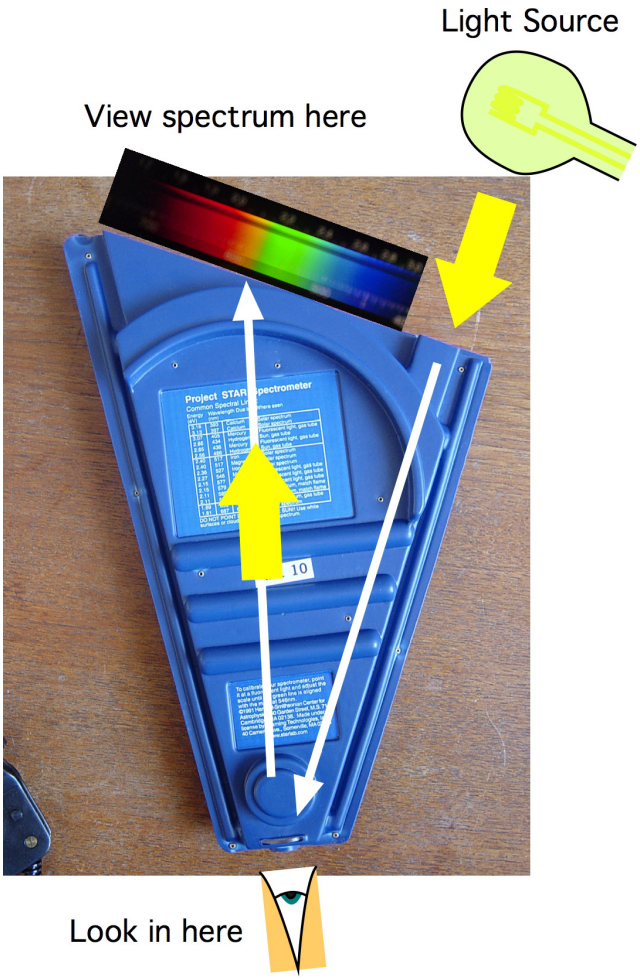
Exploring with the spectrometer

Emma and Peter Woolliams (January 2006)

What is it?

A spectrometer is a device that splits light into its spectrum – it shows you the frequencies (wavelengths) of electromagnetic radiation that the light source contains. The numbers tell you the wavelength of light – the shorter the wavelength, the higher the frequency. Blue light has a wavelength of around 400 nm, and red light has a wavelength of between 600 nm and 700 nm. One nanometre (nm) is one billionth of a metre (0.000 000 001 m = 10^{-9} m) or one millionth of a millimetre.

How do I use it?



Make sure it's the way up shown here. There's a small slit at the point where the light goes in (top right) and there's a thin film and lens at the point where your eye goes (bottom).

1. Look through the eye-hole towards the slit and make sure you can see the light source you want to examine brightly in the slit. This will make sure you're lined up with the slit.

2. Without moving the spectrometer, the light source, or your head, move your eye to the left to look at the spectrum.

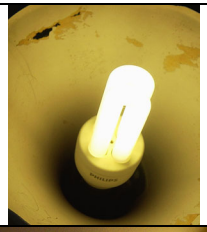
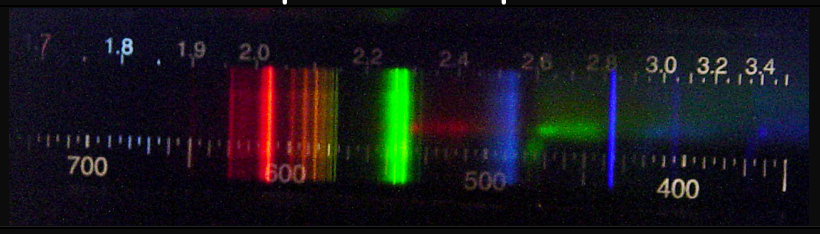
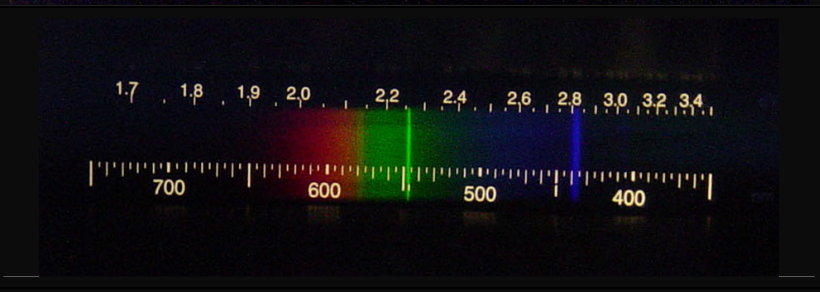
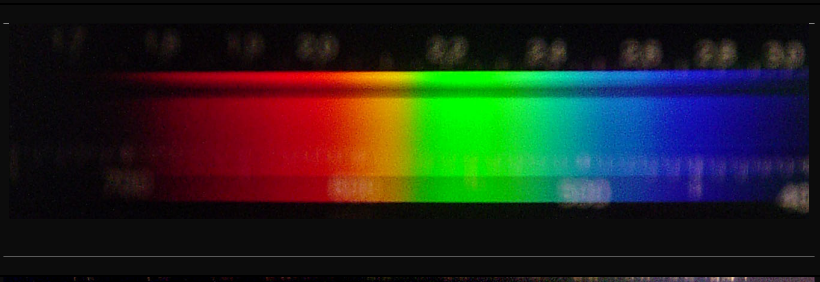
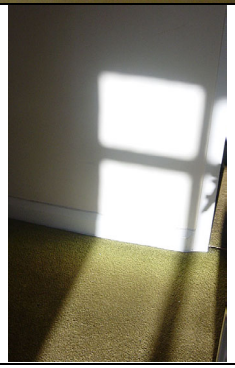
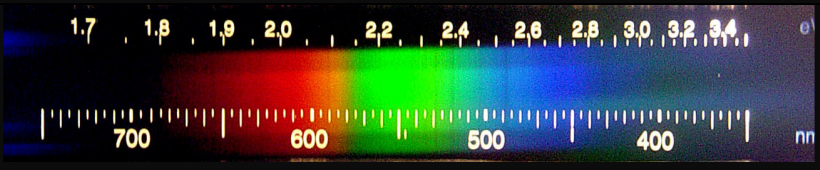
3. If you don't see a clear spectrum, try moving closer to the light source and move your eye to double check that the light is going into the slit.

Tips

- If you have more than one light source on in the room (e.g. there's sunlight, low energy bulbs and tungsten bulbs all on) then you might get a confusing mixture of spectra.
- Start with some bright light sources: they are easier to see!

What can I look at? What will I see?

All the photos on the next page were taken in a flat on a Sunday morning. The photos were taken with a digital camera with a lens approximately the same size as the eye-piece at the eye entrance. The pictures were tricky to take: we had two people to hold the spectrometer and camera, and a tripod or two!

Source	Spectrum Examples	Notes
		Low energy light bulbs and 'strip lights' contain mercury vapour. An electric current passing through the vapour causes the mercury atoms to 'ring' like a bell and emit light with just a few different frequencies. • You can see some of these frequencies as individual lines in the spectra on the left. • The atoms also emit ultra violet light that is absorbed by a chemical on the inner wall of the tube. This chemical, (called a *phosphor* because it generally contains the element phosphorous) then emits light of a different colour. A mix of phosphors is used to give either a 'warm' pink light or a 'cooler' blue light Very little light is emitted in the infra red (which we can't see) and so these fluorescent lights emit more light for a given energy input than a normal light bulb.
		
		This is a "tungsten halogen" lamp – it's like a traditional light bulb only smaller and brighter. The lamp works by heating a filament of wire made from the element tungsten. The full spectrum – all colours – is seen because this works by heat. The tungsten atoms are too close together to "ring" like a bell.
	 DO NOT LOOK AT THE SUN DIRECTLY! IT CAN PERMANENTLY DAMAGE YOUR EYESIGHT!	It is definitely worth looking at some bright sunlight falling on a white wall or on a piece of white paper. You'll see a full spectrum – the Sun is hot – but you'll also see dark lines (e.g. the one just below 490 nm). These are caused by cooler gas on the outside of the Sun absorbing the hot light from the Sun to make the gas atoms 'ring' – so that bit of light is missing from the spectrum of the hot Sun underneath. You can see this more clearly with your eye than with the camera – you should see lots of lines the camera can't detect.

Other ideas: Sodium (orange) street lights. Other (whiter) types of street light. Neon lights in shop windows. The lights on your TV or other electrical applicances. Your computer screen with a white /red/blue/green background. Candles (with and without salt)… What else can you think of?!