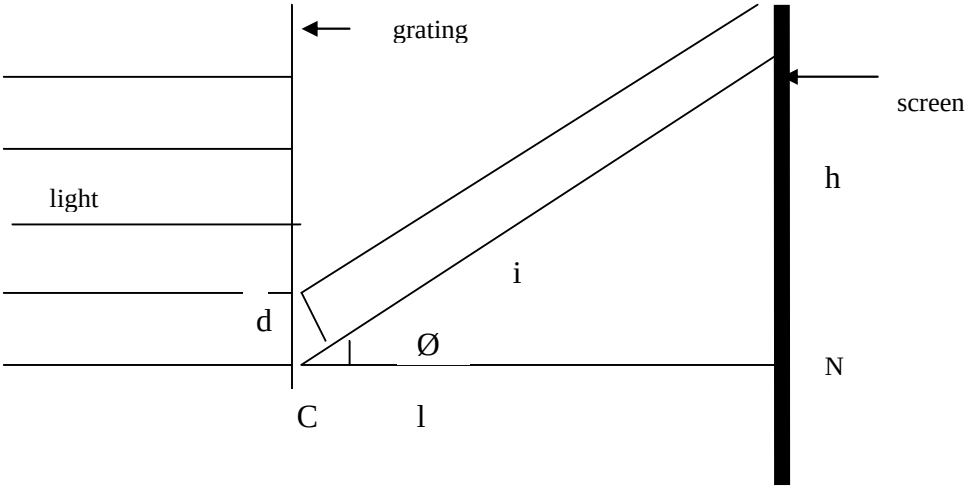
Introduction to spectroscopy

Angela Turricchia
Laboratorio per la Didattica Aula Planetario
Comune di Bologna

Introduction

When we work with students on light spectrum, it's important that they have some prerequisites particularly about grating diffraction and about what happens when light passes through this grating.

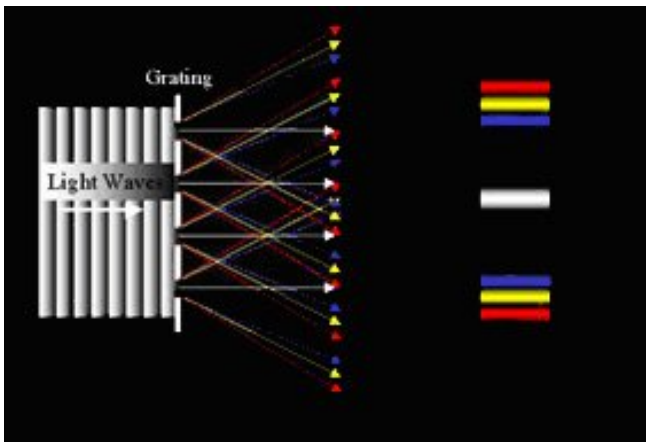
diffraction



d sen Ø= λ
but
sen Ø= h/i i= $(h^2+l^2)^{1/2}$

dand we can calculate

λ= h/d $(h^2+l^2)^{1/2}$



m lambda = *d* sinØ,
where:
m is order number,
lambda is a selected wavelength,
d is the spacing of the grooves in the grating, and
Ø is angle of incidence of light.

Here we present three simple experiments, useful for the students before they approach other activities related to spectroscopy and to the measurements that can be done on spectral lines, such as the measurement of the mass of a galaxy

Experiment #1 - Measurement of the wavelength of different colours

Materials:
1. white filament lamp
2. thin slit made out of a black cardboard
3. diffraction grating
4. white screen.

We build the experiment so that when we turn on the lamp, the light passes across the slit, across the grating and on the screen we can see different colours.
We can measure the wavelengths corresponding of the different colours.
Conclusion:
The different colours in the spectrum of the light represent different wavelength and different frequencies.
We can use different lamps, but always filament lamps, and we can verify with the spectroscope that we see continuous spectrum.
Attention: when we measure the wavelengths we will get some errors, particularly because we measure the centre of the coloured band and this measure is very approximate

Experiment #2- absorption spectrum

Materials:
1. white filament lamp
2. thin slit made out of a black cardboard
3. diffraction grating
4. white screen
5. coloured filters (for example blue and red) between the lamp and the screen (if we want to make a qualitative experience we can use lamps with red and/or blue cover)

We turn on the lamp, the light passes across the slit, across the grating and on the screen we can see different colours.
We observe that the blue/red part of the spectrum completely disappears

Conclusions
In experiment #1 we see an emission spectrum and we see a continuum; in experiment #2 we see an absorption spectrum: only one colour disappears.
We can deduce information about light source and about what is in between the light source and the observer.

Experiment #3 - emission spectrum of a gas

Material:
1. Plucker's tube
2. thin slit made out of a black cardboard
3. diffraction grating
4. white screen.

N.B: we can use an optical bench and put the lamps on this bench.

We can measure the different wavelengths of the lines in the spectrum (is important that we measure also the associated errors)

Conclusions:
We don't see a continuum spectrum, but a spectrum with lines; if we use different lamps we see different lines in the spectrum.

And now...what is the element in the lamp??
We see now a spectrum of a lamp: What is the chemical element inside the lamp?
We can use this website
http://jersey.uoregon.edu/vlab/elements/Elements.html
for comparing the spectrum of the lamp to the spectra of different elements.