

Molecular Spectroscopy Homework Assignment #2

1. Calculate the wavenumber of the 3rd Balmer line for Li III and name the spectral region in which it appears. Use the Rydberg constant $R_8 = 109737.31568549 \text{ cm}^{-1}$, but find in a handbook what the mass of the electron and the nucleus are.
2. Calculate the average (expectation) value of $\cos\theta$ for a system with an eigen function of the spherical harmonic $Y_{10}(\theta,\varphi)$, which is the integral $\langle Y_{10}|\cos\theta|Y_{10}\rangle$.
3. The Na $n^2P^o - 3^2S$ transitions are observed at the following positions (C. Moore tables):

n	J	$\tilde{\nu}$ (cm ⁻¹)
5	0.5	35040.27
5	1.5	35042.79
6	0.5	37296.51
6	1.5	37297.76
7	0.5	38540.40
7	1.5	38541.14
8	0.5	39298.54
8	1.5	39299.01
9	0.5	39794.53
9	1.5	39795.00
10	0.5	40137.23
10	1.5	40137.23

Using these data and by means of a computer determine the ionization energy of Na and the quantum defect for P states of the sodium atom. At what wavelength do you expect the so-called D line (i.e., the strongest line of Na)?

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