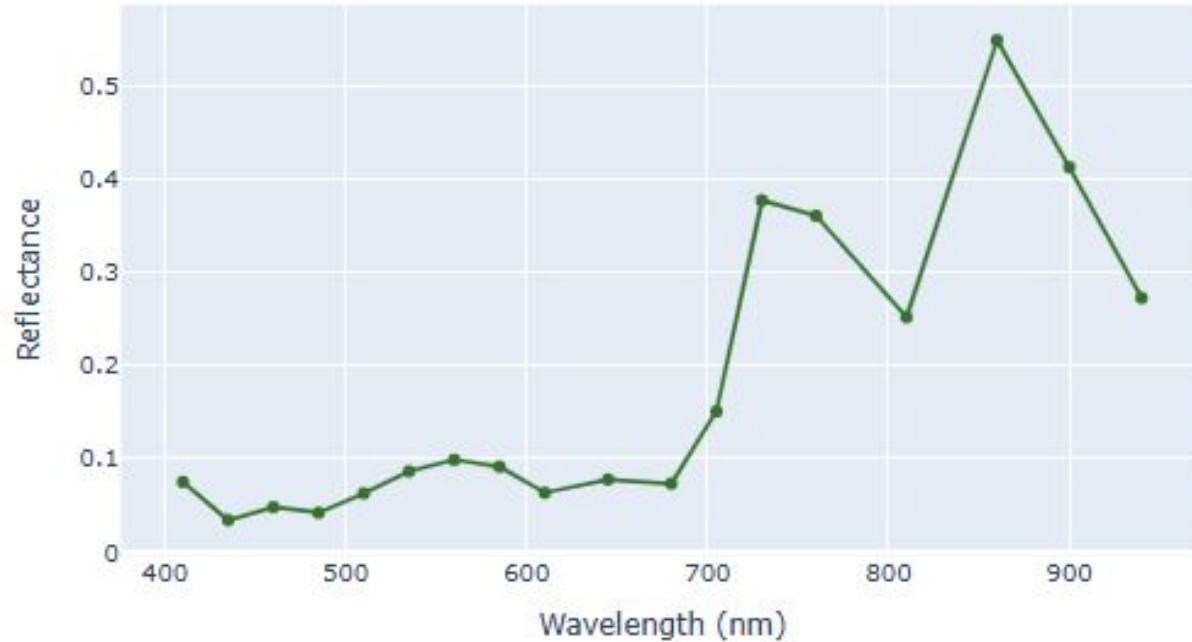
Mystery 7

STELLA-Q2 Reflectance Curve



Mystery 7 - Dead leaf

STELLA-Q2 Reflectance Curve



Thank you!