8.9 Electron Spin: A fourth quantum number
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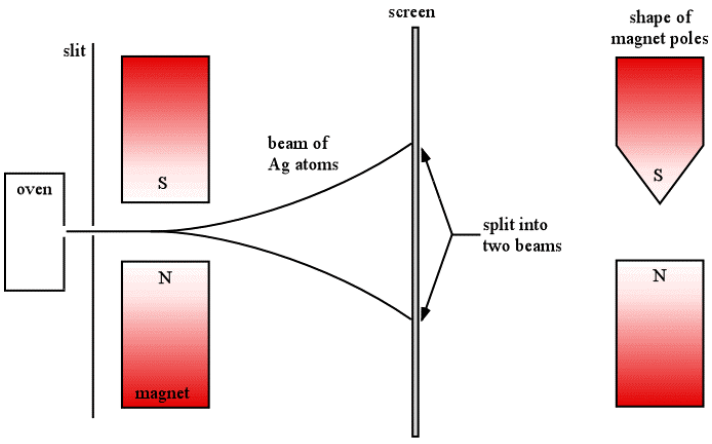
This is a short section, should be very easy to understand.

The basic idea here is that electrons behave in some aspects like a spinning sphere. An electron is only allowed two spinning states, represented by the arrows $\uparrow or \downarrow$. One of the electrons will be spinning in the clockwise direction, the other in the counter-clockwise direction.

This spinning generates a magnetic field. Two electrons with the opposite spins will have the opposite magnetic field. They would attract each other and this attraction permit two electrons to stay on the same orbital. This is called pairing up. (If only one electron exists in an orbital, this electron is called unpaired)You cannot fit a third electron into the orbital because this 3rd electron will have a spin that is in the same direction as the one of the two electrons already in the orbital. Thus, it would get "kicked" out.

This electron spin allows us to distinguish electrons in the quantum number system. We now add a 4th quantum number, m_s (prounced m sub s). This number is called the spin magnetic quantum number. It can only have 2 possible values, $+\frac{1}{2}$ or - $\frac{1}{2}$. This allows us to identify the specific electron on a single orbital. Now, an electron in an atom will be identified by the 4 quantum numbers, n, ℓ, m_l, m_s.

The experimental evidence for the electron spin comes from the Stern-Gerlach experiment.



STERN-GERLACH EXPERIMENT

Here is the experimental setup. You have a beam of silver atoms. Silver atoms have 47 electrons. 46 of the electrons are paired up but there is 1 unpaired electron. Now, this electron could have an "up" spin or "down" spin. The chances

of a silver atom with a up spin unpaired electron or down spin unpaired electron is about 50/50. In a beam of silver atoms, about half of the atoms would have a spin up unpaired electron, while the other half would have a spin down unpaired electron.

If you pass this beam through a magnet field, the beam would split in half. Half of the beam would go in one direction while the other half would go in the opposite direction. Why does this happen?

You see, if two electrons are paired up in an orbital, they would cancel out each other's magnetic field. However, unpaired electrons have no one to cancel their magnetic field with. Thus, they would cause the atom to exhibit magnetic behaviors. This field interact with the magnet, cause the atoms to sideways rather than hit the center of the screen.

Thus, this idea was confirmed experimentally by Stern and Gerlach.