

Atoms, Molecules, Solids: Their basic features made simple

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All systems from atoms to asteroids, i.e. from 10^{-10} m to 10^5 m, come to equilibrium under the action of the squeezing pressure of (mainly) electrostatic forces of the form $\sum_j \mp e^2 / r_{ij}^2$ and the expansive pressure of the quantum perpetual motion associated with the Heisenberg/Pauli kinetic energy given by the formula $E_K \propto \hbar^2 N^{5/3} / m_e V^{2/3}$. Thus all physical quantities ought to depend on the universal constants \hbar , e , m_e or, equivalently, \hbar , m_e , $a_B \equiv \hbar^2 / m_e e^2$ and possibly others. This allows extensive use of dimensional analysis coupled with a “little physical thinking” as a tool for estimating the values of physical quantities.

The size and the ionization potential of the atoms is obtained this way; to obtain the angular dependence of the atomic orbitals, which determines the structure of the periodic table of the elements, requires some simple mathematical manipulations. Dimensional analysis and a “little physical thinking” produces reasonable estimates for quantities associated with molecules, solids, and liquids with the exception of electrical conductivity; this last failure proves to be revealing in understanding the true nature of the motion of detached electrons in solids.