Overlapping and Partial Orders

Introduction

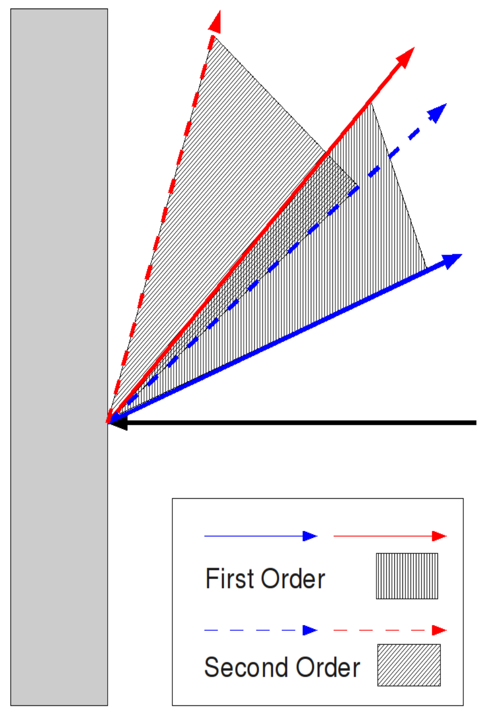
The grating equation, for normal incidence, is

$$p\,\lambda = a \sin\theta$$

where the order number (p) is any integer (usually in the range 0 to 3) and a is the spacing between lines (grooves of the grating.

Overlapping orders

For some angles two different wavelengths can be seen, with different values of the order number. For example, a line of wavelength 7000 Å in first order will been seen at the same angle as a line of wavelength 3500 Å in second order. This is referred to as an overlapping order. It is always found in the spectra from diffraction gratings, but is not generally a serious problem. For the example given here the second order line at 3500 Å can be removed by the simple solution of introducing a red transmitting filter which is transparent at 7000 Å but not at 3500 Å.



Overlapping orders are illustrated in the diagram to the right. He extent of first order is given by the two solid lines and the vertical hatching. Second is defined by the two dashed lines, and the horizontal hatching. There is a range of angles covered by both vertical and horizontal hatching. This is the region of overlapping orders.

Suppose that we have a grating whose line spacing is 2 μ to resolve a spectrum running from 3000 Å to 7000 Å. Then solving for the diffraction angle using the grating equation

Order	Wavelength	Angle
First order	3000 Å	8.6°
	7000 Å	20.5°
Second order	3000 Å	17.5°
	7000 Å	44.4°

We can see that for angles between 17.5° and 20.5° there is an overlap of the red end of first order and the UV and blue end of second order. There can also be an overlap between second and third orders, and between third and fourth orders, etc.

Partial orders

For the higher order numbers the grating equation has a solution for the lower wavelength (UV and blue) end of the spectrum, but does not have a solution for the long wavelength (red) end of the spectrum.

For the grating in the previous example ($a = 2\ \mu$) in third order

- for $\lambda = 3000$ Å, $\theta = 26.7^o$
- for $\lambda = 7000$ Å, θ has no solution.

The third order is therefore a partial order. It contains some wavelengths in the spectrum, but not all. The highest wavelength in any given order that does exist is the one for which $\theta = 90^o$. In our example in third order this is 6666 Å. Similarly the fourth order is also partial, with a maximum wavelength of 5000 Å.