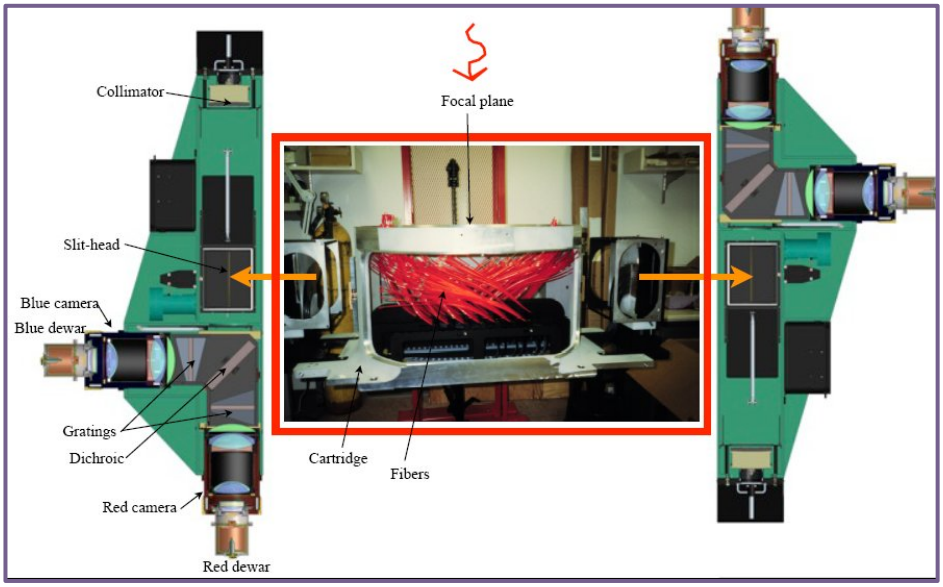
Make an SDSS CD Spectroscope

A spectroscope is a scientific instrument, which splits light into a rainbow in order to make precise measurements of it. After we finished taking images of a third of the sky, SDSS became a purely spectroscopic survey. To date we have used three different spectroscopes (the SDSS, BOSS and APOGEE instruments) to measure the light from millions of stars and galaxies. In this activity you will make your own spectroscope using simple household materials and use it to measure the spectra of common light sources.

Make Your Own Spectroscope

First use the included instructions to make your own SDSS CD Spectroscope.

This instrument you have made has many similarities to the BOSS spectroscope shown on the right.



The BOSS spectrograph. Centre - with optical fibres plugged into it. The diagrams at the side show the path of the light through the instrument, with parts labeled..

1. You have constructed a slit through which the light will pass. In the diagram of the BOSS spectroscope this is labeled "slit-head", and the light from the optical fibres is collected, "collimated" (i.e. lined up) and passes though it.
2. You have used an old CD to make a grating (the BOSS spectroscope has 4 gratings; 2 on each side, and sandwiched between prisms to make a "grism"). A typical CD has 625 lines per mm. The the BOSS spectrograph has 520 and 400 lines/mm for the blue and red sides respectively.

Your spectroscope will be sensitive to all visible light. In the BOSS spectroscope a "dichroic" is used to split the light into red and blue before passing it through the gratings. A dichroic has a special property that it is reflective to blue light, while red light passes through it. This means the light can be spread out more, and special cameras can be used to detect light from near ultraviolet, right across the visible rainbow to the near infrared.

Instead of a camera you will use your eye (or you could try using a camera lined up with the viewing window). In the BOSS spectroscope there are four cameras (two for blue and two for red light) each kept specially cold in a "dewer".

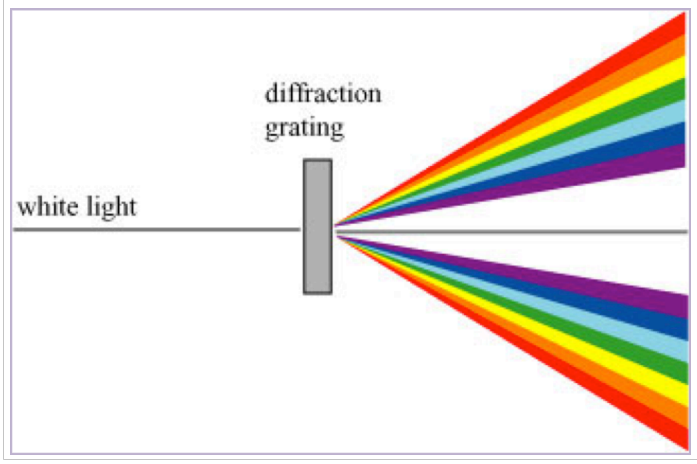
Using Your Spectroscope

Point the slit at a light source, and look through the window to see the spectra (it will look like a rainbow). Her are some suggestions of different light sources to investigate:

1. Scattered sunlight (**never look directly at the Sun**) from clouds, or coming in you classroom window
2. Streetlights at night
3. Gas lamps of different chemical elements (your school physics lab may have these).
4. Light bulbs with filament
5. Fluorescent (or energy saving) light bulbs
6. Computer/TV screens
7. LEDs (light emitting diodes) e.g. the light in a remote control, or power indicator lights

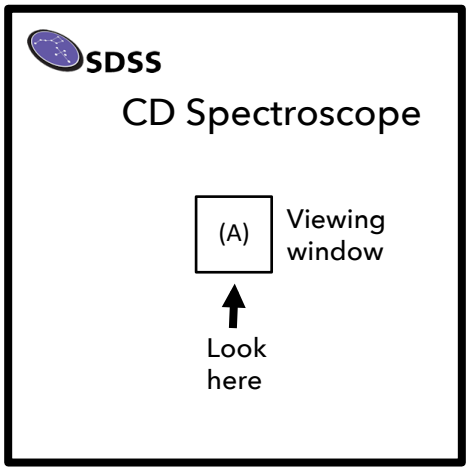
What's Happening?

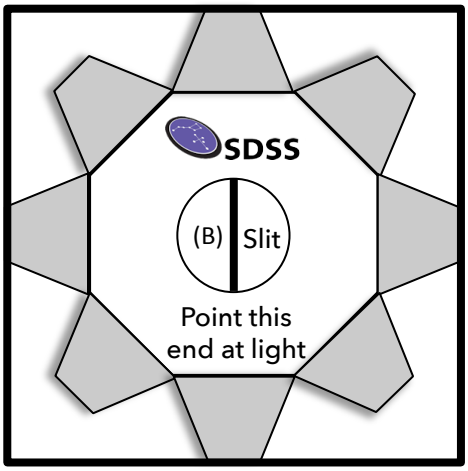
When the light passes through the slit it gets spread out a little bit, and then when it passes through the CD, the very fine slits in it (the diffraction grating) spread it out more. Different colours are spread out (or "dispersed") by different amounts. The angle of dispersion is set by both the wavelength (colour) of the light, and the line spacing on the diffraction grating.



Suggested Topics for Investigation

Make an SDSS CD Spectroscope





Instructions

You will need:

1. An old/unwanted CD (broken)
2. A cardboard tube (inner tube of toilet roll or kitchen roll; or a roll of thin dark card)
3. Two squares of black card (approx. 6cmx6cm)
4. Two index cards (or two very precisely cut squares of card; or two razors)
5. Dark sticky tape
(e.g. electrical tape, or duct tape).
6. Glue and scissors (and/or paper cuttting knife)

Start by cutting out and sticking the templates at left onto black card.

1. Make a very thin slit

Cut out the slit (B), and carefully tape two index cards on the back so that they almost touch. The aim is to make a very thin precise slit to let in the light (razor blades also work well for this).

2. Make your grating

Cut out the viewing window (A)
Use a piece of sticky tape to peel any remaining reflective (silver) coating from a piece of broken CD that is large enough to cover the window.
Taking care not to touch the middle of the CD, tape the piece to the back of the window.

3. Assemble your Spectrograph

Using dark tape attach the squares of card to each end of the cardboard tube.
The idea is to make sure no light can get into the tube except though the slit.
You will get the best results if you line up the lines on the CD with the slit.

4. Investigate Light Sources

Now use your SDSS CD Spectrograph to investigate the spectra of light sources (WARNING: never look directly at the Sun).