

M01Q.2—Two Hydrogen Atoms

Problem

Consider two hydrogen atoms with a fixed distance r between their nuclei that is large compared to the size of the atoms. Treat the Coulomb interaction as instantaneous (no retardation), and neglect the interactions between the spins.

- a) The ground state energy of this pair of atoms depends on r as $C_0 + A_0 r^{-\delta_0} + \dots$, where C_0, A_0 are constants. Find δ_0 .
- b) Give an order of magnitude estimate for A_0 and give a general argument why A_0 should be negative.
- c) Now consider the first excited state of the system (keeping the distance r between the nuclei fixed and large). The energy depends on r as $C_1 + A_1 r^{-\delta_1} + \dots$. Find δ_1 .
- d) Estimate at what distance (between the atoms) you will have to take into account the retardation effects in electromagnetsim.