1.1: What is spin?

The fundamentals of NMR begin with the understanding that a nucleus belonging to an element with an odd atomic or mass number has a nuclear spin that can be observed. Examples of nuclei with spin include ^{1}H, ^{3}H, ^{13}C, ^{15}N, ^{19}F, ^{31}P and ^{29}Si. All of these nuclei have a spin of ½. Other nuclei like ^{2}H or ^{14}N have a spin of 1. Nuclei with even atomic and mass numbers like ^{12}C and ^{16}O have spin of 0 and cannot be studied by NMR. The following introductory discussion of NMR is limited to spin ½ nuclei.

Nuclei that possess spin have angular momentum, ρ. The maximum number of values of angular momentum a nucleus can have is described by the magnetic quantum number, I. The possible spin states can vary from +I to –I in integer values. Therefore, there are 2I +1 possible values of ρ.

Exercise 1.1.1

How many spin states would you predict for ^{2}H?

For spin ½ nuclei, the angular momentum can have two possible values: +½ or –½. Since spin is a quantum mechanical property, it can be difficult to visualize. One way to imagine spin is by thinking of spin ½ nuclei as tiny bar magnets that can have two possible orientations with respect to a larger external magnetic field. It is important to note that in the absence of an external magnetic field, these discrete spin states have random orientations and identical energies.