# The Wave Function

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# The Wave Function

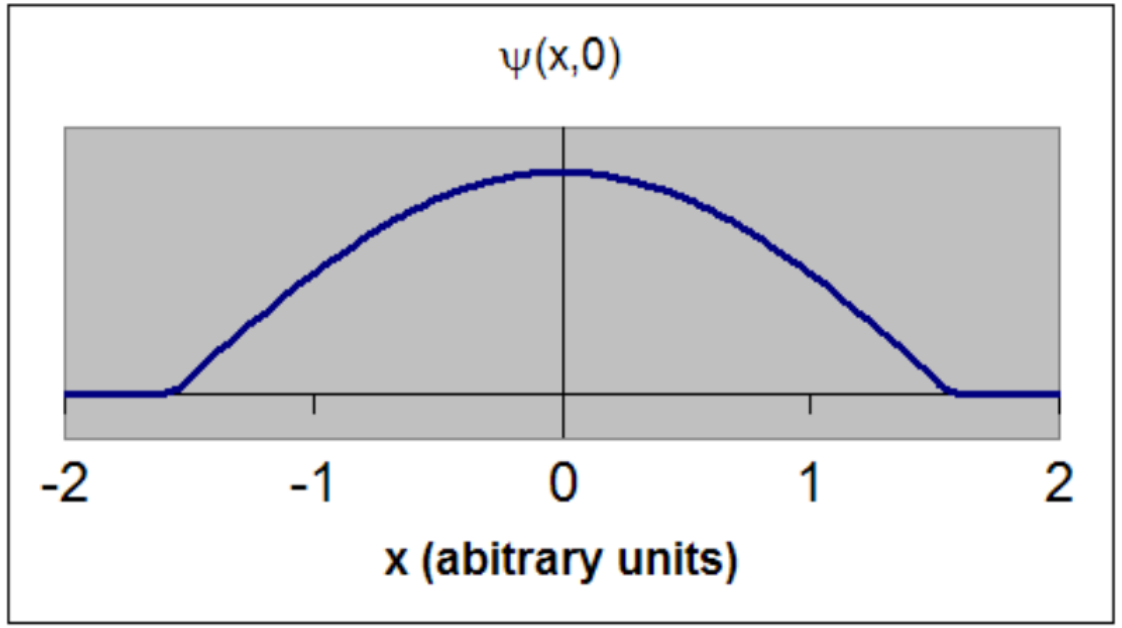
1. In order to avoid infinite probabilities, $\Psi$ must be finite everywhere.
2. In order to avoid multiple values of the probability, $\Psi$ must be single valued.
3. For finite potentials, $\Psi$ and $\partial\Psi/\partial x$ must be continuous. This is required because the second-order derivative term in the wave equation must be single valued. (There are exceptions to this rule when $V$ is infinite.)
4. In order to normalize the wave functions, $\Psi$ must approach zero as $x$ approaches $\pm\infty$.

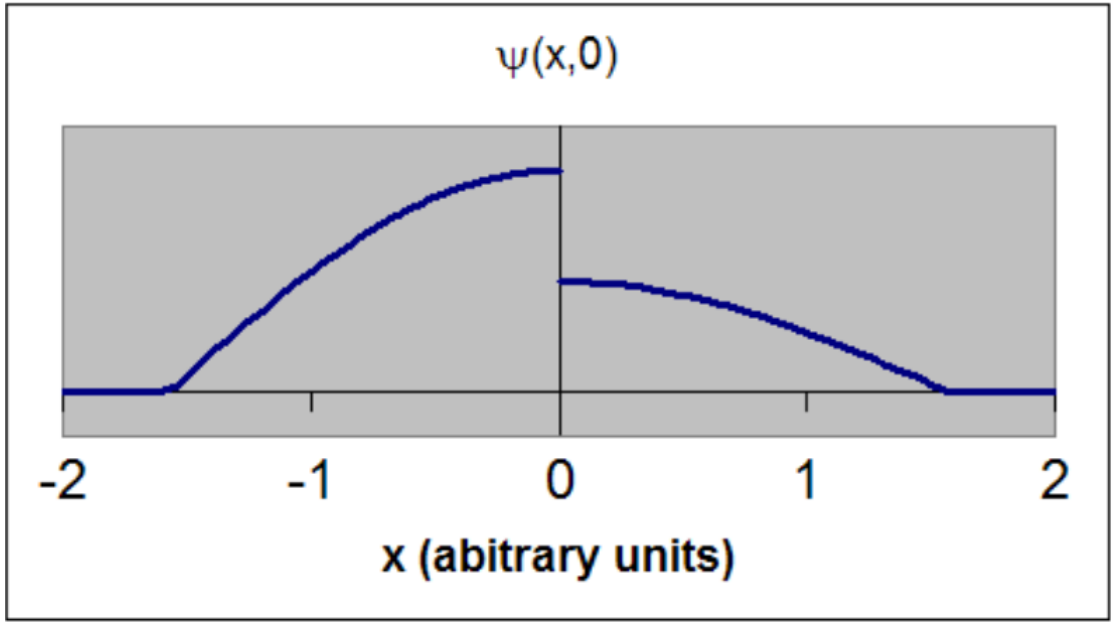
# The Wave Function

Single-valued wave function: $\Psi(x) = x^2$

Multi-valued wave function: $\Psi(x) = \pm\sqrt{x}$

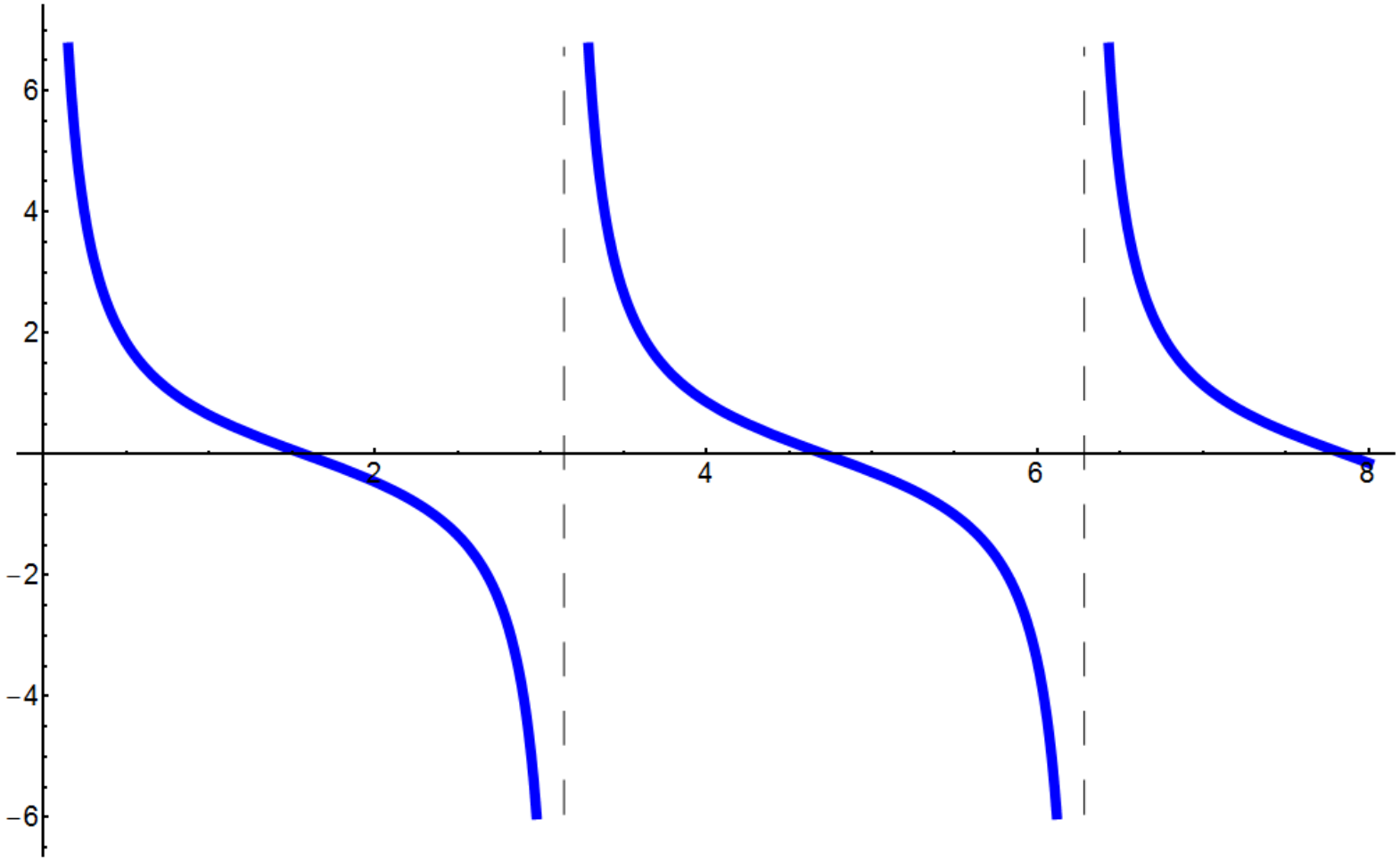
# The Wave Function



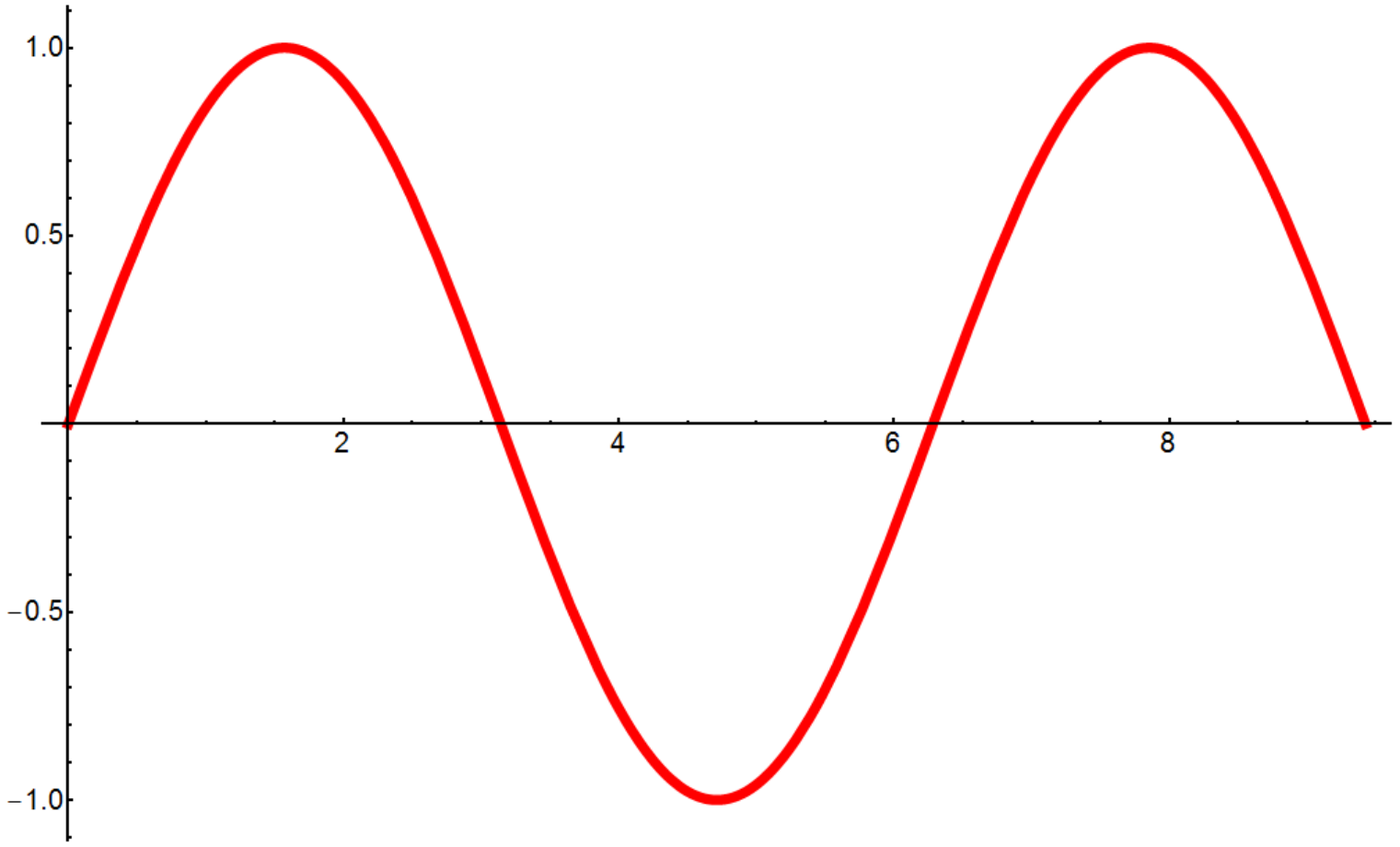
# The Wave Function

$$\Psi(x) = A \cot x$$



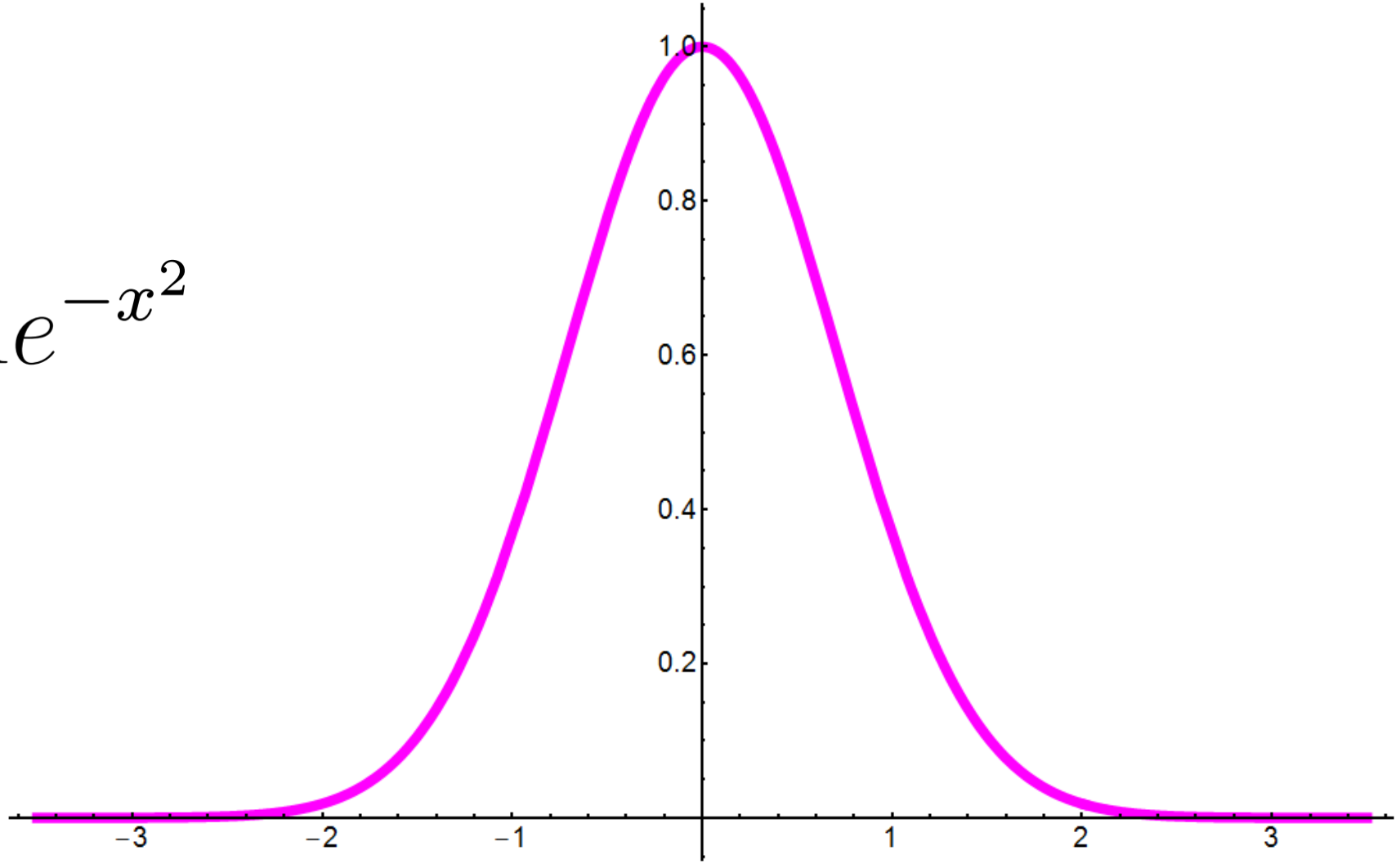
# The Wave Function

$$\Psi(x) = A \sin x$$



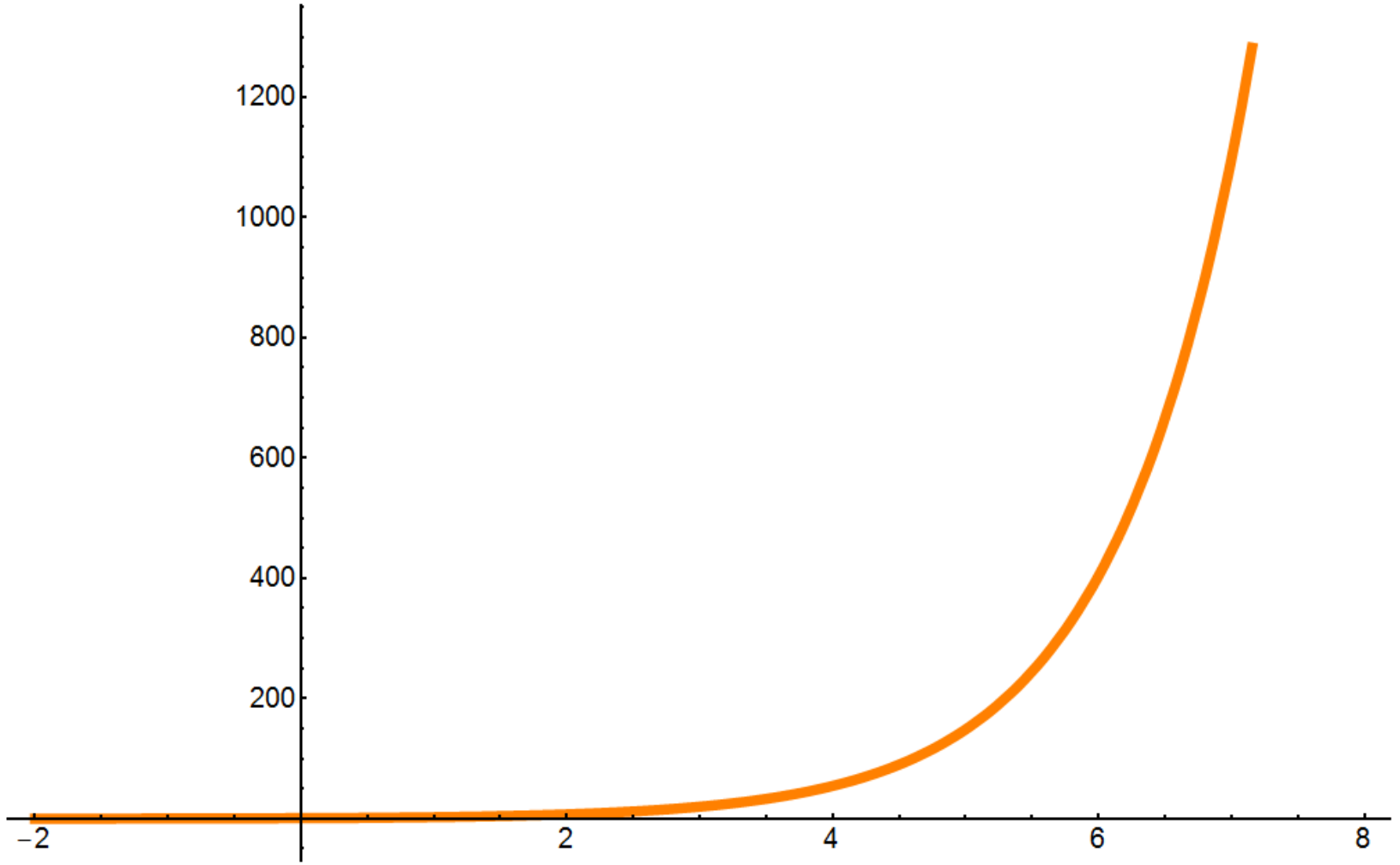
# The Wave Function

$$\Psi(x) = Ae^{-x^2}$$



# The Wave Function

$$\Psi(x) = Ae^x$$

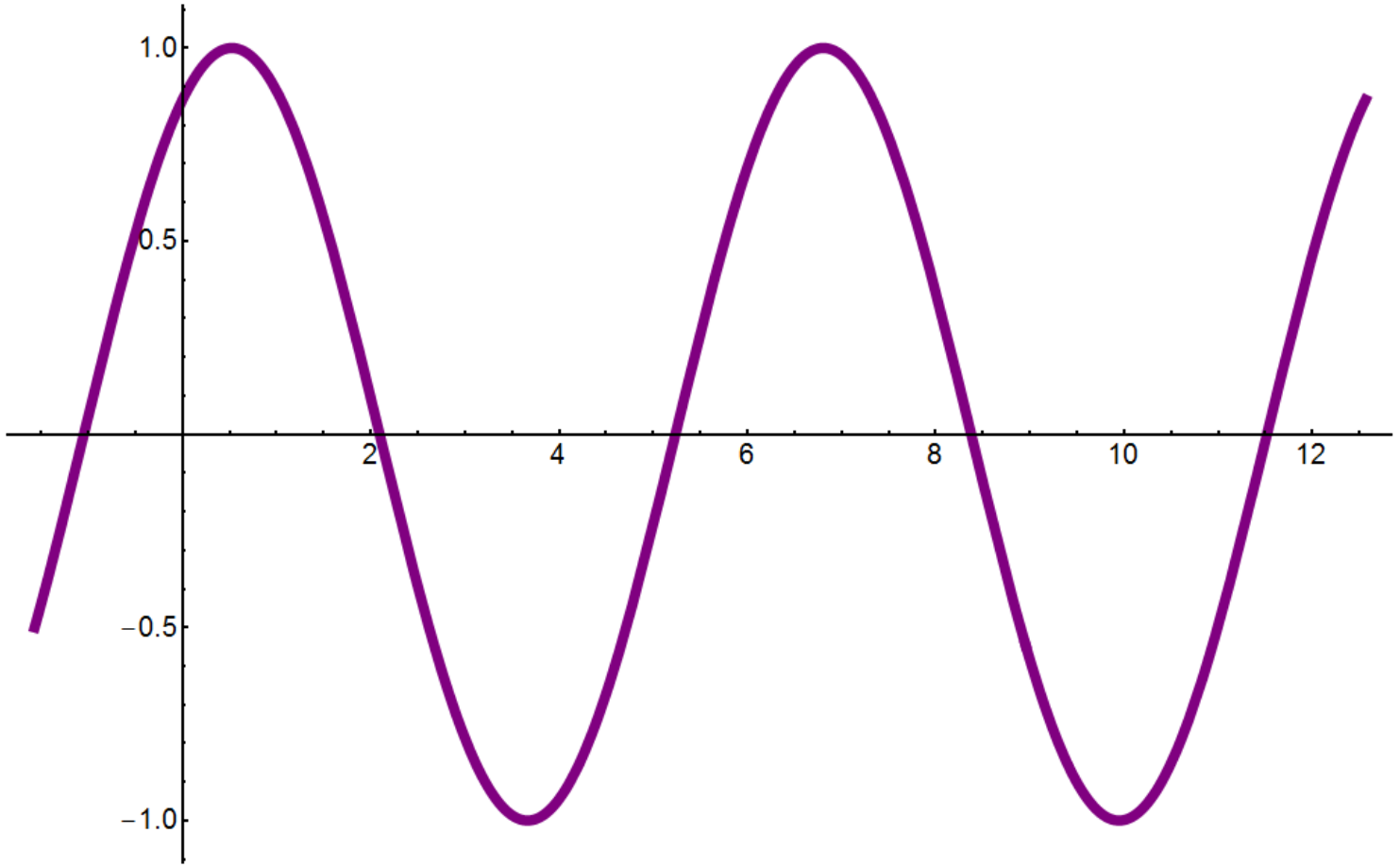


# The Wave Function

$$
\begin{aligned}
\Psi(x) &= A(\sqrt{3}\cos x + \sin x) \\
&= 2A\left(\frac{\sqrt{3}}{2}\cos x + \frac{1}{2}\sin x\right) \\
&= 2A\left(\cos(\pi/6)\cos x + \sin(\pi/6)\sin x\right) \\
&= A'\cos(x - \pi/6)
\end{aligned}
$$

# The Wave Function

$$\Psi(x) = A' \cos(x - \pi/6)$$



# The Wave Function

$$\Psi(x) = A \ln(1 + 3x)$$

$$\boxed{x = -1/3}$$

$$\Psi(-1/3) = A \ln 0 = \infty$$

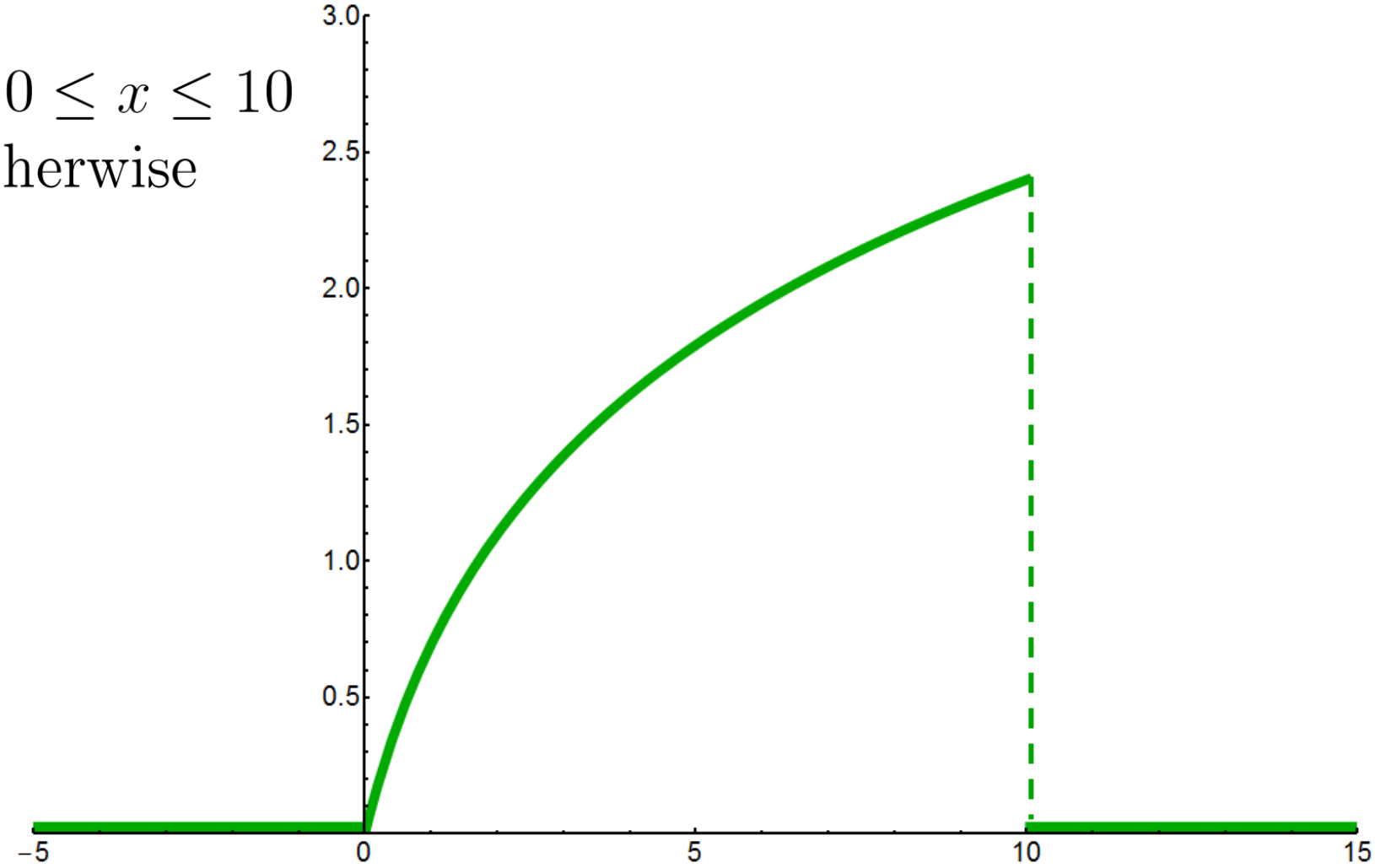
# The Wave Function

$$\Psi(x) = \begin{cases} A(a^2 - x^2), & \text{if } -a \leq x \leq +a \\ 0, & \text{otherwise} \end{cases}$$

$$\Psi(x) = \begin{cases} A \ln(1 + x), & \text{if } 0 \leq x \leq 10 \\ 0, & \text{otherwise} \end{cases}$$

# The Wave Function

$$\Psi(x) = \begin{cases} A\ln(1+x), & \text{if } 0 \le x \le 10 \\ 0, & \text{otherwise} \end{cases}$$



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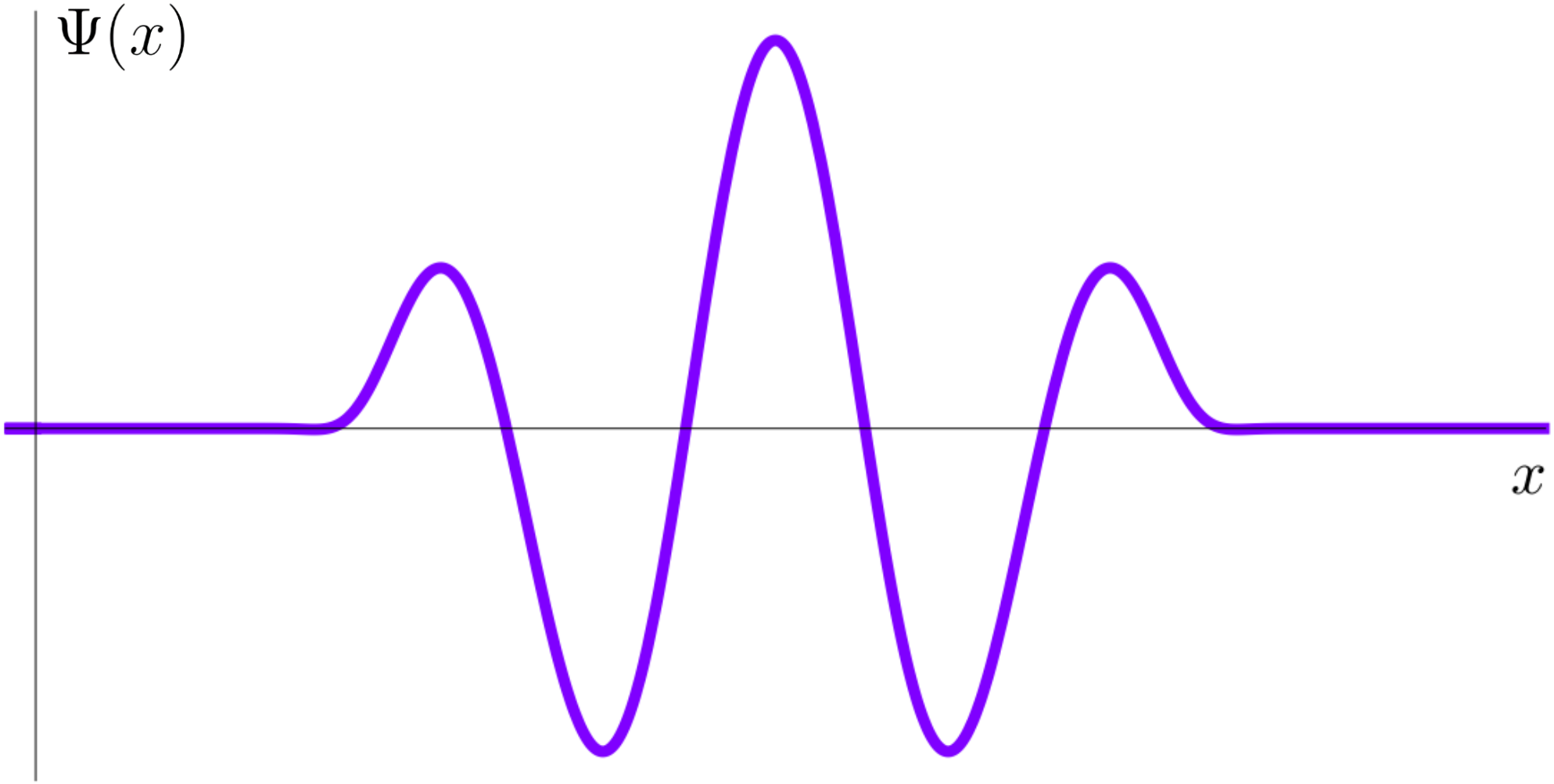

# Thank You

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