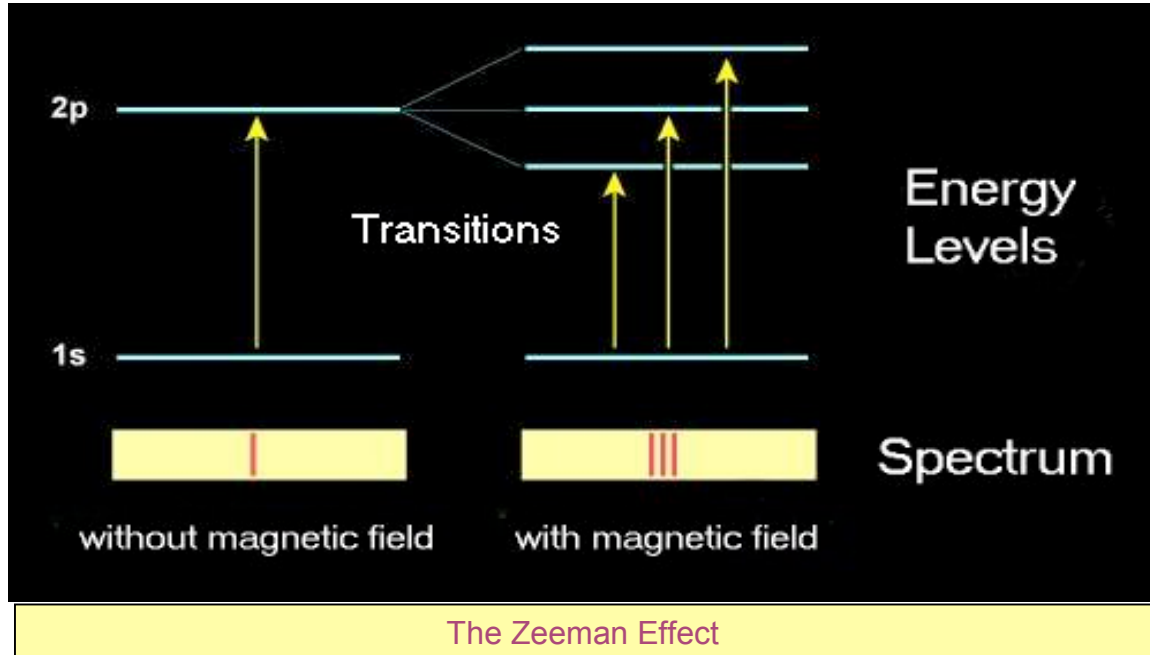


Zeeman Spectral Line Splitting

The pattern and amount of splitting in an atomic spectral line denote the presence of a magnetic field and its strength. The splitting is associated with what is called the *orbital angular momentum quantum number* L of the atomic level. This quantum number can take non-negative integer values. The number of split levels in the magnetic field is $2 * L + 1$. The following figure illustrates the Zeeman effect.



Atomic physicists use the abbreviation “s” for a level with $L=0$, “p” for $L=1$, and “d” for $L=2$, and so on (the reasons for these designations are of historical interest only). It is also common to precede this designation with the integer principle quantum number “n.” Thus, the designation “2p” means a level that has $n=2$ and $L=1$.

In the preceding example the lowest level is an “s” level, so it has $L=0$ and $2L + 1 = 1$, so it isn’t split in the magnetic field, while the first excited state has $L=1$ (“p” level), so it is split into $2L + 1 = 3$ levels by the magnetic field. Thus, a single transition is split into 3 transitions by the magnetic field in this example.

Polarization of Spectral Lines

The lines corresponding to Zeeman splitting also exhibit *polarization effects*. Polarization has to do with the direction in which the electromagnetic fields are vibrating. This in turn can have an effect on whether the light at a certain wavelength (or frequency) can be observed. For example, polarizing sunglasses are often effective in suppressing ambient glare because light reflected from surfaces has a particular polarization and polarizing sunglasses are designed to not pass that polarization of light.

One practical example in astronomy of such polarization effects is that in the preceding example the middle transition is polarized such that it cannot be easily observed from directly over a surface perpendicular to the magnetic field. As a consequence, when looking directly down on a sunspot (which has magnetic fields) typically only two of the three transitions shown above can be seen and the line is observed to split into two rather than three lines (the missing transition could be observed from a different angle where its light would not be suppressed by the polarization effect, but it is very weak when observed from directly overhead.)