Slow inhibition applied at various phases; near 25ms delays spiking most
Inhibition is also ineffective immediately after and before spiking.
Immediately after, the driving force (i.e., $V_m$) is small.
Immediately before, there isn't enough time to rise.

Calculating the PRC
Shifting \( x(t) \) up by \( A \) corresponds to shifting it left by \( PRC(t) \).

The PRC and the membrane voltage increase \((A)\) are related by:

\[
x[t + PRC[t]] = x[t] + A
\]

\[ \Leftrightarrow \]

\[
PRC[t] = x^{-1}[x[t] + A] - t
\]

which requires us to solve for the waveform and find its inverse.

### Quadratic integrate-and-fire neuron

Neuron's phase plot (left) and PRCs (right); threshold is at \( x = 0 \) due to offset.

This model can be solved analytically:

\[
x[t] = -\text{Cot}[t] \quad \text{with} \quad T = \pi
\]

\[ \Leftrightarrow \]

\[
PRC[t] = \text{Cot}^{-1}[A - \text{Cot}[t]] - t
\]

The PRC depends on \( A \) as well, becoming more asymmetrical as it gets large. Because, larger kicks send neuron across the minimum—where they are most helpful—only if they happen earlier.
For small $A$, $\dot{x}$ yields a good approximation for $\text{PRC}(t)$

Extrapolating $x(t)$ linearly yields:

$$\dot{x}[t] \text{PRC}[t] = A \iff \text{PRC}[t] = A / \dot{x}[t]$$

Predicts that phase advance is greatest when $x$ is minimum—at the inflection point.

For the quadratic I&F neuron, we get:

$$\dot{x}[t] = 1 / \sin^2[t] \Rightarrow \text{PRC}[t] = A \sin^2[t]$$

This matches the $A = 0.1$ curve in the previous slide.
Inhibition

The PRC becomes more asymmetrical as \( A \) gets large in this case as well. But it is skewed toward latter times, because the kicks send the neuron back across the minimum.