In class problem

Paschen - Back effect

large $\vec{B}$

$$\Delta E = \frac{e\hbar}{2m}\left(m_\ell + 2m_s\right) B_z$$

$\Delta m_s = 0$

$\Delta m_\ell = 0, \pm 1$

$\Delta \ell = \pm 1$

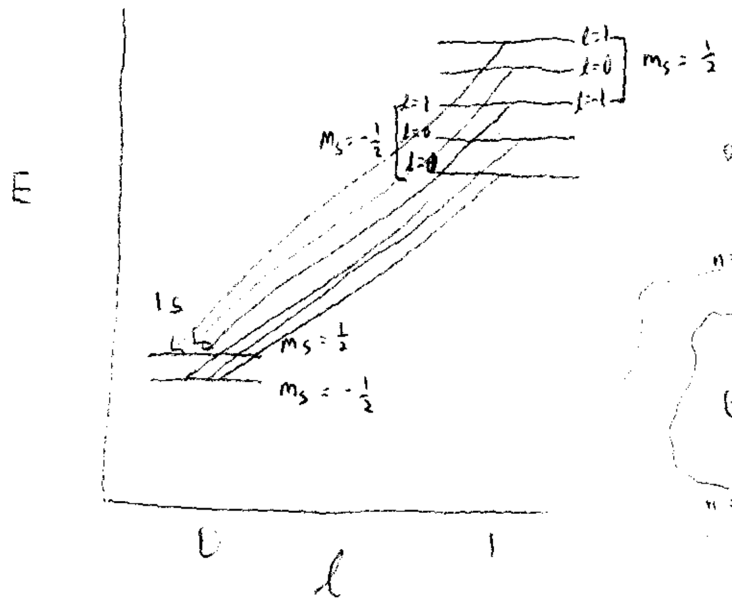
$1s_{1/2}$ $\ell = 0$, $m_\ell = 0$, $m_s = \pm\frac{1}{2}$, $\Delta E = \pm \frac{e\hbar B}{2m}$, $\frac{\Delta E}{\left(\frac{e\hbar B}{2m}\right)} = \pm 1$

2p $\ell = 1$, $m_\ell = -1, 0, 1$

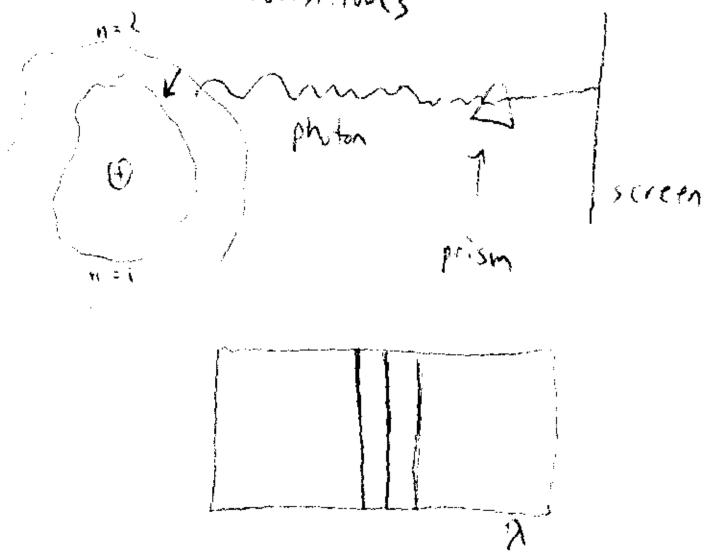
$m_s = +\frac{1}{2}, -\frac{1}{2}$

m_s \ m_ℓ	-1	0	1
$\frac{1}{2}$	0	1	2
$-\frac{1}{2}$	-2	-1	0

← $\frac{\Delta E}{\left(\frac{e\hbar B_z}{2m}\right)}$



only 3 unique transitions



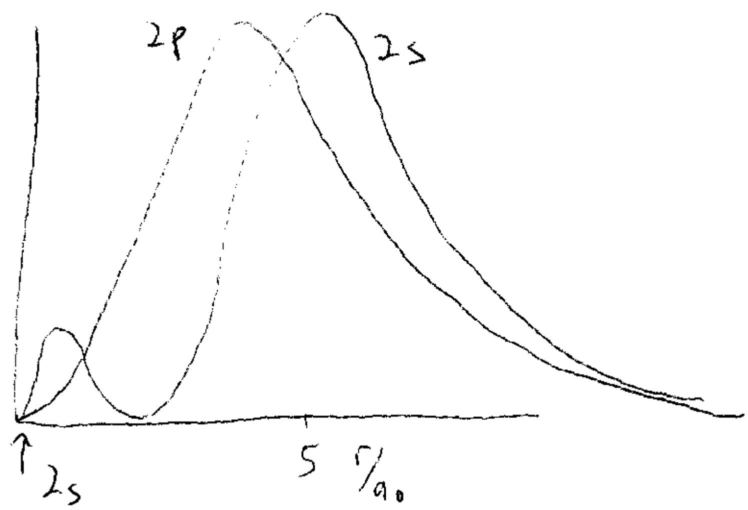
Lamb Shift.

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

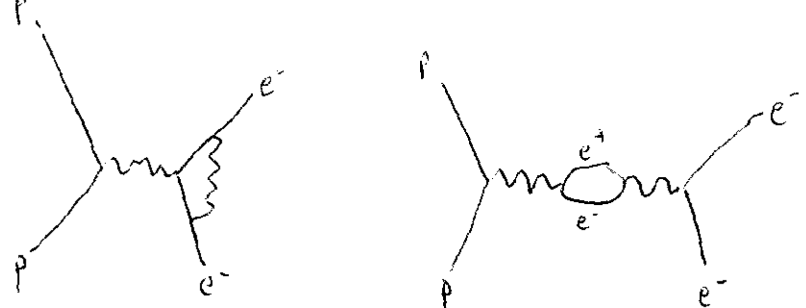
$\Delta E = \Delta E_{n,j}$ - only dependent on n and j quantum numbers

This means $2s_{1/2}$ and $2p_{1/2}$ should have identical energy levels.

But they don't!



↑ 2s can be closer to proton



↑ can 'screen' proton field giving $2s_{1/2}$ higher energy

See 'QED' by Richard Feynman