CHAPTER OVERVIEW

2: Spectroscopy- how we know what we know about the structure of matter

Spectroscopy is the study of how energy (particularly electromagnetic radiation) and matter interact. By analyzing these interactions, we can infer a great deal of evidence about the structure of matter. In organic chemistry, spectroscopy allows us to determine the structure of products and reactants (and in some cases we can also get information about intermediates of reactions). By using spectroscopy of different kinds, we can gather evidence about reaction rates and from this information we can infer mechanisms of reactions. In this chapter, we will briefly review the background that you (probably) learned in general chemistry, and then we will move on to the various type of spectroscopy and discuss what each type can and cannot tell us about the structure of organic compounds.

From your earlier studies, you will recall that at the atomic/molecular level, the energies of atoms and molecules are quantized: that is, there are discrete, separate energy states with nothing in between. This applies not only to the energies of electrons, but also to the energies of vibration of bonds and rotation around bonds. Nuclear energies are also quantized. It is possible to switch from one energy state to another by absorbing or emitting an amount of electromagnetic energy (a photon) that corresponds to the energy difference between the two states. Photons with the energy that does not correspond to differences between two energy states are not absorbed or emitted, which means that we can use the energies of the photons absorbed or emitted to tell us about the energy differences between quantum states in atoms and molecules. The differences between these quantized energy levels is highly dependent on the identity and environment of the atoms and molecules, and therefore we can the photons emitted to identify particular species. For example, in isolated atoms the energy differences between levels often correspond to electromagnetic energy in the ultraviolet or visible. This results in the atomic absorption or emission spectra that allow us to determine what elements are present in (for example) stars, and interstellar space.
