

1.1: What is spin?

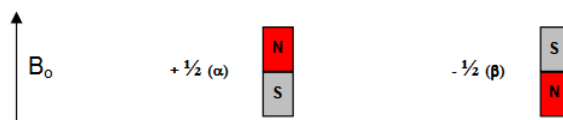
The fundamentals of NMR begin with the understanding that a nucleus belonging to an element with an odd atomic or mass number has a nuclear spin that can be observed. Examples of nuclei with spin include ^1H , ^3H , ^{13}C , ^{15}N , ^{19}F , ^{31}P and ^{29}Si . All of these nuclei have a spin of $\frac{1}{2}$. Other nuclei like ^2H 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 $\frac{1}{2}$ 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 ^2H ?

For spin $\frac{1}{2}$ nuclei, the angular momentum can have two possible values: $+\frac{1}{2}$ or $-\frac{1}{2}$. Since spin is a quantum mechanical property, it can be difficult to visualize. One way to imagine spin is by thinking of spin $\frac{1}{2}$ 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.



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