Static Magnetic Fields

And the motion of charges within them.

Old Observations

- A light-weight magnet suspended from a string will always orient "North" (compass needle)
- Some kind of materials, iron in particular, can effect the magnet.
 - Around 1820 Orsted discovered that an electric current also had the property of effecting the directio of a compass needle.

Orsted's Discovery



Magnetic Fields

- Over the next 12 years a concept of a "Magnetic Field" developed and this field is sustained by electric currents through wires.
 - How does this field effect single charges?



Charge at rest. Just sits there. Since $\mathbf{F} = \mathbf{ma}$ there can be no force.

Charge Motion in Mag. Fields



Charge Motion in Mag. Fields

When the charge is given a velocity along the wire the trajectory curves.

Clearly there is a force. The magnetic field is the cause



B-field Summary

$$\vec{B} = \frac{\mu_0}{4\pi} \int \vec{J}(\vec{r}') \times \frac{(\vec{r} - \vec{r}')}{|\vec{r} - \vec{r}'|^3} dV'$$

Impies:

 $\nabla \times \vec{B} = \mu_0 \vec{J}$

Magnetostatics $\nabla \bullet \vec{B} = 0$