

Matrix mechanics 3

From “Lectures on Quantum Mechanics, Second Edition” by Weinberg, p. 154.

Let \mathbf{R} be the Runge-Lenz vector

$$\mathbf{R} = -\frac{Ze^2\mathbf{x}}{r} + \frac{1}{2m}(\mathbf{p} \times \mathbf{L} - \mathbf{L} \times \mathbf{p}) \quad (4.8.1)$$

where \mathbf{L} is the orbital angular momentum vector

$$\mathbf{L} = \mathbf{x} \times \mathbf{p}$$

Verify that

$$\mathbf{R}^2 = Z^2e^4 + \frac{2}{m}H(\mathbf{L}^2 + \hbar^2) \quad (4.8.7)$$

where H is the Hamiltonian

$$H = \frac{\mathbf{p}^2}{2m} - \frac{Ze^2}{r}$$

Verify that \mathbf{R} and \mathbf{R}^2 commute with H .

Eigenmath script