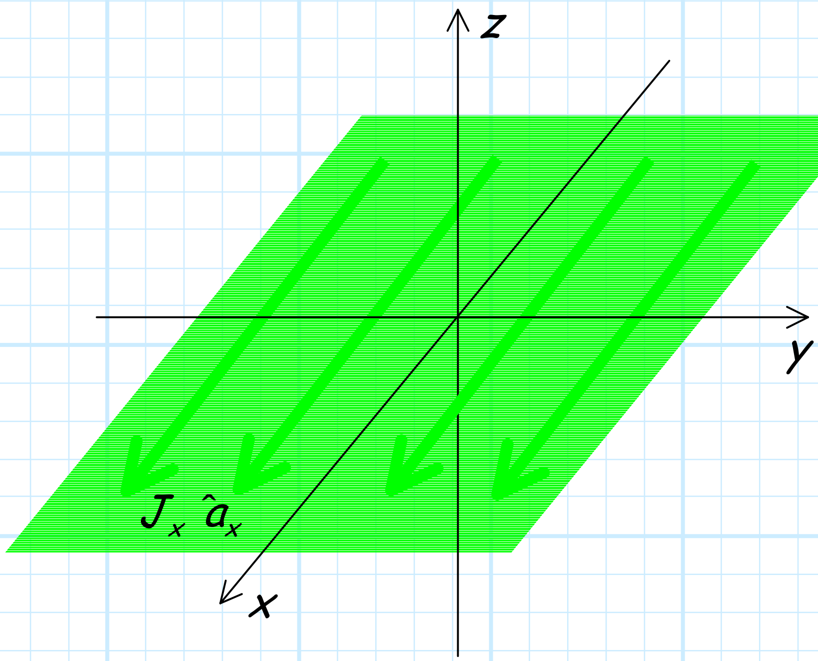
B-Field from an Infinite Sheet of Current

Consider now an **infinite sheet** of current, lying on the $z = 0$ plane. Say the surface current density on this sheet has a value:

$$\mathbf{J}_s(\bar{\mathbf{r}}) = J_x\, \hat{a}_x$$

meaning that the current density at every point on the surface has the same magnitude, and flows in the $\hat{a}_x$ direction.



Using the Biot-Savart Law, we find that the magnetic flux density produced by this **infinite** current sheet is:

$$\mathbf{B}(\bar{\mathbf{r}}) = \begin{cases} -\dfrac{\mu_0 J_x}{2}\,\hat{a}_y & z > 0 \\[2ex] \dfrac{\mu_0 J_x}{2}\,\hat{a}_y & z < 0 \end{cases}$$

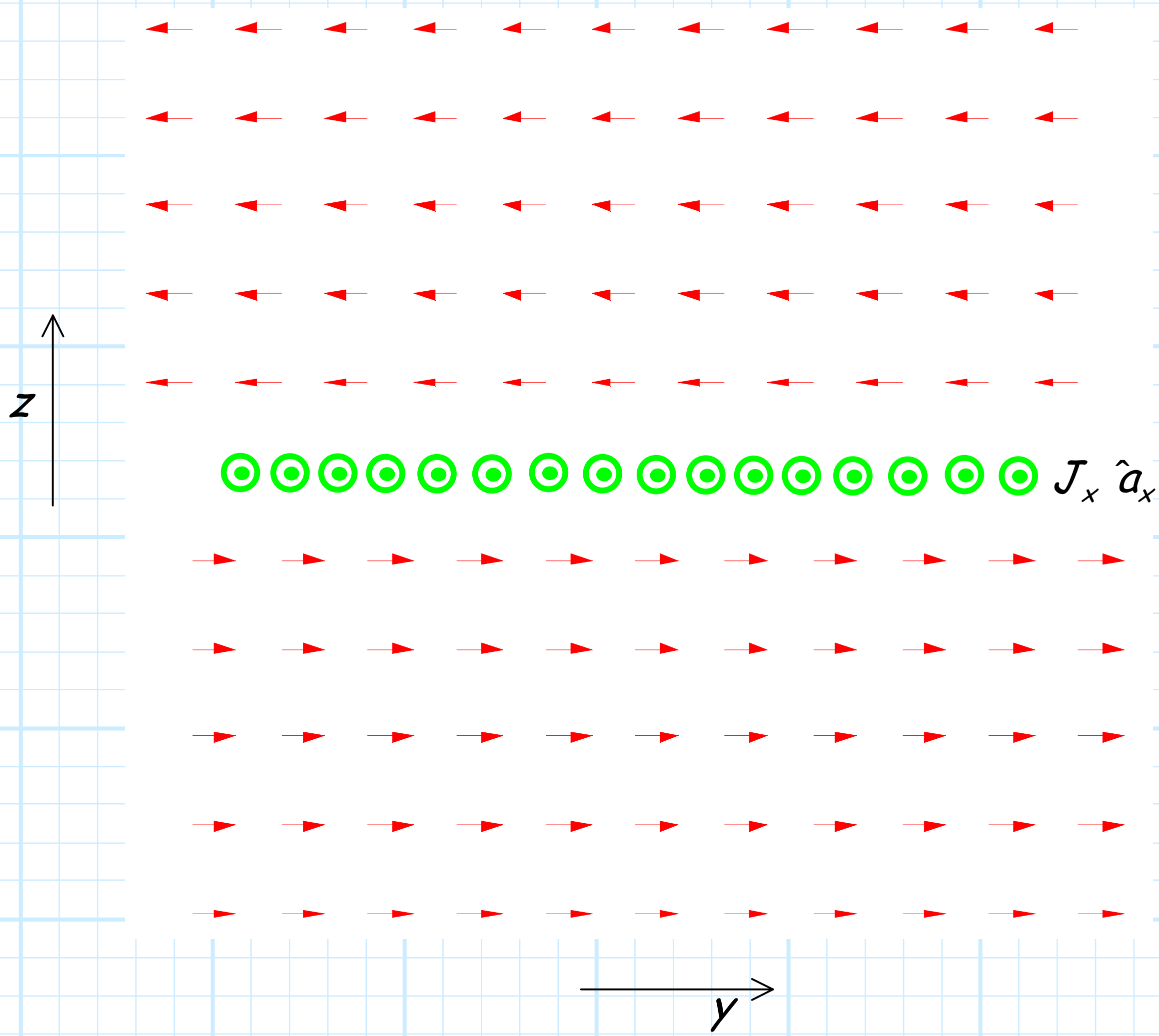
Think about what this expression is telling us.

* The magnitude of this magnetic flux density is a **constant**. In other words, $\mathbf{B}(\bar{\mathbf{r}})$ is **just** as large a million miles from the infinite current sheet as it is 1 millimeter from the current sheet!

* The **direction** of the magnetic flux density in the $-\hat{a}_y$ direction **above** the current sheet, but points in the **opposite** direction (i.e., $\hat{a}_y$) **below** it.

* The direction of the magnetic flux density is **orthogonal** to the direction of current flow $\hat{a}_x$.

Plotting the vector field $\mathbf{B}(\bar{\mathbf{r}})$ along the *y-z* plane, we find:


z
$J_x \hat{a}_x$
y