CHM 598, Photochemistry, Spring 2005

Homework 3

On the website are two absorption spectra of ethidium bromide in the form of electronic text files. To do this weeks homework you will need to download these files and get them into some sort of graphing program, e.g. Excel, Sigmaplot, Graphical Analysis, or my favorite, Cricket Graph!

The files are "dna.txt" and "buffer.txt", corresponding to ethidium bromide intercalated into DNA, and simply dissolved in aqueous buffer. Each file consists of absorbance versus wavelength, which is which should be obvious!

The concentrations of the ethidium are 1.18×10^{-4} M in the buffer solution, and 2.42×10^{-4} M in the DNAsolution.

You must hand in the following:

1. A plot of extinction coefficient versus wavelength for both solutions (on the same plot)

2. A plot of absorption cross section versus wavelength for both solutions (on the same plot)

3. Give the oscillator strength for both absorption bands

4. Give the transition dipole moment for both bands

5. Give the effective distance that a single electron would have to move (in Å) to generate such a dipole moment.

6. Estimate the radiative rate constant for ethidium in buffer and in dna from these absorption spectra.

Some hints!

1. if you don't have access to a suitable computer program, come and see me before you start!

2. The absorption spectrum shows more than one absorption band. It isn't obvious where one bands ends and the other starts! Next week we will talk about absorption band shapes, until then, just guess where to stop integrating the lowest energy band (there is obviously going to be more than 1 set of correct answers to this homework, all part of the fun!).

3. The only tricky part is figuring out how to do the integral properly. Some programs will have built-in functions, with others you may have to "cut and weigh", which is historically authentic (I used to do it) and is quite accurate!

4. Use the following equations:

$$\varepsilon = A / c \,.\, l$$
$$\sigma = 3.824 \times 10^{-5}\, \varepsilon$$
$$f = 4.32 \times 10^{-9} \,.\, A$$
$$A = \int \varepsilon(\tilde{\nu})\; d\tilde{\nu}$$
$$f = 4.70 \times 10^{-7}\, \tilde{\nu}_{abs}{}^{max} \,.\, \mu_i^2$$
$$r = \mu_i / 4.8$$
$$k_f = 2.881 \times 10^{-9}\;\; (\tilde{\nu}_{abs}{}^{max})^2\;\; n^2\;\; A$$

We will see more accurate equations relating absorption and emission next week!