Homework 4

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5. (60 points) Using the expressions :

\begin{bmatrix} L_{i}, L_{j} \end{bmatrix} = i \sum_{k} \epsilon_{ijk} L_{k}
\begin{bmatrix} L_{i}, A_{j} \end{bmatrix} = i \sum_{k} \epsilon_{ijk} A_{k}
\begin{bmatrix} A_{i}, A_{j} \end{bmatrix} = -2 \operatorname{im} \tilde{D}^{2} H \sum_{k} \epsilon_{ijk} L_{k}
and

\begin{bmatrix} H, A_{i} \end{bmatrix} = 0
Calculate

\begin{bmatrix} L^{2}, A_{i} \end{bmatrix}, \begin{bmatrix} L^{2}, A^{2} \end{bmatrix} = 0,
\begin{bmatrix} H, A^{2} \end{bmatrix},
\begin{bmatrix} A^{2} A_{i} \end{bmatrix}
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6. (70 points) Using above relations as well as the relation : $\hat{A}^2 = 2 m \hbar^2 \hat{H} (L^2 + 1) + m^2 Z^2 e^4$

calculate the energy spectrum of Hydrogenlike atoms.

7. (20 points) Calculate the Rydberg Constant.