Midterm 2 Practice

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I PERTURBATION THEORY: HYDROGEN

A

From I.B,

$$E_0^{(0)} = -\frac{1}{2}mc^2\alpha^2, \tag{I.1}$$

$$E_0^{(1)} = \frac{2}{3a}mc^2\alpha^2\lambda\left(\frac{3a}{2Z}\right), \qquad (Z=1), \tag{I.2}$$

$$E_0^{(0)} + E_0^{(1)} = mc^2\alpha^2\lambda\left(\lambda - \frac{1}{2}\right). \tag{I.3}$$

B

$$\langle\psi|H|\psi\rangle = \frac{1}{2m}\left(m^2c^2\alpha^2Z^2\right) - \hbar c\alpha\left(\frac{mc\alpha Z}{\hbar}\right) + \frac{2}{3a}mc^2\alpha^2\lambda\left(\frac{3a}{2Z}\right), \tag{I.4}$$

$$= mc^2\alpha^2\left(\frac{Z^2}{2} - Z + \frac{1}{Z}\right). \tag{I.5}$$

C

$$\partial_Z\langle\psi|H|\psi\rangle = 0 = mc^2\alpha^2\left(Z - 1 - \frac{\lambda}{Z^2}\right), \tag{I.6}$$

$$0 = Z - 1 - \frac{\lambda}{Z^2}. \tag{I.7}$$

II HYDROGEN STARK INTERACTION

A

B

C

D

E