

Part III

The Realm of Electromagnetism

The structure of matter from the level of atoms up to the level of an asteroid, which has linear dimension less than a few hundred kilometers, is dominated by only one of the four interactions: The electromagnetic one whose strength is determined by the charge e (of the proton). The quantum kinetic energy, which counterbalances this force depends (according to Eq. 2.6) on the ratio \hbar^2/m . The dominant kinetic energy will be the one with the smaller mass in the denominator, i.e., the mass of the electron, m_e .

The three quantities e , \hbar , m_e define a system of units, called atomic system of units (asu). In this asu, the units of mass, length, and time are the following:

unit of mass: m_e , the rest mass of electron $\approx 9.109 \times 10^{-31}$ kg

unit of length: Bohr radius, $a_B \equiv \hbar^2/m_e e^2 \approx 0.529$ Å

unit of time: $t_0 = \hbar^3/m_e e^4 \approx 2.42 \times 10^{-17}$ s

The units of various other physical quantities in the asu are given in Table 2 (p. 142). In many cases, we shall find it more convenient to use the triad a_B , \hbar , m_e , rather than e , \hbar , m_e .