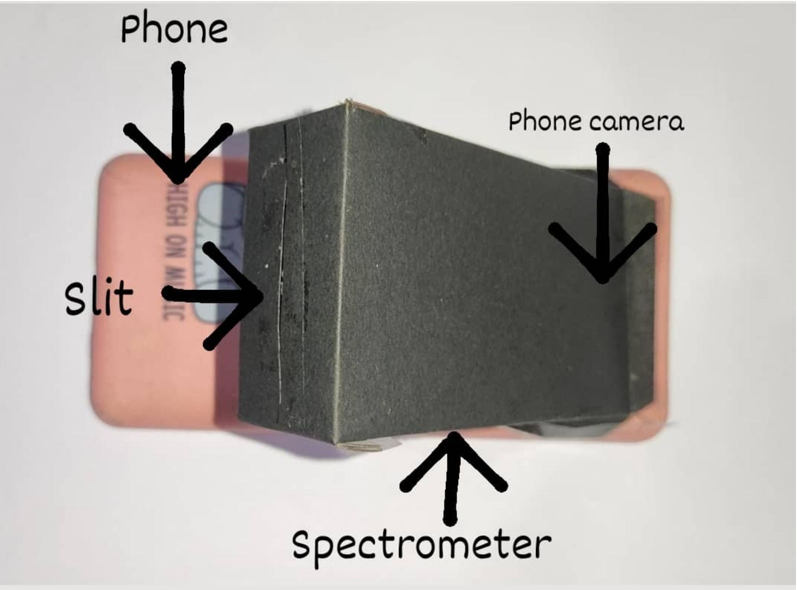
Home Projects :

1. CD Spectrometer:

You must have noticed that if you move the CD around, you can often see the rainbow on it. The reason for that is the CD is made up of millions of tiny grooves. And these grooves are the reason why when light is incident on the CD, different colors are reflected at different angles. To explain this phenomenon we'll use the theory of a diffraction grating. A diffraction grating consists of a large number of equally spaced parallel slits. When light is incident on a grating, the light from each slit diffracts and will interfere with the light from the other slits. When the conditions for constructive interference for a given wavelength are satisfied, that color is enhanced and hence observed.
A CD has a spiral, grooved track (usually composed of pits). For a small region on the surface of a CD, the grooves create an approximately parallel pattern. Consequently, the light reflected from a small portion of the surface diffracts as if from approximately parallel sources. This results in the colored patterns you see when viewing white light reflected from a CD. Because of this, an ordinary CD is a reflection grating and works as the optical spectrometer. The optical spectrometer is the instrument used to measure the interaction of electromagnetic radiation with a sample or the emission of electromagnetic radiation from a sample. They are concerned with electromagnetic radiation that falls within the optical region of the electromagnetic spectrum. They use dispersive element to separate light into its constituent wavelengths. This dispersive element is a diffraction grating which spatially separates polychromatic light that is incident on the grating. In the CDS, CD works as this diffraction grating.

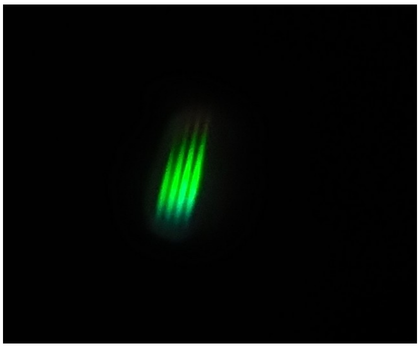
Procedure:
To make the CD spectrometer, all we need is a CD, a slit through which light will pass and a box-like system to hold this CD and slit arrangement. Also, we'll need a detector, our eyes or phone camera, to observe and record the spectra.
I followed the procedure from this tutorial which uses an easy paper cuttable model to make the spctrometer.
For taking the pictures of spectra, I attached the instrument to my phone camera using tape.
To get the precise spectra, you'll need to try to tilt the apparatus at different angles. Make sure that the slit made (refer to the tutorial) is small enough for sharp lines (the slit width of my instrument is <1mm).

Pictures of the apparatus:

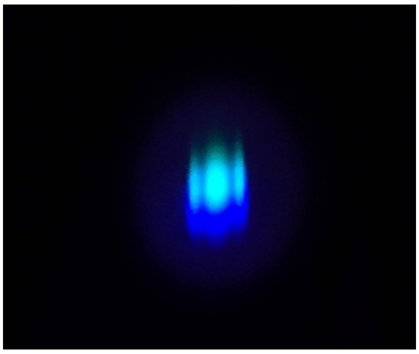


Observations:

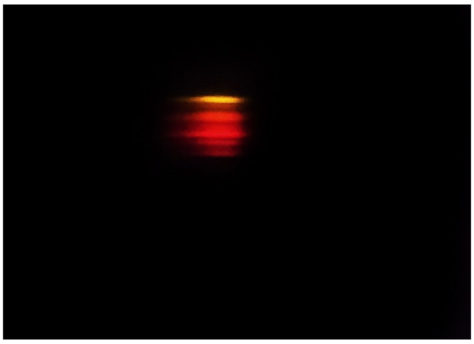
I observed the spectra of various light sources available at home. Including below the pictures of few of them.



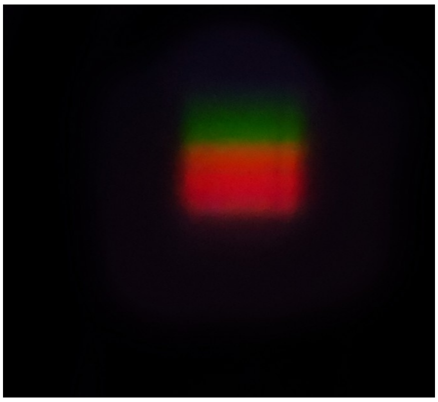
a. The green light on the WiFi Dongle



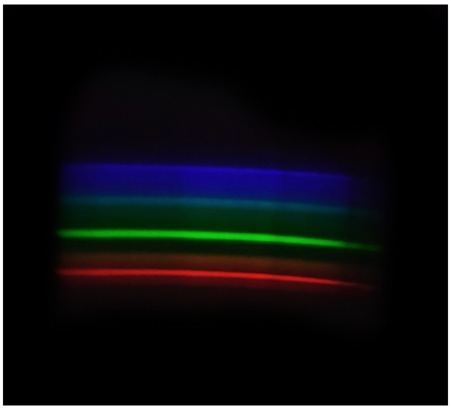
b.The blue light on the WiFi Dongle.



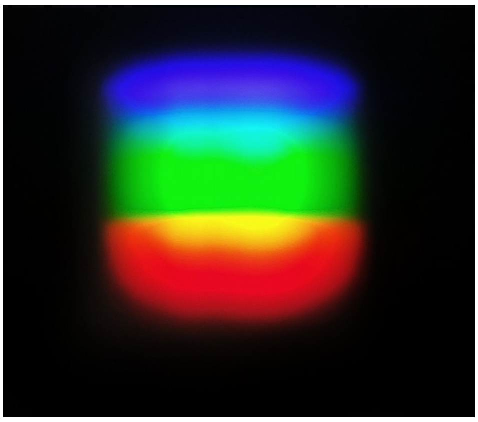
c.The red light on the Electricity board.



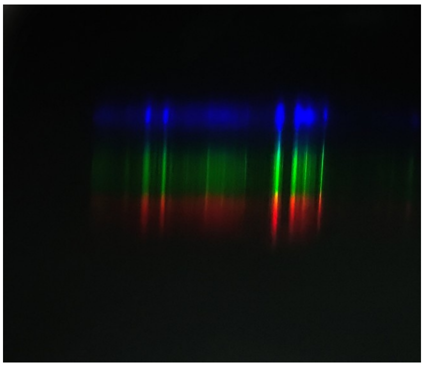
d. Yellow Incandescent Light Bulb



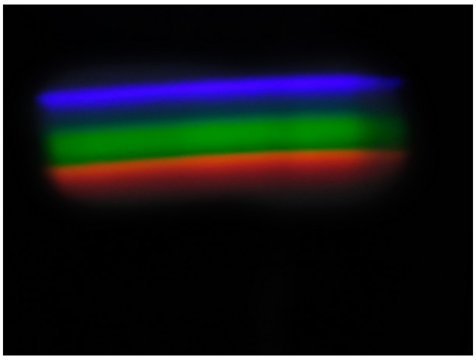
e. White Fluorescent (CFL) Bulb



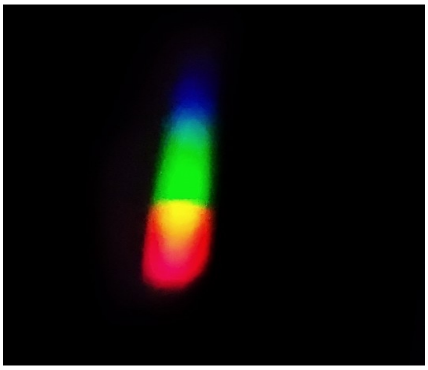
f. White Incandescent Light Bulb



g. White Flashlight of Mobile



h. Laptop Screen



i. Candle Flame.

Inferance:

If we compare the observed spectra with the actual spectra of corresponding sources noted in literature, then we find that spectra recorded through CDS do show similarities with the actual spectra.

For an example, in the first row of pictures above, the light sources are mostly LEDs of Green, Blue and red light used in the WiFi Dongle and the Electricity Board. They show the spectra of majorly single colored light which is explained by almost monochromatic light of colored LEDs.

In the second row of pictures, the comparison between White Fluorescent (CFL) Bulb and White Incandescent Light Bulb shows that the CFL gives sharper lines of colors (white light) comapared to spread out spectrum of Incandescent Bulb. Also, the CFL spectrum is made up of particular wavelengths (VBGR, corresponding to mecury lines) whereas, Incandescent bulb appears to have almost the continuous spectrum.
Similarly the candle light shows complete continuous spectrum like sunlight. Laptop screen light is composed of three specific wavelengths correspoding to RGB colors, which can be seen in the picture too.

General uses of spectrometer:

- Studying spectral emission lines of astronomical bodies to determine the elemental composition of them.
- Analyzing the gases to determine their properties.
- Monitoring the contents of water bodies.

Limitations of CDS:

- One of the major limitations of this method is that the spectrum is not well resolved.
- We cannot measure the wavelengths with precision from the colors of spectrum.
- If we are using our eyes as detector then there’s a high chance of harming ourselves while observing an intense radiation.
- The source needs to be considerably bright in order to get the spectrum with CDS.

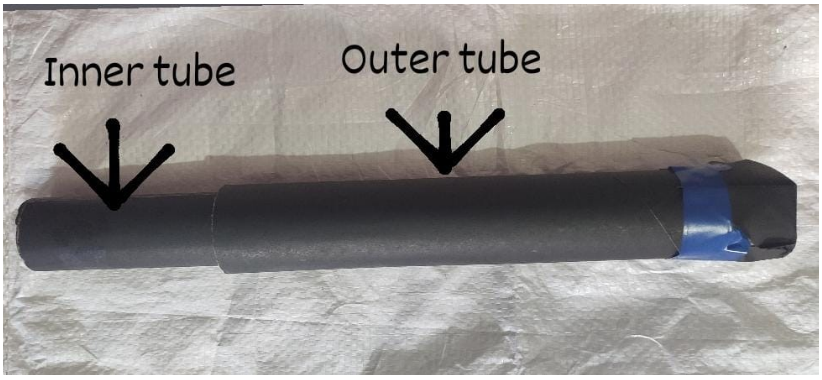
Thus, we can infer that although CDS has multiple limitations, it is a pretty useful diy tool to observe the spectra of different sources of light at home and it was fun doing this!

2. Pin Hole Camera:

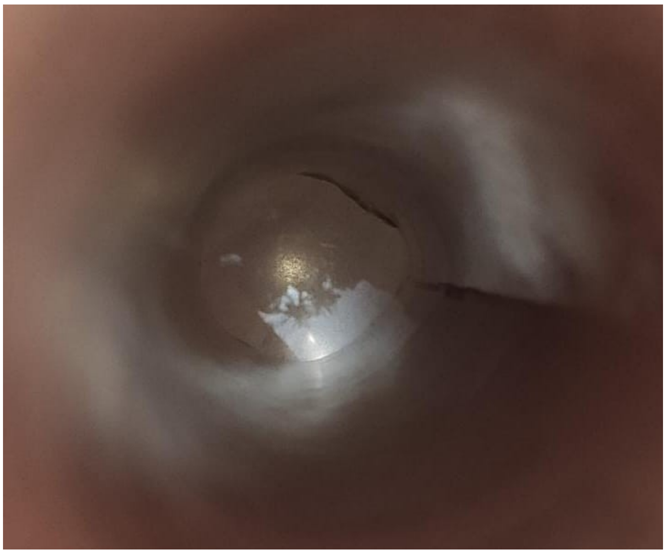
A pinhole camera is a simple camera without a lens but with a tiny aperture called pinhole – effectively a light-proof box with a small hole in one side. Light from a scene passes through the aperture and projects an inverted image on the opposite side of the box, which is known as the camera obsura effect. Camera obscura is the natural optical phenomenon that occurs when an image of a scene at the other side of a screen (or, for instance, a wall) is projected through a small hole in that screen as a reversed and inverted image (left to right and upside down) on a surface opposite to the opening. The surroundings of the projected image have to be relatively dark for the image to be clear.

Procedure:
The material we need for the pin-hole camera is two tubes of slightly different diameter so that one tube would fit into another, a piece of any transuscent material (as the screen) and a piece of opaque material (to make a hole into) and a safety pin to make the hole.
I followed this tutorial to make the apparatus.
We need to adjust the tubes carefully in order to make the image focussed on the screen.
Keep the width of the pin hole as small as possible for sharper image.
While observing some object, make sure that the object is bright and the surrounding is dark, otherwise the image might get blurred.

Pictures of the apparatus:



Observations:



Obejct Images through the camera

Inference:

The image obtained through the pin hole camera is vertically and diminished wrt the object.

Uses of Pin Hole Camera:
A common use of pinhole photography is to capture the movement of the sun over a long period of time in solargraphy.
It is also used to learn about the basics of photography.