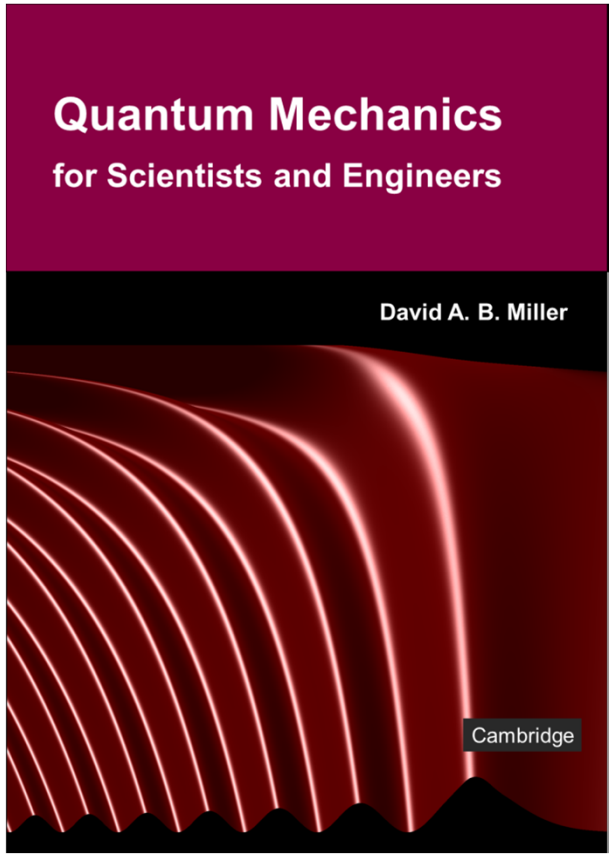
7.2 The L squared operator

Slides: Video 7.2.5 Notations for spherical harmonics

Text reference: Quantum Mechanics for Scientists and Engineers

Section 9.4



The L squared operator

Notations for spherical harmonics

Quantum mechanics for scientists and engineers

David Miller

Dirac notation

We often use Dirac notation

in writing equations associated with angular momentum

It is common to write

$$\hat{L}^2 \left| l,m \right\rangle = \hbar^2 l\left(l+1\right) \left| l,m \right\rangle$$

instead of

$$\hat{L}^2 Y_{lm}\left(\theta,\phi\right) = \hbar^2 l\left(l+1\right) Y_{lm}\left(\theta,\phi\right)$$

and

$$\hat{L}_z \left| l,m \right\rangle = m\hbar \left| l,m \right\rangle$$

instead of

$$\hat{L}_z Y_{lm}\left(\theta,\phi\right) = m\hbar Y_{lm}\left(\theta,\phi\right)$$

“s, p, d, f” notation

The spherical harmonics arise in the solution of the hydrogen atom problem

Different values of l give rise to

different sets of spectral lines from hydrogen

identified empirically in the 19th century

Spectroscopists identified groups of lines called

- “sharp” (s)
- “principal” (p)
- “diffuse” (d), and
- “fundamental” (f)

“s, p, d, f” notation

Each of these is now identified with the specific values of l

Now we also alphabetically extend to higher l values

l	0	1	2	3	4	5
notation	s	p	d	f	g	h

It is convenient that

the “s” wavefunctions are all spherically symmetric

even though the “s” of the notation originally

had nothing to do with spherical symmetry