Electrons in a Magnetic Field:Special Spin in de Haas- van Alphen Effect

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When the magnetic field is applied in a metal, the electrons behave like a harmonic oscillator. When field is increased these harmonic oscillator type levels cross the Fermi energy at a particular point resulting into discontinuities in the population of any particular level at a point. For a large orbital magnetic moment, different from L=0 and both signs of spin in the total magnetic momentum quantum number,$j = l \pm s$, the discontinuities in the population of the electrons in a particular level become double valued resulting into doubling of oscillations in the magnetization. There is a double valued change in the energy of the electrons when they transfer from the harmonic oscillator type level to the Fermi level. The magnetization depends on the value of $j = l \pm s$ so that there is a double valued period in the oscillations. The de Haas-van Alphen effect is usually described for the L=0 electrons. Hence, we see that the de Haas-van Alphen effect is considerably modified in going from L=0 to $j = l \pm s$, with both signs in the spin.