53

Kodutöö 4

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1 5. Is it possible measure simultaneously square of angular momentum and its z projections of angular momentum (L2 hat and Lz hat)? Why? Proof. 18

Taking the L2 hat operator we can break it down to its components L2x hat L2y hat and L2z hat, witch if added up make L2 hat. These components satisfy the standard commutation relations. so taking not our problems operators L2 hat and Lz hat and commute them we get L2x hat + L2y hat + L2z hat *Lz hat, breaking this down we get commute(L2x hat *Lz hat) + commute(L2y hat *Lz hat) + commute(L2z hat *Lz hat). turning those into the commutation relations and simplyfying a bit we get i*h covered(Lx hat*Ly hat + Ly hat*Lx hat) for commute(L2x hat Lz hat). For commute(L2x ha Lz hat) its -i*h covered(Lx hat*Ly hat + Ly hat*Lx hat) commute(L2z hat Lz hat) is zero. now summing all the parts we can see that it's zero, meaning that the commute itself is zero. Meaning yes it is possible because they are independant of eachother.

2 17. A disk with a radius of 1 mm and a mass of 1 mg rotates around an axis perpendicular to its plane with a frequency of 1 Hz. Calculate the minimal possible value for angle between vector L and z-axis. 10

We have a radius r=1 mm = 0,001 m, a mass of m = 1mg = 0,001 kg and a frequency f = 1Hz =¿ omega = 2*pi rad/s around our z axis. L = I*omega = (1/2)*M*r*r * 2*pi = M*r*r*pi = pi*10 to the power of -12. quantuim number ? l = L/h covered = 2.98*10 to the power of 22. alfa min = sqrt(1/l) = 5,78* 10 to the power of -12 rad .

3 20.Obtain the equation for radial part of wave function:

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Due to time constraints and the formula being very long, I could not finish this in time. I will be sending a version with hopefully a correct answer in this space but for now forme to submit this on time I will leave it.

4 31. Calculate the possible maximum number of electrons in 4p and 2d orbitals for hydrogen atom.

20

So we have 2 orbitals 4p and 2d with principal quantum numbers n1=4 and n2=2. The asymuthal quantum numbers are l1=3 and l2=1. Taking first the first orbital and its levels for the azymuthal numbers are: sl=0 , pl=1, dl=2, we care about the p orbital so our l is pl=1. thus out megnetic quantum number is m= [-l,l]= -1 , 0, 1. Because each orbital can have 2 electrons, so the maximum number of electrons we can have for 4p is 3*x = 6. Moving on to 2d. Since l2=1 means that we only have levels: sl=0 and p=1, but no d level, meaning we don't have a 2d orbital.

5 42. Can you prove the following expression (page 127): "In the first order approximation of lambda coefficient a1n must satisfy a1n +(a1n)*=0 ".

5

So the statement refers to a coefficient a1n that in our case is undetermined and needs to be determined. The determination of it comes for the normalization of the first order wave function(integral((psi0n+lambda*sum-m(a1mpsi0m))*(psi0n+lambda*sum-m(a1mpsi0m)))). The part is imaginary and a1n=0 is taken for simplicity.