PROBLEMS (II)

1. TAKING INTO ACCOUNT THE FOLLOWING EQUATIONS (POSTULATES):

$$\hat{S}_x\alpha = \frac{1}{2}\hbar\beta \qquad \hat{S}_y\alpha = \frac{i}{2}\hbar\beta \qquad S_z\alpha = \frac{1}{2}\hbar\alpha$$

$$\hat{S}_x\beta = \frac{1}{2}\hbar\alpha \qquad \hat{S}_y\beta = -\frac{i}{2}\hbar\alpha \qquad S_z\beta = -\frac{1}{2}\hbar\beta$$

SHOW THAT AN EXPERIMENTAL FACT

$$|\bar{S}|^2 = s(s+1)\hbar^2 = \frac{1}{2}\left(\frac{1}{2}+1\right)\hbar^2$$

IS REPRODUCED WITHIN THE FORMALISM OF QUANTUM MECHANICS

2. IN THE CASE OF TWO ELECTRON SYSTEM IDENTIFY THE SPIN FUNCTIONS $\chi_1, \chi_2, \chi_3, \chi_4$ (SEE TRANSP. I 18) AS EIGENFUNCTIONS OF $\hat{S}^2$ AND $\hat{S}_z$

3. CONSTRUCT FUNCTIONS THAT ARE OF GOOD SYMMETRY (AND NORMALIZED) IN THE CASE OF THE EXCITED CONFIGURATION OF He ATOM

$$1s^1\,2s^1$$

4. IN THE CASE OF EXCITED CONFIG. $1s^1 2s^1$ OF He ATOM SHOW THAT REQUIRED ANTISYMMETRY OF THE FUNCTIONS LEADS TO AN EXPERIMENTAL FACT THAT TRIPLET IS OF LOWER ENERGY THAN SINGLET (ASSUME THAT THE EXCHANGE TERM IS POSITIVE); WHAT WOULD HAPPEN IF THE FUNCTIONS WOULD BE SYMMETRIC?

HAMILTONIAN FOR He ATOM:

$$H = -\frac{\hbar^2}{2m}\sum_{i=1}^{2}\nabla_i^2 - \sum_{i=1}^{2}\frac{e^2}{r_i} + \frac{e^2}{r_{12}}$$

5. L–S COUPLING. FIND TOTAL S, L, J AND CONSTRUCT THE SPECTROSCOPIC TERMS FOR CONFIGURATION

$$1s^2\,2s^2\,2p^6\,3d^3$$