4/2/01

Lecture 30 Stein Gerlach Exp.

In a nonuniform magnetic field there is a force on a magnetic dipole

$$\vec{F} = \vec{\nabla}(\vec{\mu}\cdot\vec{B})$$

Let $\vec{B}(x,y,z) = -\alpha x\,\hat{x} + (B_0 + \alpha z)\,\hat{z}$

Increasing field in z direction

Note $\nabla\cdot B = 0$ for static field can't have nonuniform B field only in z direction

$$F = \gamma\alpha(-S_x\hat{x} + S_z\hat{z})$$

for $\vec{\mu} = \gamma\vec{S}$

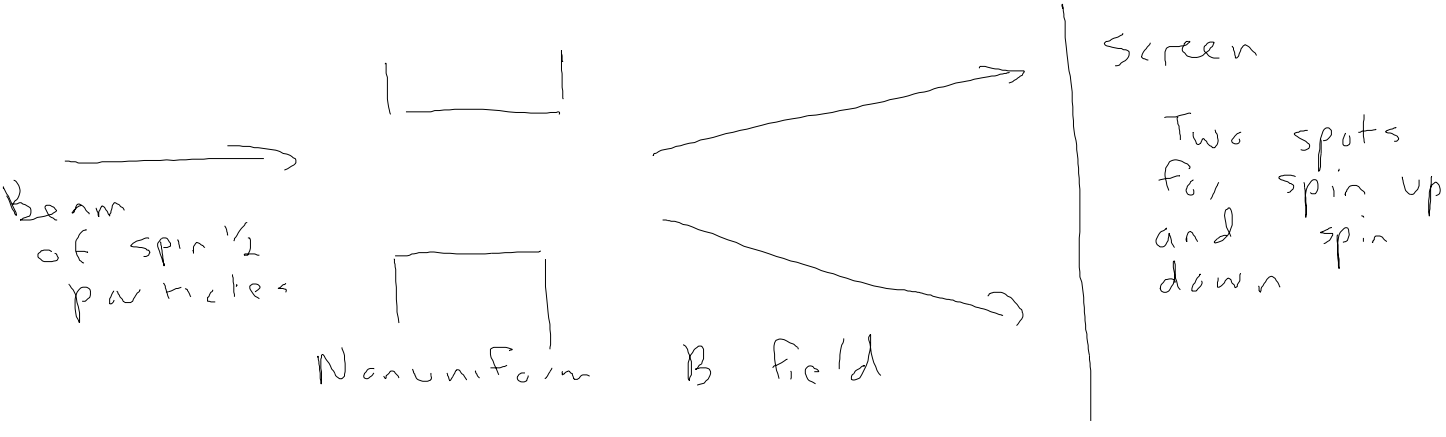
If B_0 is large $\langle S_x\rangle = \frac{\hbar}{2}\sin\alpha\cos\gamma B_0 t$ will osc. very rapidly and 2 time ave.

$$\langle \cos\gamma B_0 t\rangle \approx 0$$

So for cos on force in z direction

$$\boxed{F_z = \gamma\alpha S_z}$$

Beam of particles is deflected according to eigen value of S_z



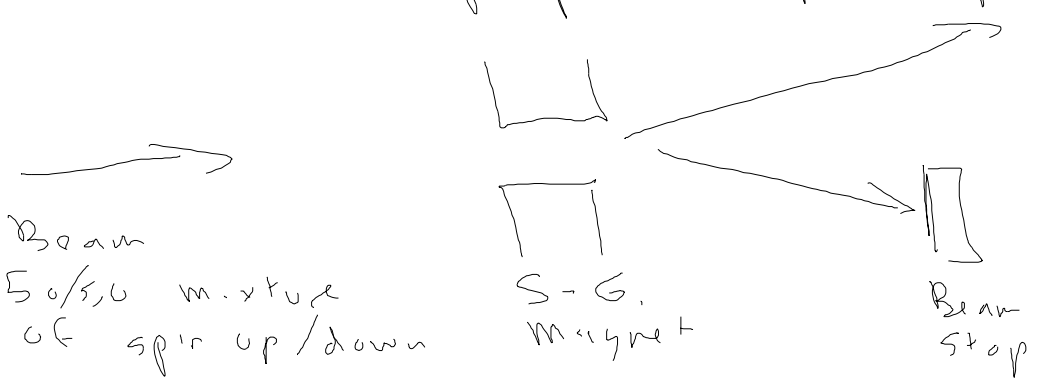
Classicly expect continuous distribution on screen since S_z can take on any value.

Quantum mech. S_z is either $+\frac{\hbar}{2}$ or $-\frac{\hbar}{2}$ only.

Determine spin by counting spots
spin s has $2s+1$ m_s values $\rightarrow$
$2s+1$ spots.

Stern Gerlach magnet is magnet with nonuniform field that can be used to seperate out spin projections

How to prepar spin up beam?



Note S-G magnet has a strong nonuniform field in only one direction. Thus can prepar only one component of spin.

IF you want spin up particles in x direction rotate magnet. so strong field is in x direction.

Lamor precession in the two directions other changes the other components of the spin as required by H.U.P.