FINE STRUCTURE CONSTANT

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As an application of perturbation theory we'll have a look again at the hydrogen atom. The original analysis assumed that the potential was given entirely by the electrostatic interaction between the proton and electron, but in fact there are several other effects that cause perturbations of this potential. As it turns out, all of these perturbations depend on a dimensionless quantity known as the *fine structure constant*, defined by

$$\alpha \equiv \frac{e^2}{4\pi\epsilon_0\hbar c} = \frac{1}{137.036} \tag{1}$$

We can write the Bohr energy levels in terms of α:

$$E_n = -\frac{m}{2n^2}\left(\frac{e^2}{4\pi\epsilon_0\hbar}\right)^2 = -\frac{1}{2n^2}\alpha^2 mc^2 \tag{2}$$

The fine structure constant has no known theoretical derivation; its value must be measured experimentally. An interesting discussion of some of the lore surrounding it can be found here.

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