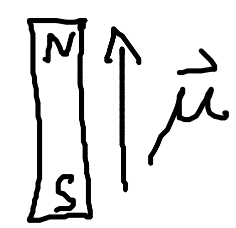
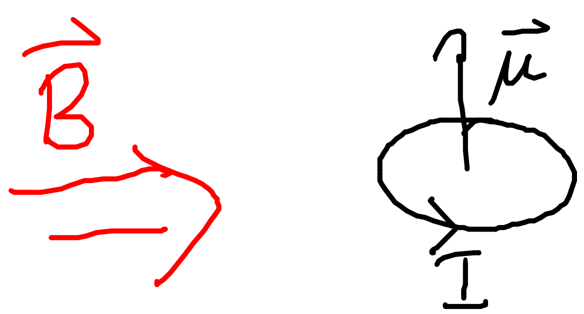
Stern-Gerlach experiment

Magnetic dipole moment $\vec{\mu}$

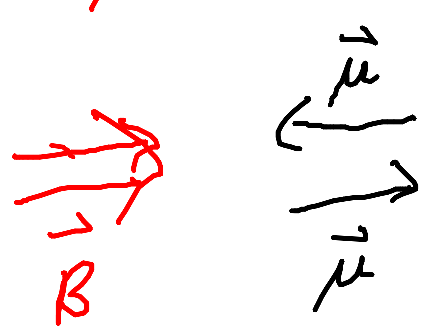




$|\vec{\mu}| = I A$

for a loop of current

$\vec{\mu}$ will align with the field



$U = +\mu B$

higher energy

lower energy

$U = -\mu B$

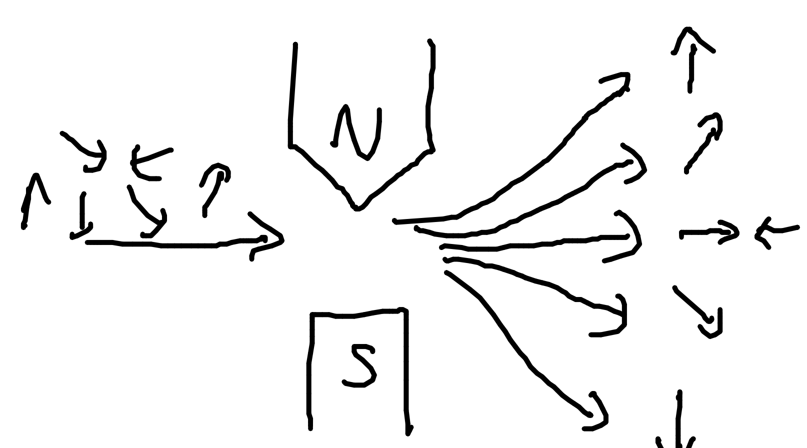
$$U = -\vec{\mu} \cdot \vec{B}$$

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

if $\vec{\mu}$ constant

$$\vec{F} = \mu_x \frac{\partial B_x}{\partial x}\hat{x} + \mu_y \frac{\partial B_y}{\partial y}\hat{y} + \mu_z \frac{\partial B_z}{\partial z}\hat{z}$$

Stern-Gerlach apparatus



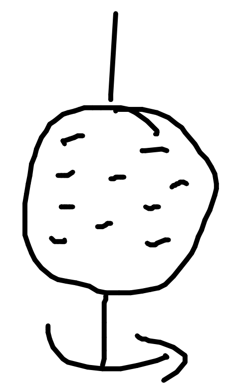
↑ increasing μ_z

↓ decreasing μ_z

Subatomic particles have an inherent $\vec{\mu}$

called "spin"

as if electrons ~~etc~~ were spinning charged globes



electron

Problem: electrons have no size

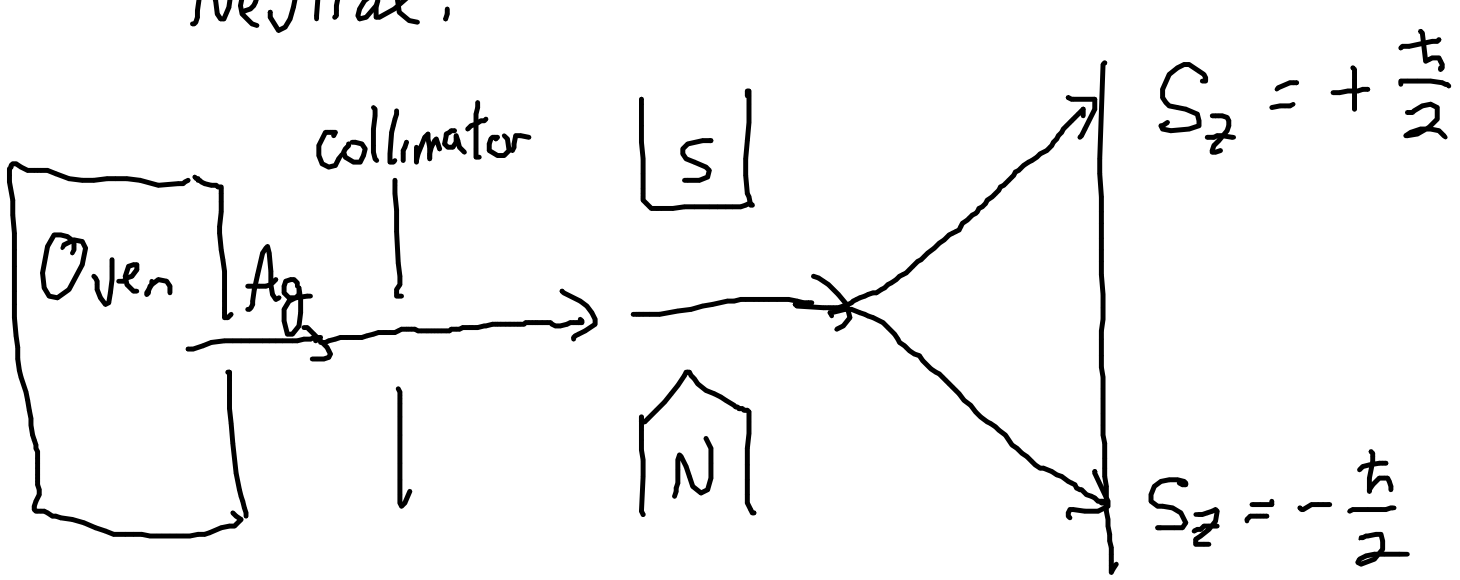
particles have spin angular momentum $\vec{S}$

$$\vec{\mu} = g \frac{q}{2m} \vec{S}$$

g: gyroscopic ratio

Stern-Gerlach uses silver atoms which have $\vec{\mu}$ due to their outermost valence electron.

Neutral.



Quantization!