In class problem

Paschen-Back effect

large $B$

$$\Delta E = \frac{e^2 B}{2m} (m_l + 2m_s) B^2$$

$m_s = 0$
$m_l = 0, \pm 1$
$l = \pm 1$

$\frac{\Delta E}{eB^2} = \pm 1$

$i s i l$$

l = 0, m_l = 0, m_s = \pm \frac{1}{2}$, \( \Delta E = \frac{e^2 B^2}{2m} \)

$2p \quad l = 1, m_l = -1, 0, 1$

\[
\begin{array}{c|ccc}
   m_l & 0 & 1 & 2 \\
   m_s & \frac{1}{2}, -\frac{1}{2} \\
   \end{array}
\]

\[\Delta E = \frac{e^2 B^2}{2m}\]

only 3 unique transitions

\[
\begin{array}{c}
\text{transitions}
\end{array}
\]

\[
\begin{array}{c}
\text{prism}
\end{array}
\]

\[
\begin{array}{c}
\text{screen}
\end{array}
\]
Lamb Shift.

Relativistic quantum theory - 'Dirac theory' predicts a spin-orbit coupling

$$\Delta E = \Delta E_{n,j} \quad \text{only dependent on } n \text{ and } j$$

This means 2s$\frac{1}{2}$ and 2p$\frac{1}{2}$ should have identical energy levels.

But they don't!

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See 'QED' by Richard Feynman