Azimuthal and magnetic quantum numbers

As angular momentum is a vector, one quantum number is related to its length, the other to its direction, in bound states the angular momentum is quantized as well.

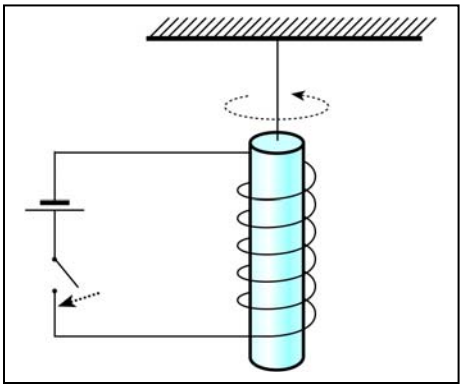
Spin and associated magnetic momentum of an electron

'The Stern-Gerlach Experiment'
atoms passing through an inhomogeneous magnetic field will be deflected

beam of Hydrogen atoms used in the experiment was split into two parts, proving the quantized nature of magnetic momentum, but based on the azimuthal and magnetic quantum numbers Hydrogen atom should have zero angular momentum in the ground state (we expect that the magnetic momentum will also be zero, i.e. such a beam is not deflected by an inhomogeneous magnetic field)

explanation: electrons have their **own** intrinsic magnetic momentum (associated with the angular momentum called **spin)**

this was proved experimentally: 'The Eistein-de Haas Experiment'
a tiny iron bar is fixed on a narrow torsion string inside a solenoid, after switching on the current the iron bar will turn



Structure of the nucleus, strong interaction, mass deficiency and binding energy

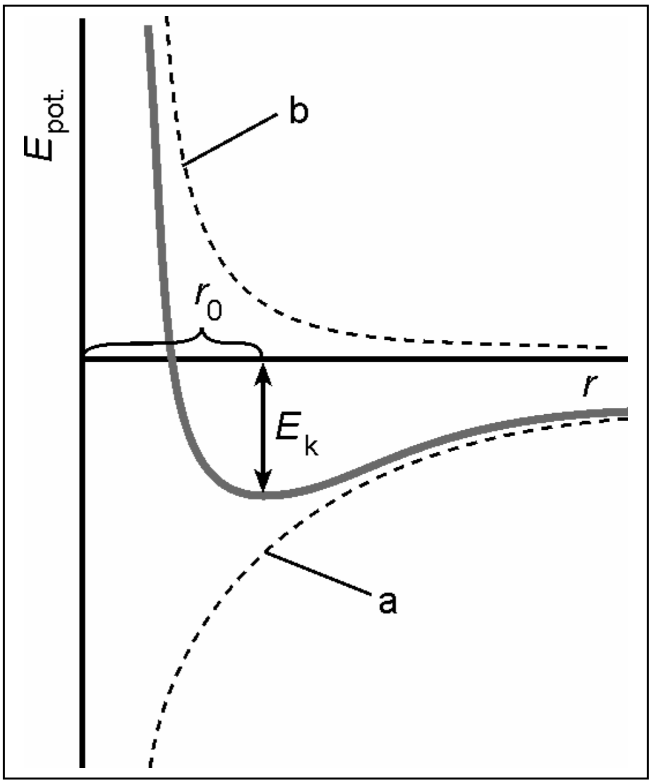
atomic number (A) is the sum of the number of protons (Z) and neutrons (N): $A = Z+N$.

$$\Delta M = [Zm_p + (A-Z)m_n] - M(A,Z) \neq 0$$

can be explained by Einstein's mass-energy relation

$$E = mc^2$$

Atomic interactions

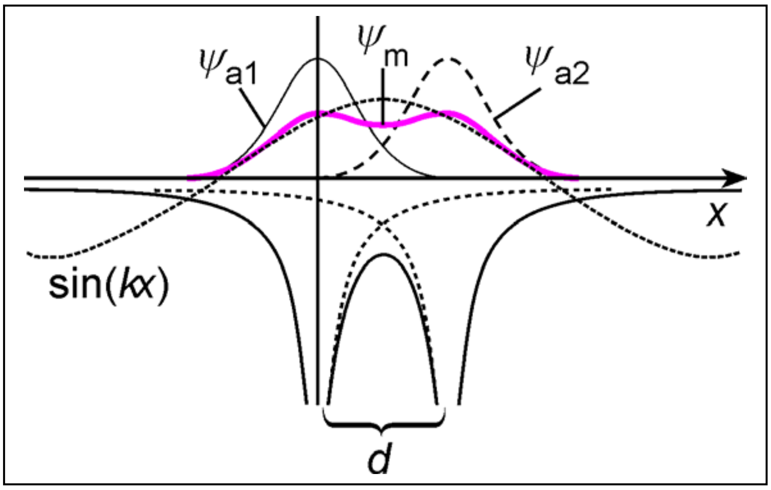


Except for the noble gases, atoms of elements form molecules by chemical bonds
potential energy of the system is minimized for certain equilibrium distances
binding distance (r_0)
binding energy (E_k)

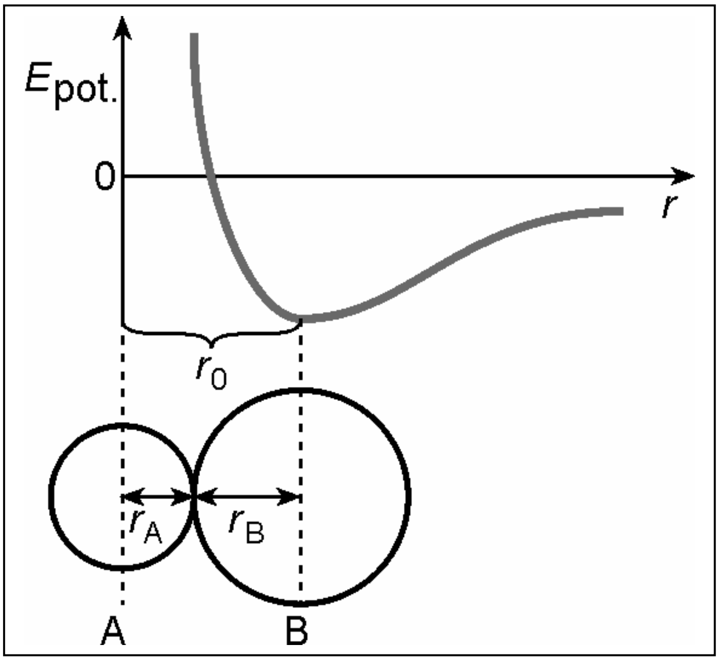
Bond types

classification of bond types:
intramolecular interactions
intermolecular interactions
Based on **the bond strength: strong** and **weak**, or **primary** and **secondary** bonds

Covalent chemical bond



Van der Waals interactions
two neutral molecules can interact even if neither of them are polar.
result of attracting forces between a temporarily created dipole within an apolar molecule (dispersional or the London-force)



distance corresponding to the energy minimum (r_0) is the sum of the **Van der Waals radii**

Many atom systems, Boltzmann distribution

In a system of thermal equilibrium (constant temperature) the total energy (E) is distributed in such a way that **an average of ½ kT energy corresponds to each degree of freedom** (equipartition theorem)

energy is constantly being redistributed among all particles and degrees of freedom.

we could specify only the distribution of energy, by determining the numbers of particles (n_0, n_1, n_2, …) with energies (ε_0, ε_1, ε_2, ...)
A series of occupation numbers $\{n_0, n_1, n_2, \ldots\} = \{n_i\}$ define state of the system.