Sources of Magnetic Field

Moving charges produce magnetic fields.

$$\vec{B} = \frac{\mu_0}{4\pi}\frac{q\vec{v}\times\hat{r}}{r^2}$$

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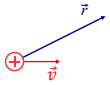

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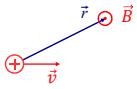

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Example: A proton is moving along the x-axis with a velocity $\vec{v}_1 = +v_0\hat{\imath}$.
a) Determine the magnetic field at $(0, a, 0)$ at the moment the proton passes through the origin.
b) Determine the force on a second proton moving through the point $(0, a, 0)$ with a velocity $\vec{v}_2 = -v_0\hat{\imath}$ at the moment the first proton passes through the origin.

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It is an interesting exercise to (1) compare $\vec{F}_{12}$ and $\vec{F}_{21}$ and find that Newton's Third Law applies and (2) repeat for $\vec{v}_2 = -v_0\hat{\jmath}$, comparing $\vec{F}_{12}$ and $\vec{F}_{21}$. It will *appear* to be a contradiction of Newton's Third Law.