25. Spin 1/2

Please begin reading Section 4.4 of Griffiths, through the end of Subsection 4.4.1 ("Spin 1/2"). I don't have much to add to what Griffiths says, but I would like to comment on his notation.

This may be the first place in the book where Griffiths actually *uses* Dirac notation. (He *introduces* it in Section 3.6, but then puts it aside until here.) There are two aspects of Dirac notation that you'll need to get used to here, one superficial and the other more important:

1. The symbol for the state of a system is delimited by a vertical line and an angle bracket: $|\cdots\rangle$. This symbol combination is called a *ket*.

2. In between the vertical line and the angle bracket, to indicate which state we're talking about, we often simply list the state's "quantum numbers," e.g., $|1\,0\,0\rangle$ to denote the ground state of hydrogen ($n = 1$, $l = 0$, $m = 0$).

Of course, this notation is horribly ambiguous if you don't already know *which* quantum numbers are being listed, and in which order. In the early parts of Section 4.4, the quantum numbers listed in each ket are always s and m, where s characterizes the eigenvalue of the total spin angular momentum ($\hbar\sqrt{s(s+1)}$, in analogy to $\hbar\sqrt{l(l+1)}$ for orbital angular momentum), and m (sometimes called m_s) characterizes the eigenvalue of the z component of the spin angular momentum ($\hbar m$, just as for orbital angular momentum).

Besides the potential ambiguity over which quantum numbers are being listed, this notation also has the drawback that it can't easily handle the vast majority of states for which we haven't defined any quantum numbers. Typically we express such states as superpositions, for example, $(|\frac{1}{2}\ \frac{1}{2}\rangle + |\frac{1}{2}\ -\frac{1}{2}\rangle)/\sqrt{2}$ for the state with $S_x = +\hbar/2$.

After a couple of pages of kets, however, Griffiths introduces the more familiar notation of column vectors (spinors) and matrices. He uses the Greek letter χ ("chi") for a spinor, and uses a boldface sans-serif S to represent the matrix form of a spin operator.