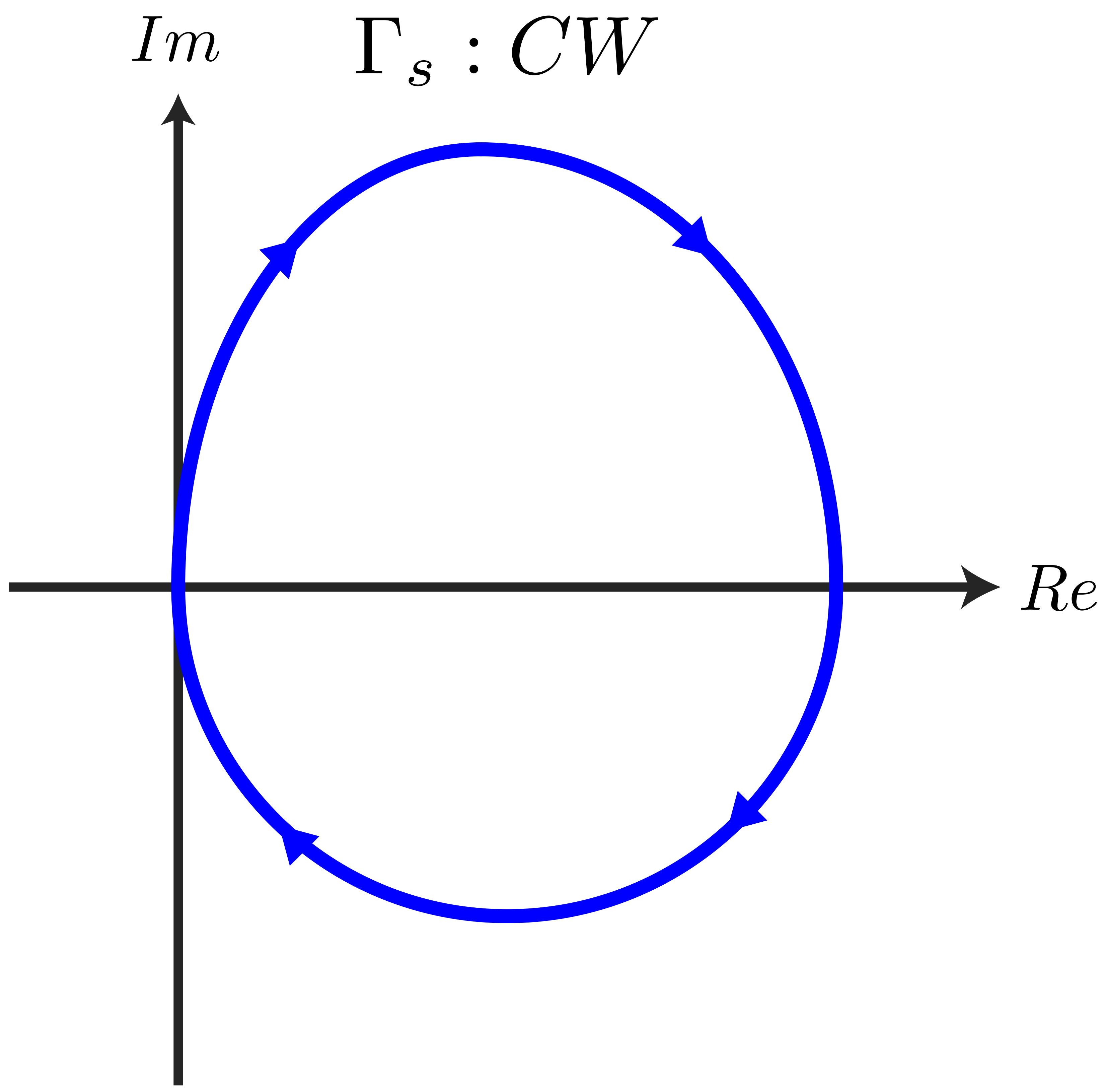
Frequency Response Techniques in Feedback Control Systems

https://github.com/mertankarali/Lecture-Notes/tree/master/METU-EE302/Frequency_Response

Part I - Polar Plot

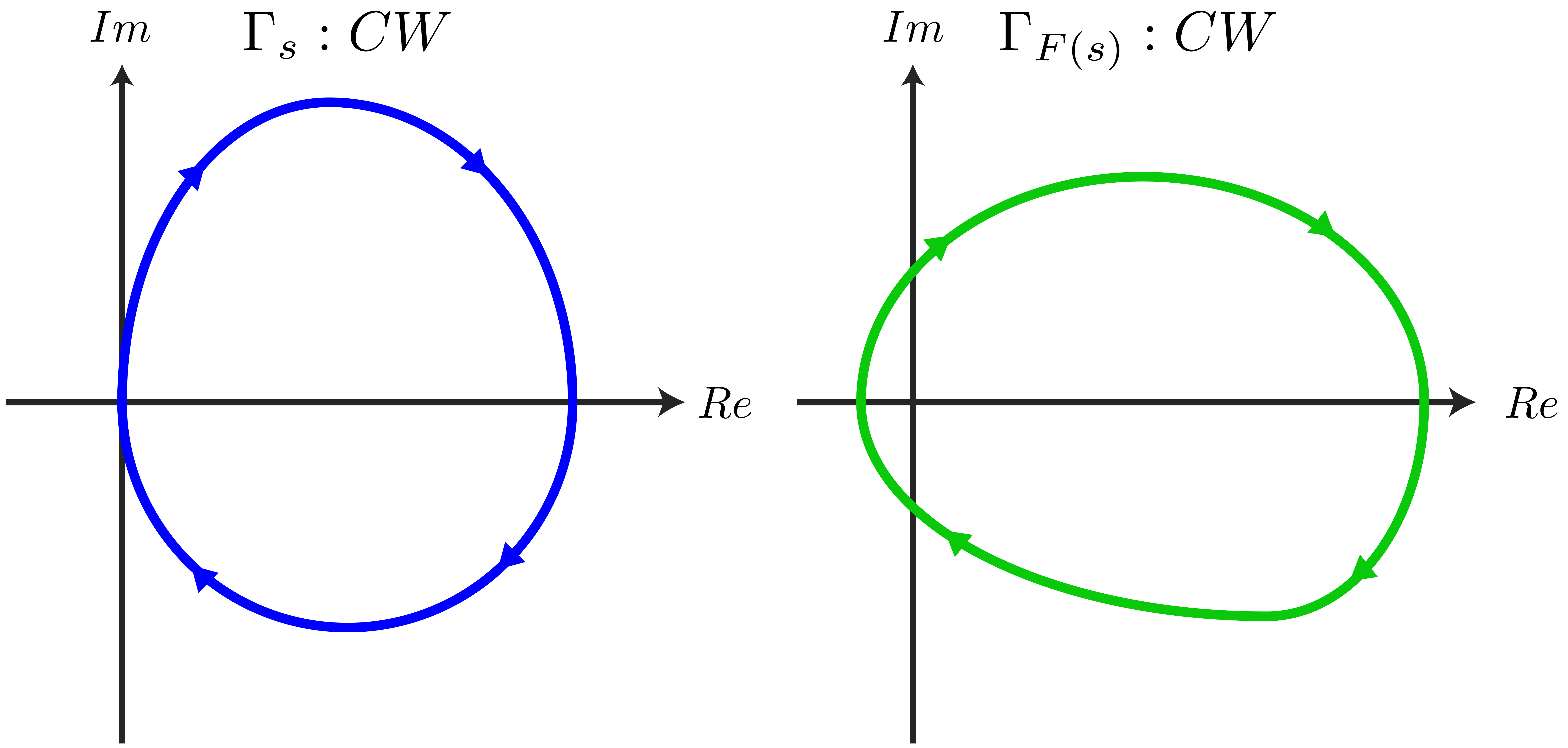
Part II - Nyquist Plot

Definition: A contour Γ_s is a closed path with a direction in a complex plane.



Definition: A contour Γ_s is a closed path with a direction in a complex plane.

Remark: A continuous function $F(s)$ maps a contour Γ_s in $s-$plane to another contour $\Gamma_{F(s)}$



Let's assume $G(s)$ has *no poles and zeros* on the *imaginary axis*

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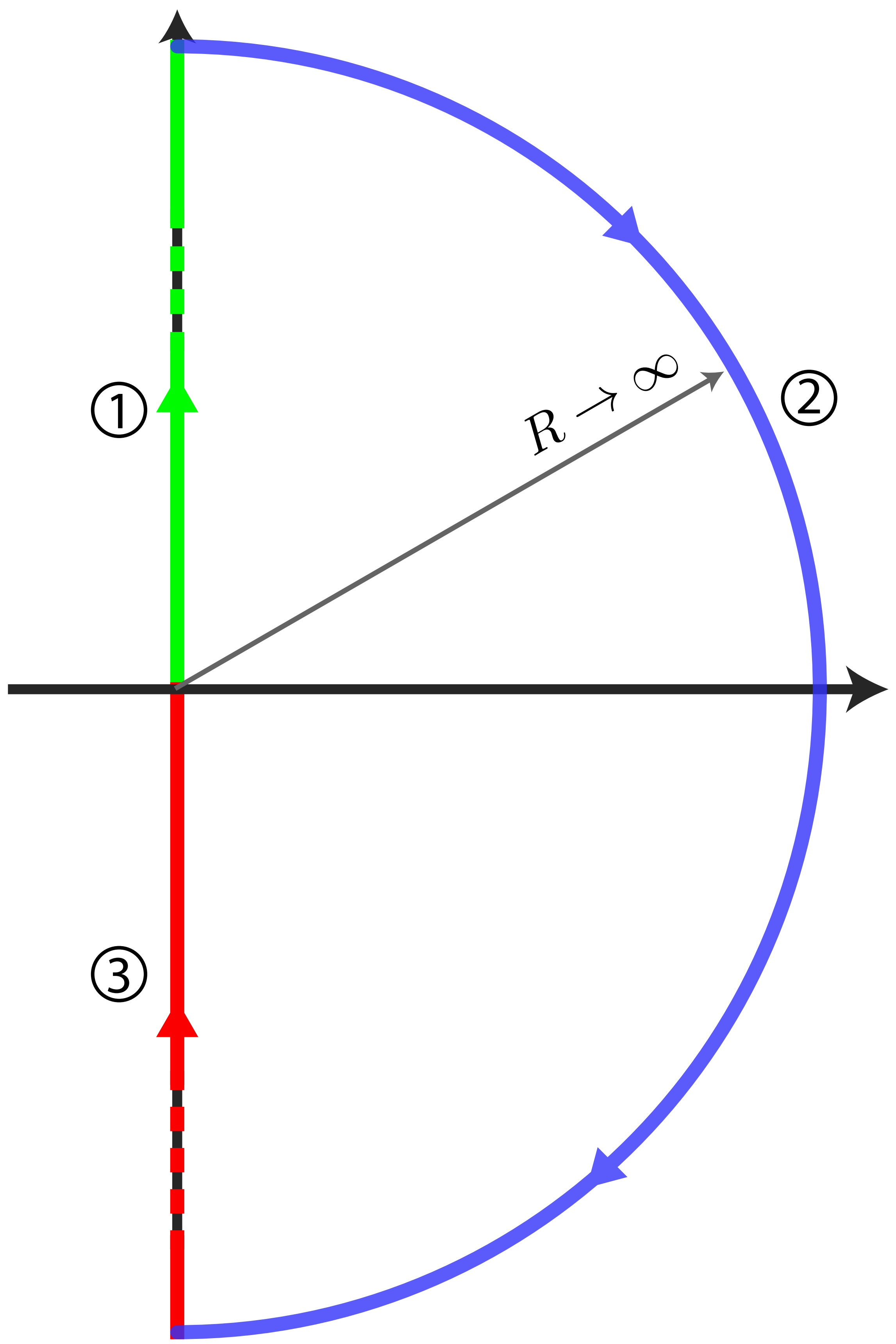
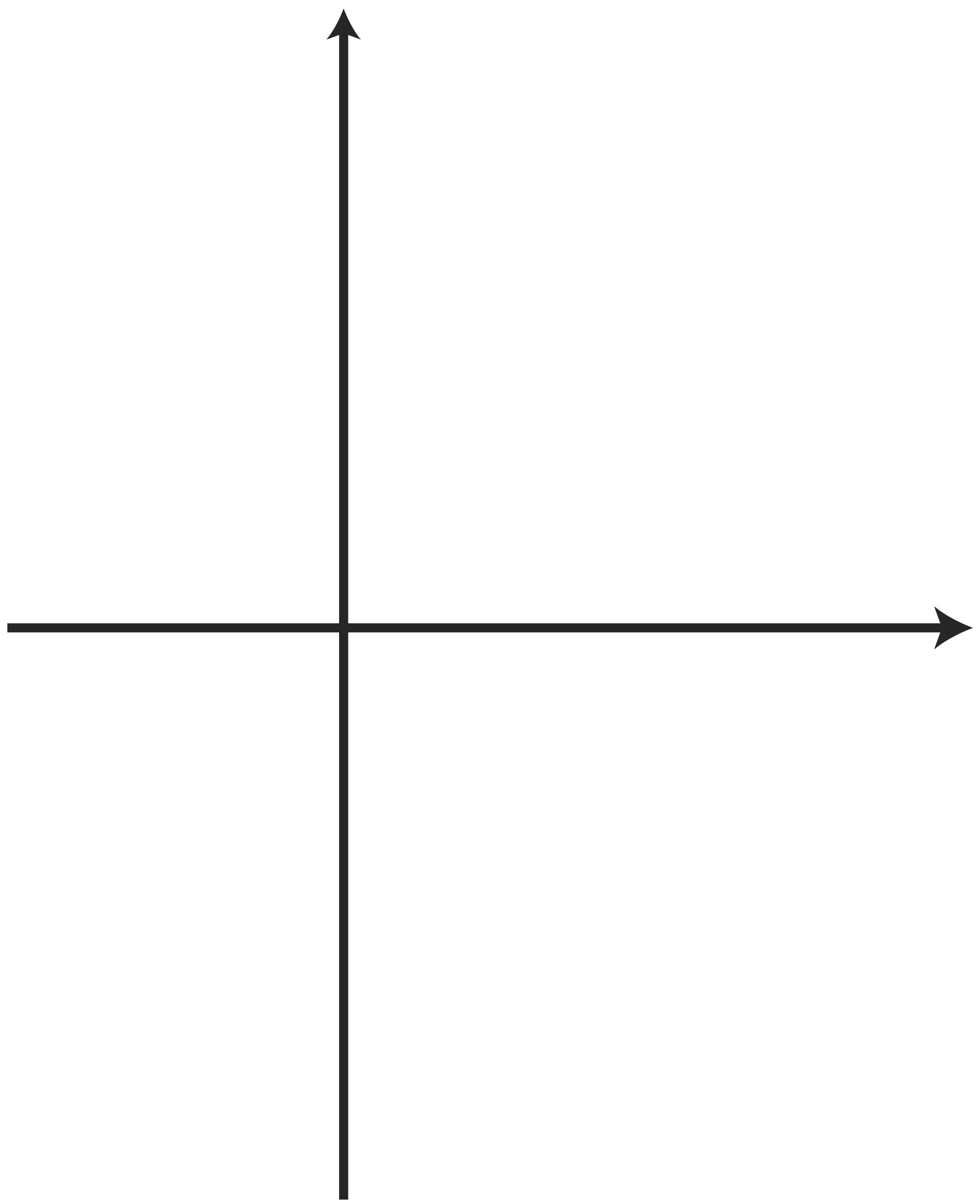
Nyquist Contour



Nyquist Plot



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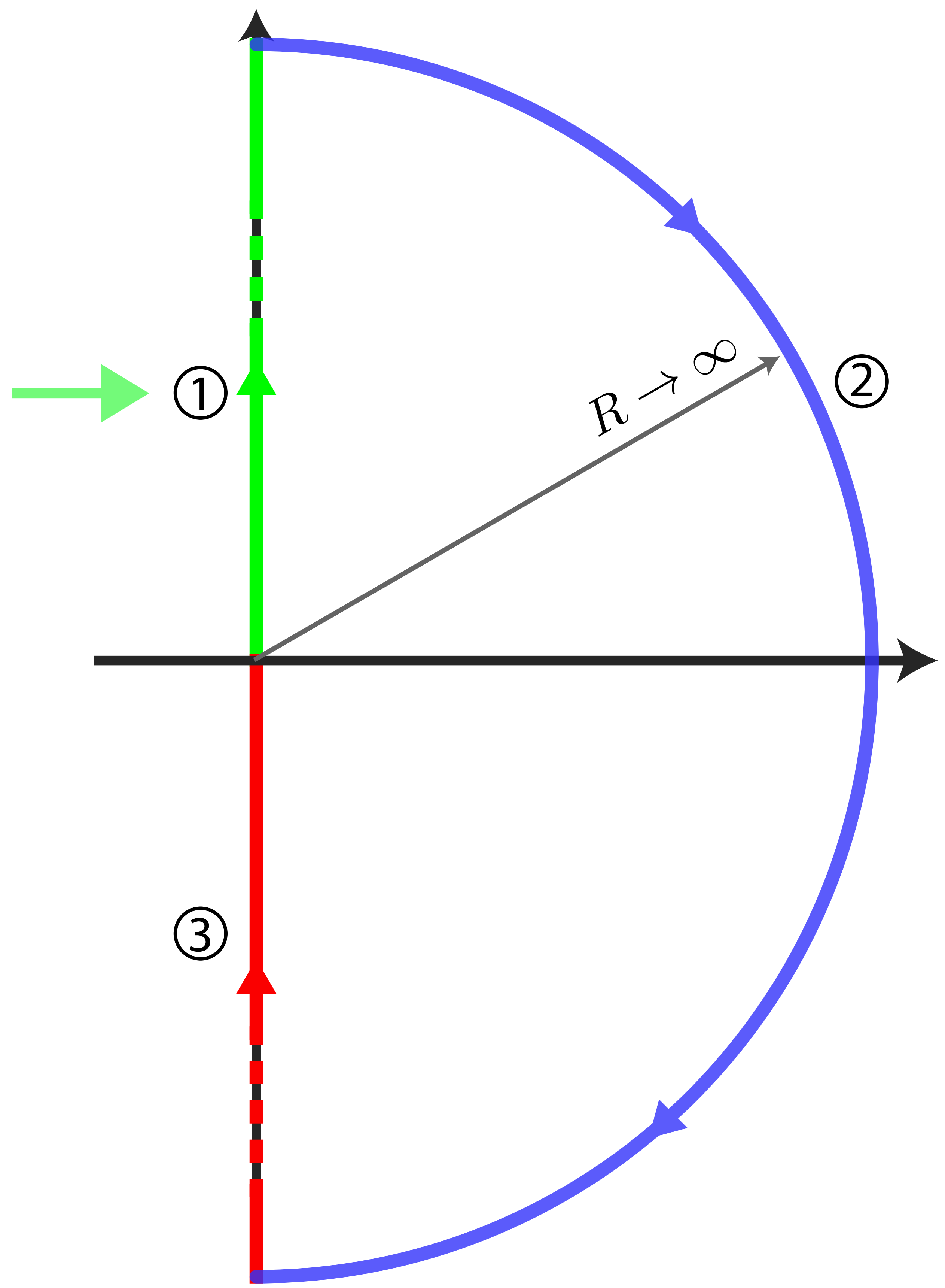

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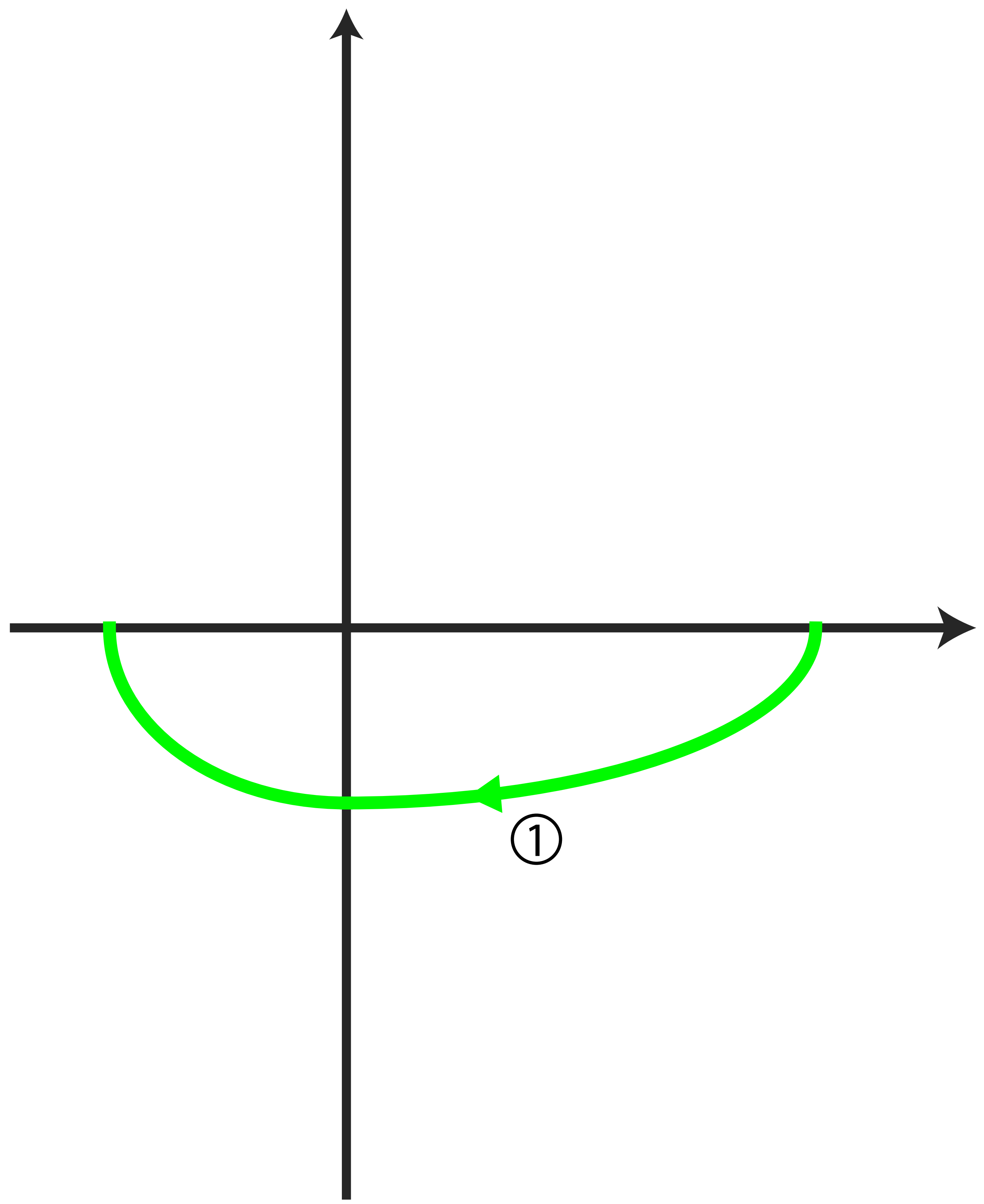

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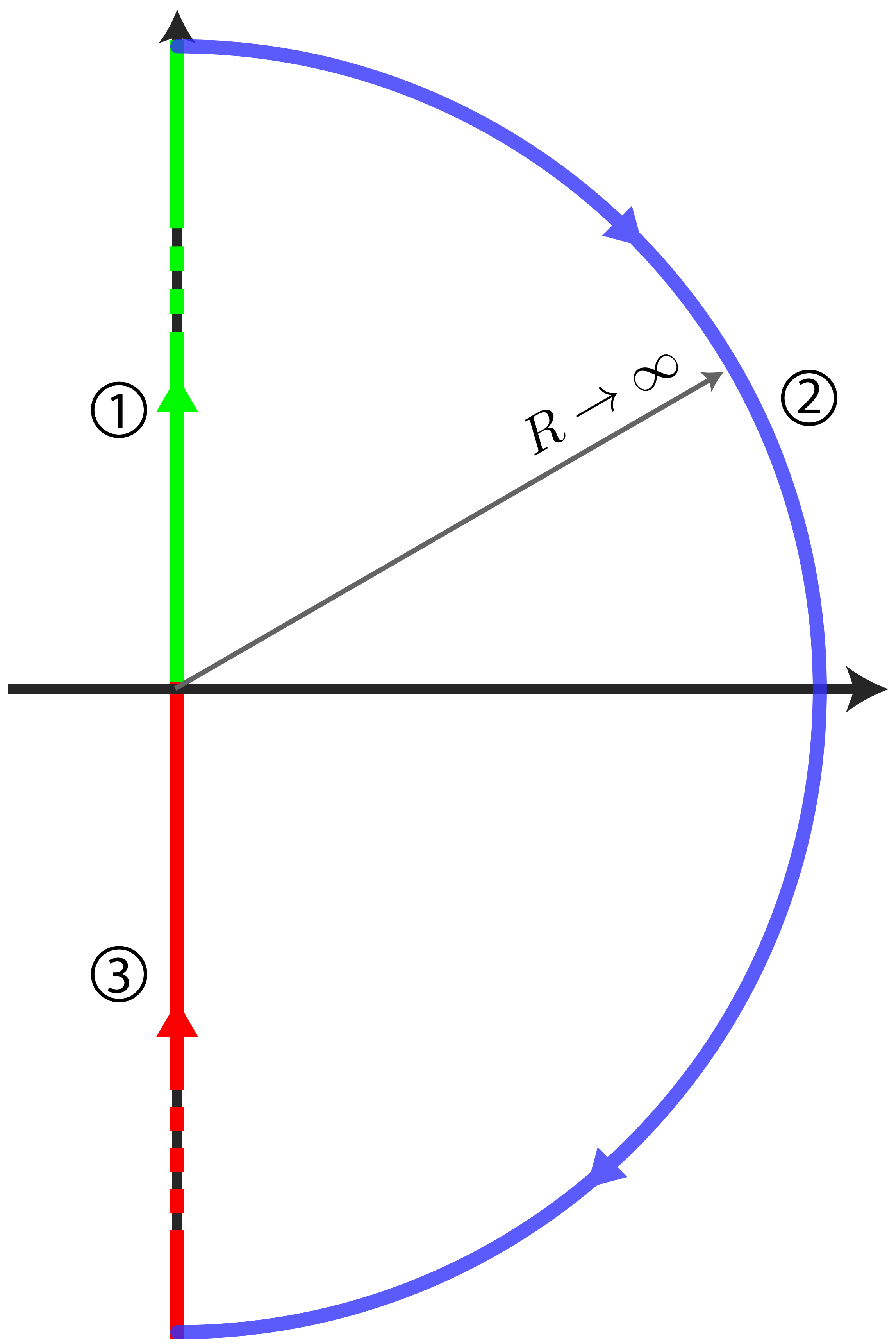

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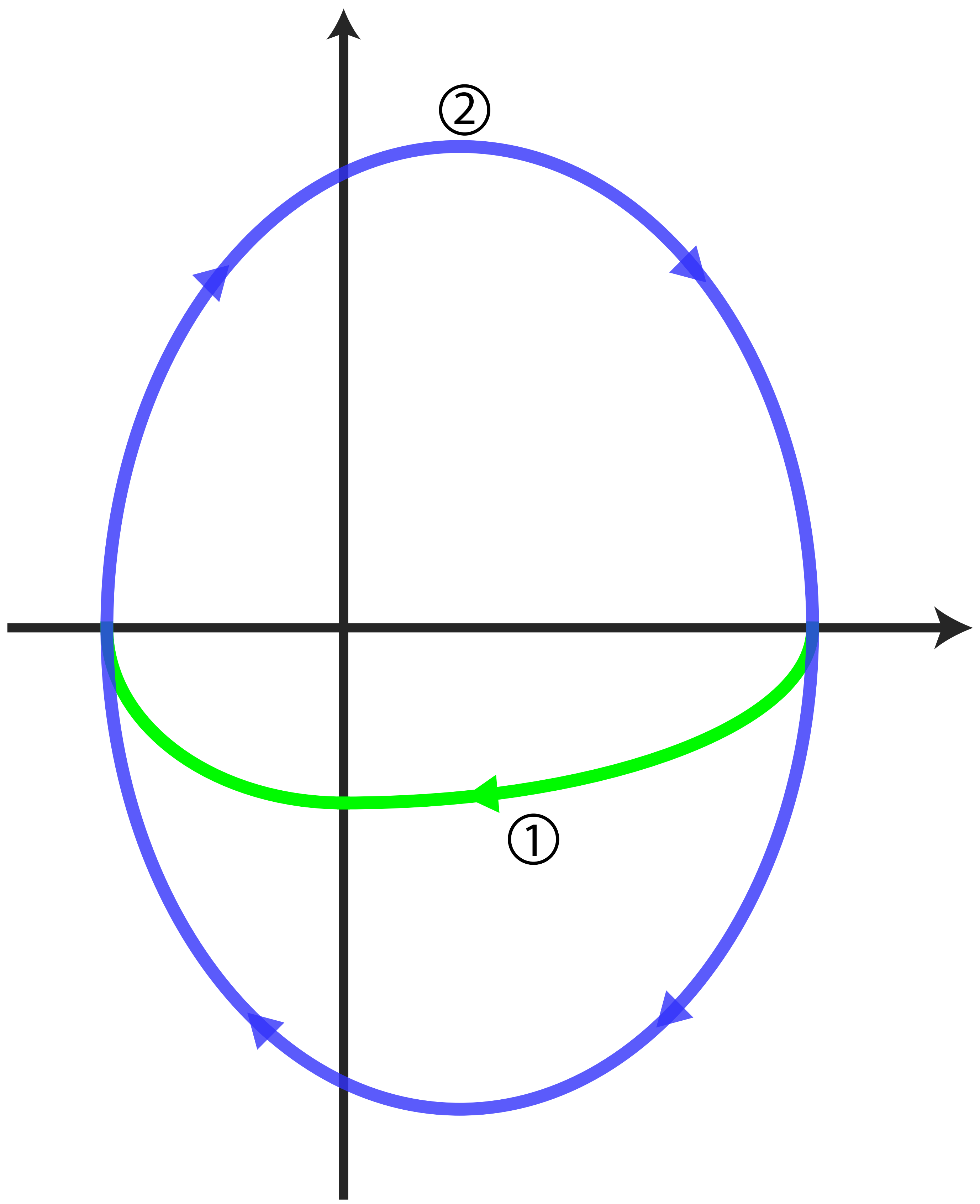

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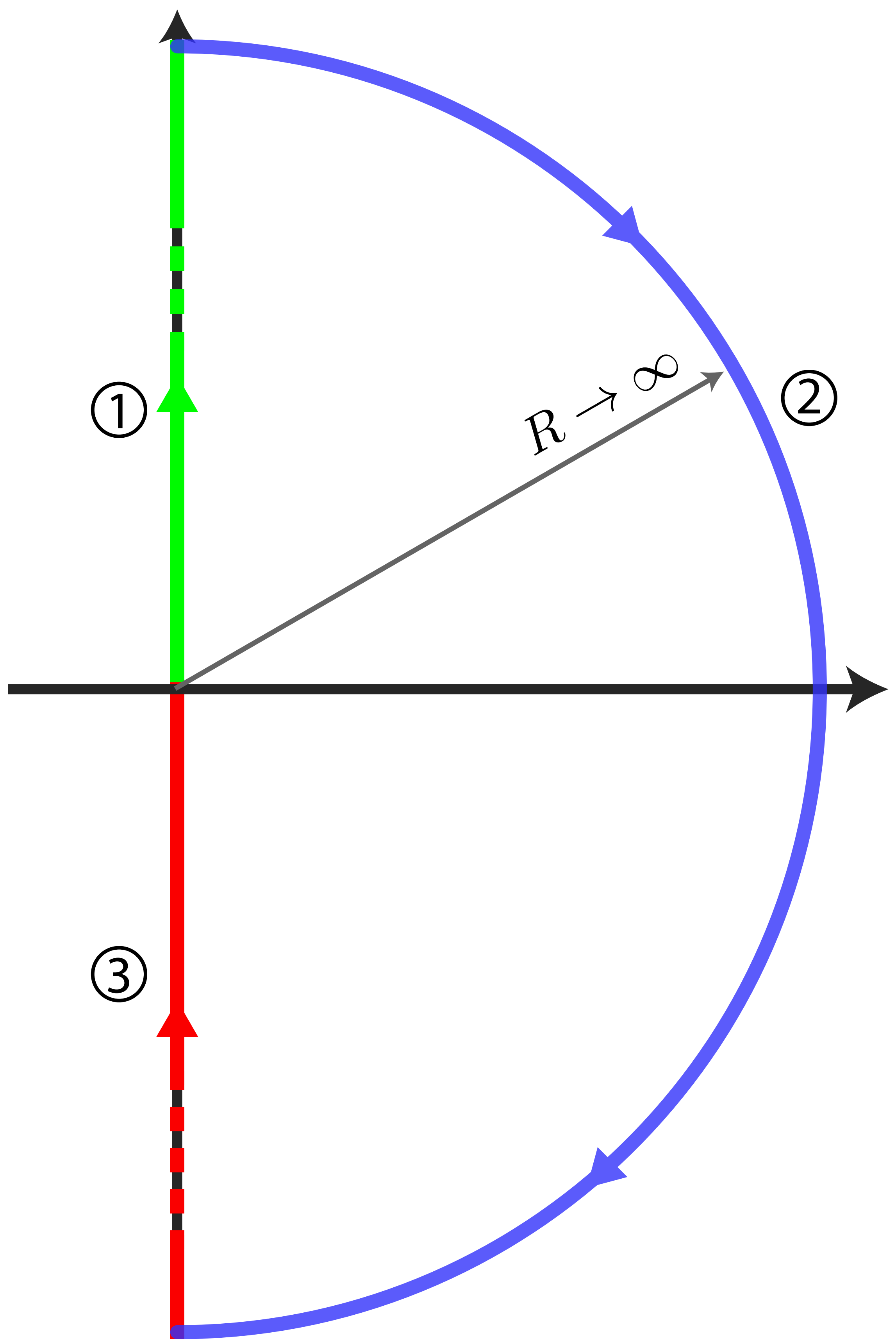

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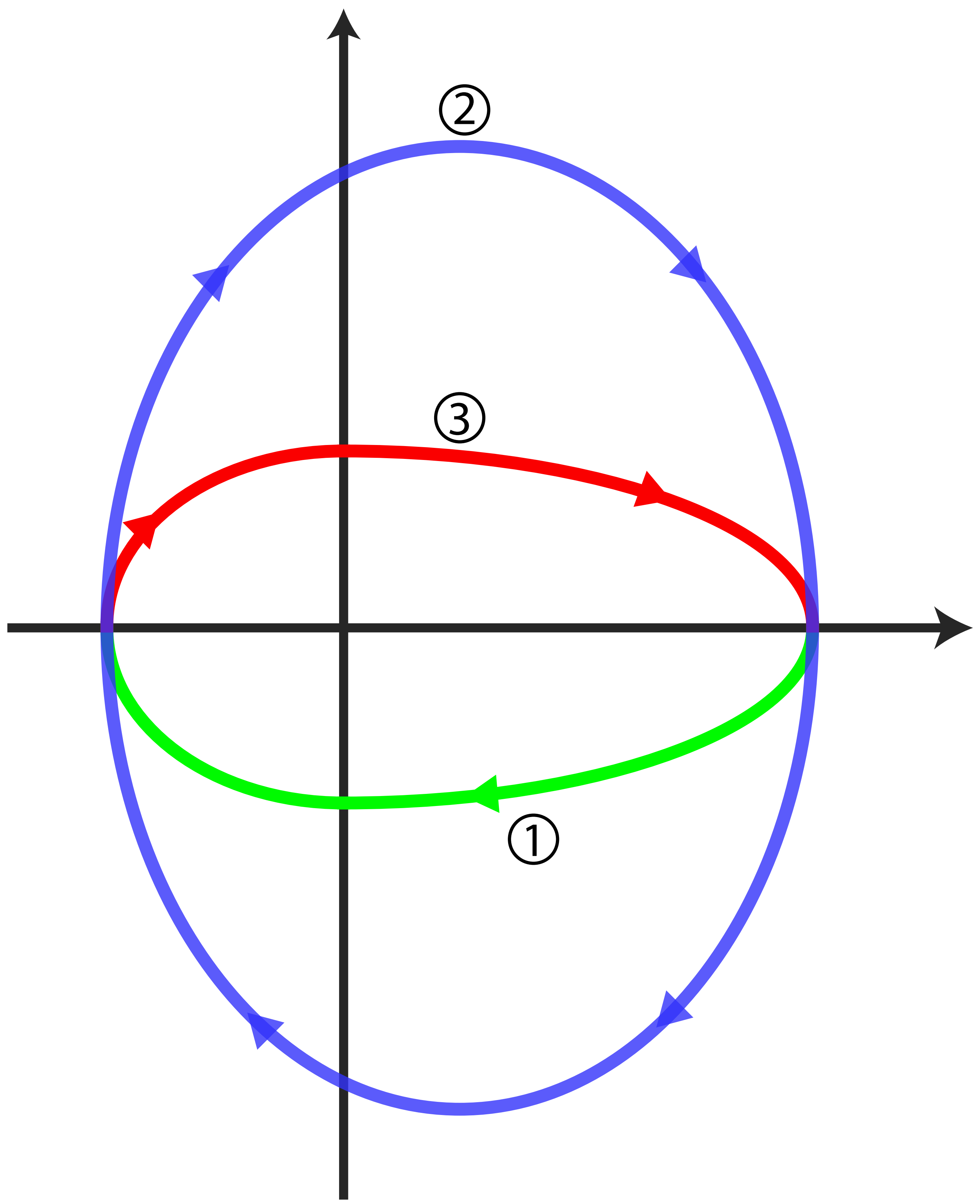
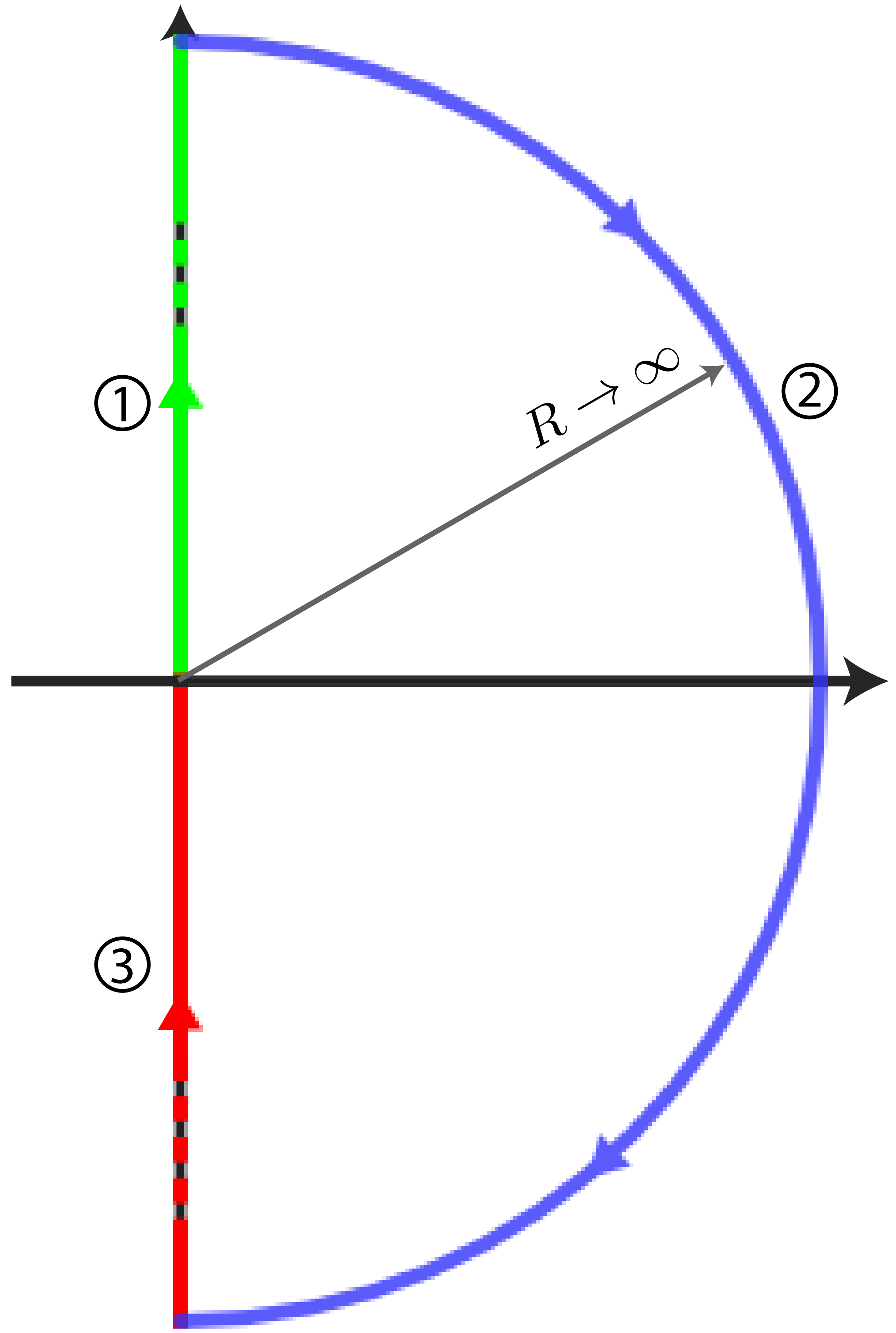
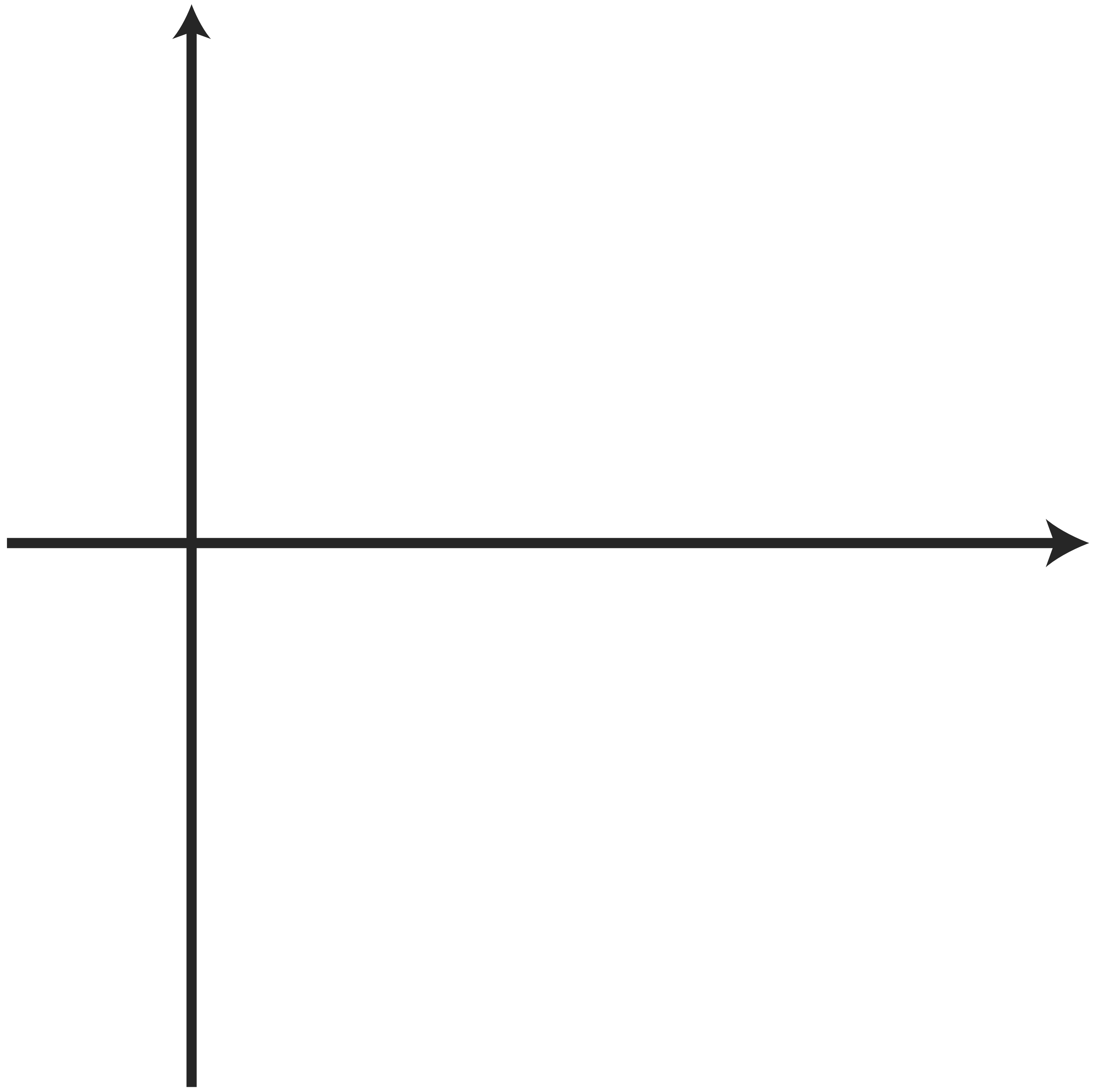


$$G(s) = \frac{1}{s+1}$$





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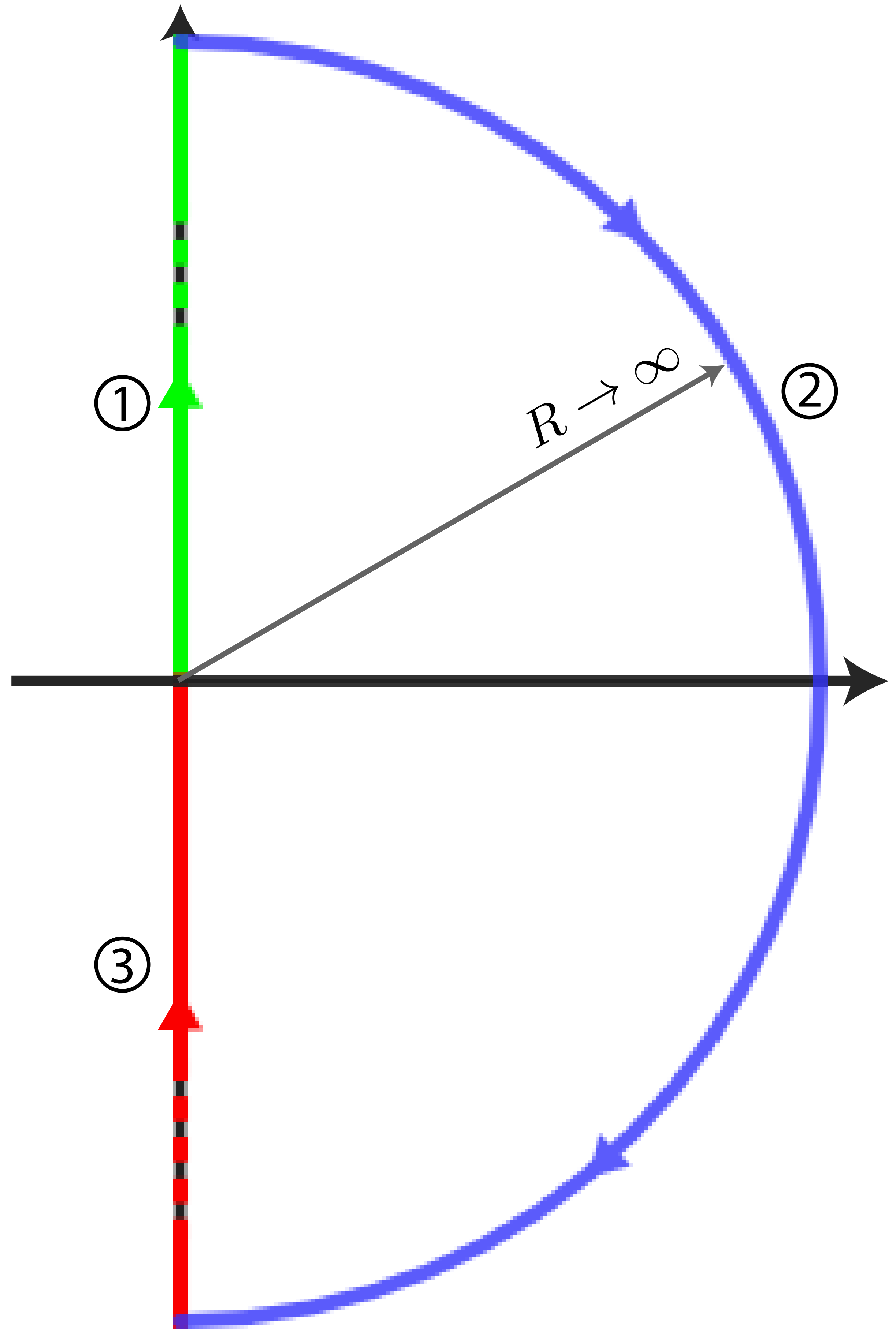
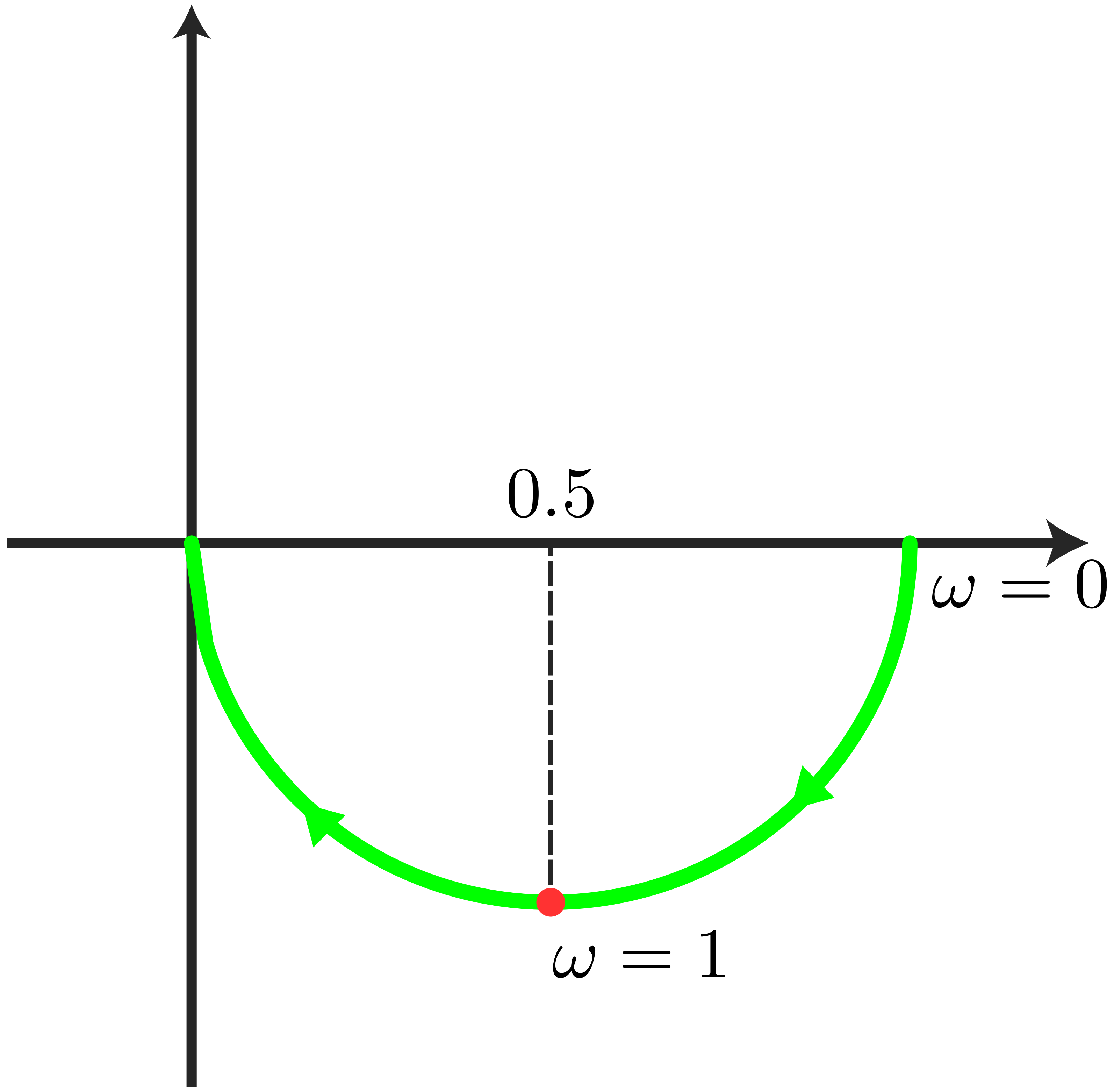
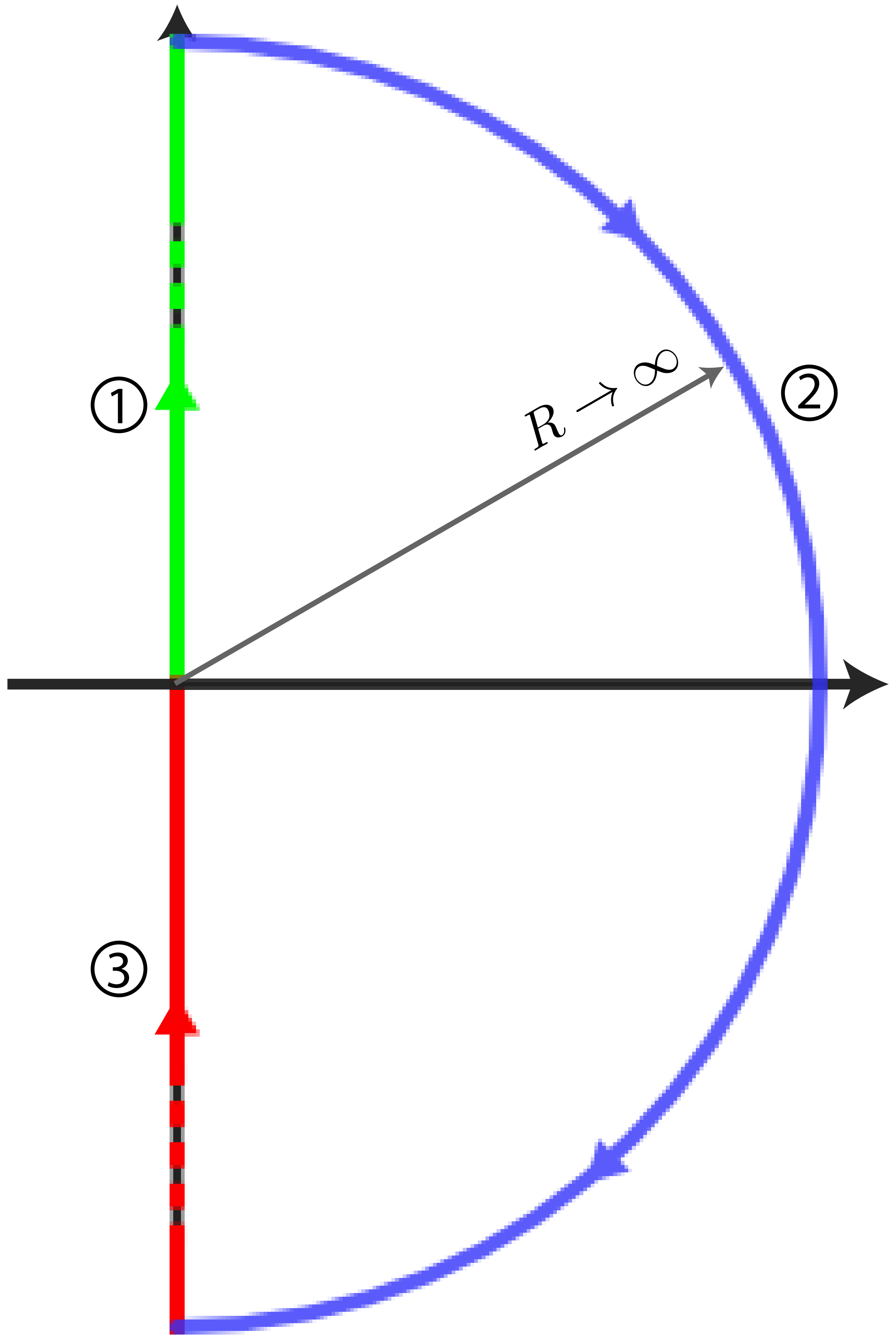
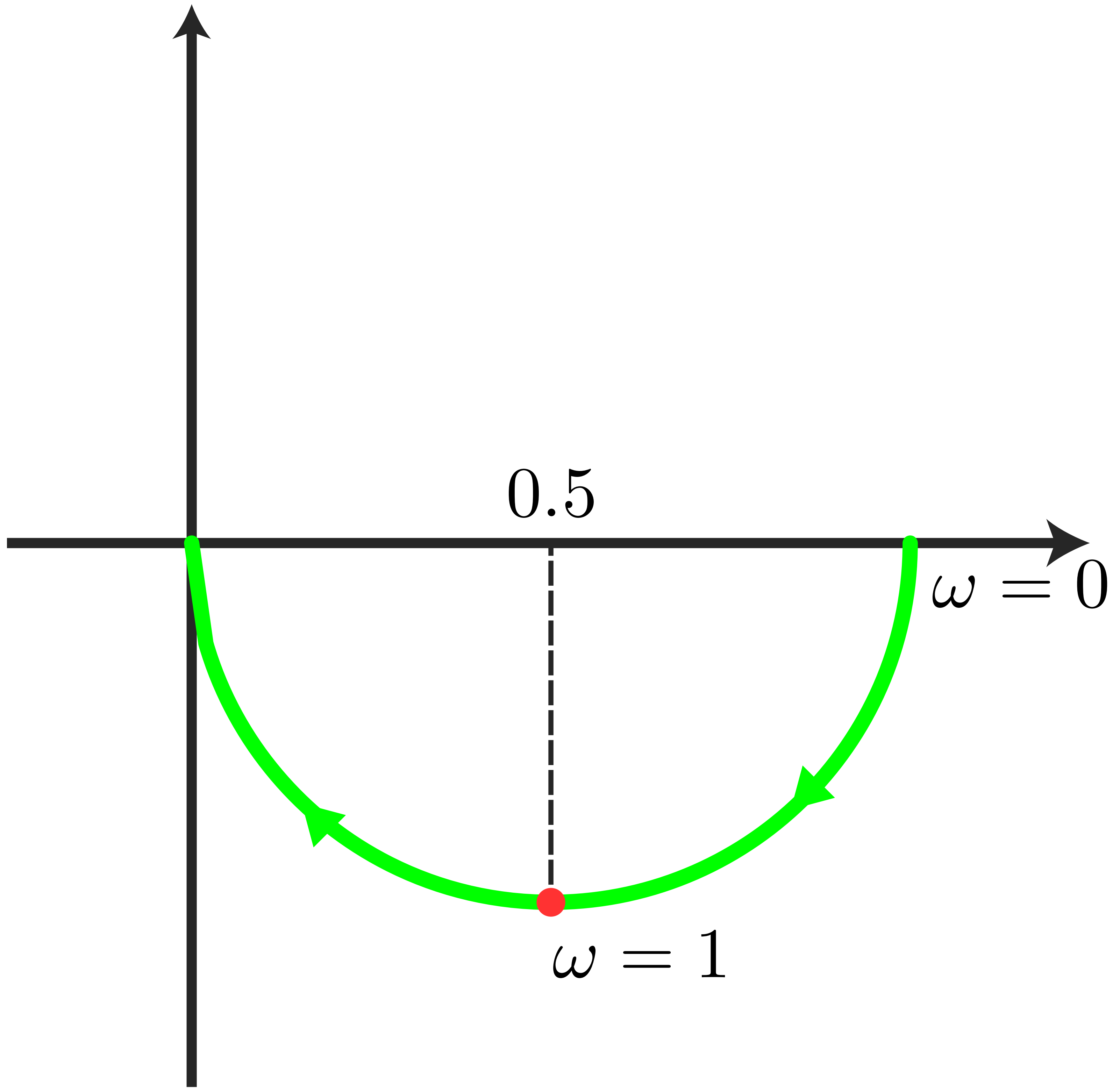




$$G(s) = \frac{1}{s+1} \quad \rightarrow \quad \begin{array}{l} s = Re^{j\theta} \\ R \to \infty \\ \theta: \pi/2 \to -\pi/2 \end{array} \quad \rightarrow \quad \begin{array}{l} G(Re^{j\theta}) = \dfrac{1}{Re^{j\theta}+1} \approx \dfrac{1}{Re^{j\theta}} \\ |G(Re^{j\theta})| \approx 0 \end{array}$$





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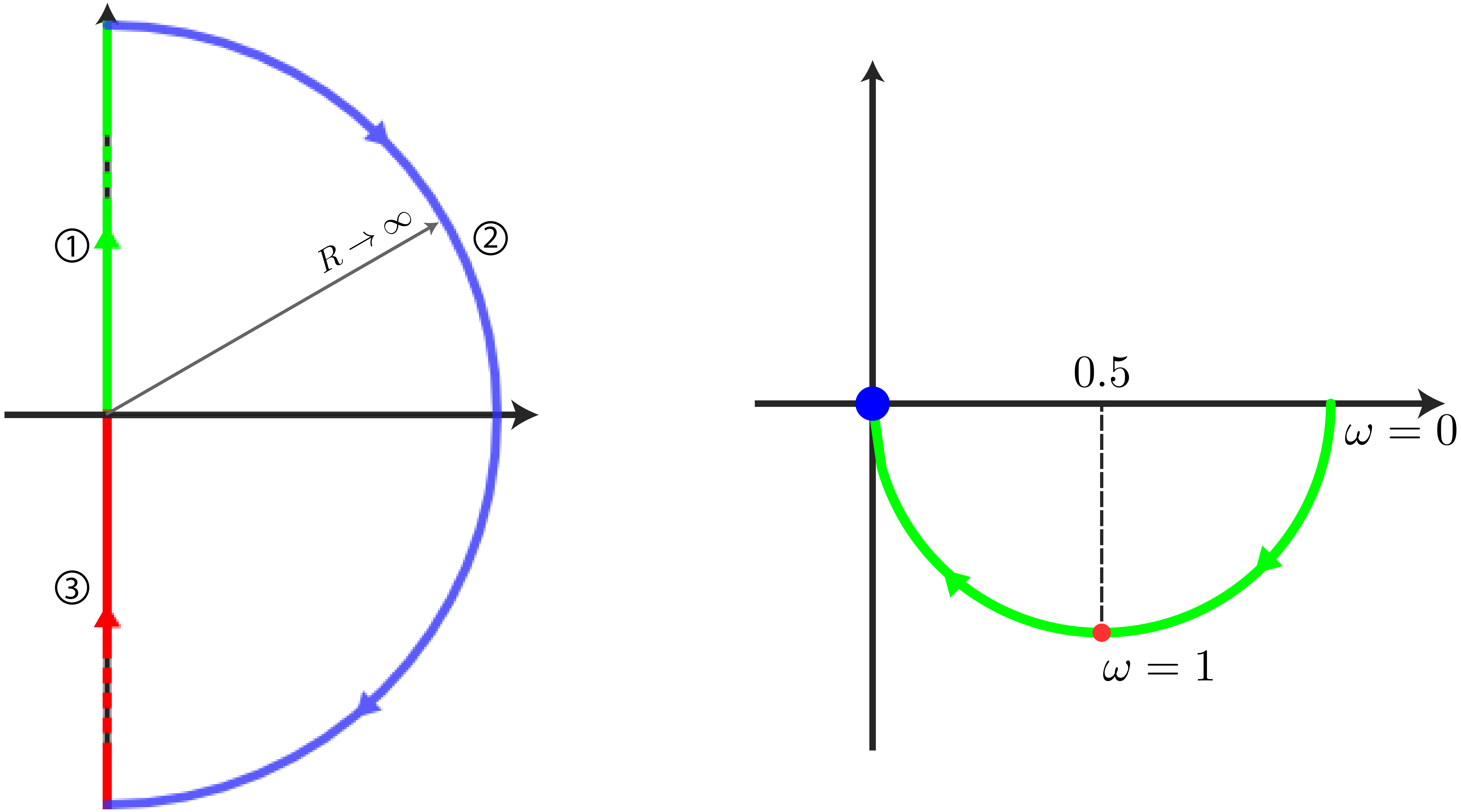

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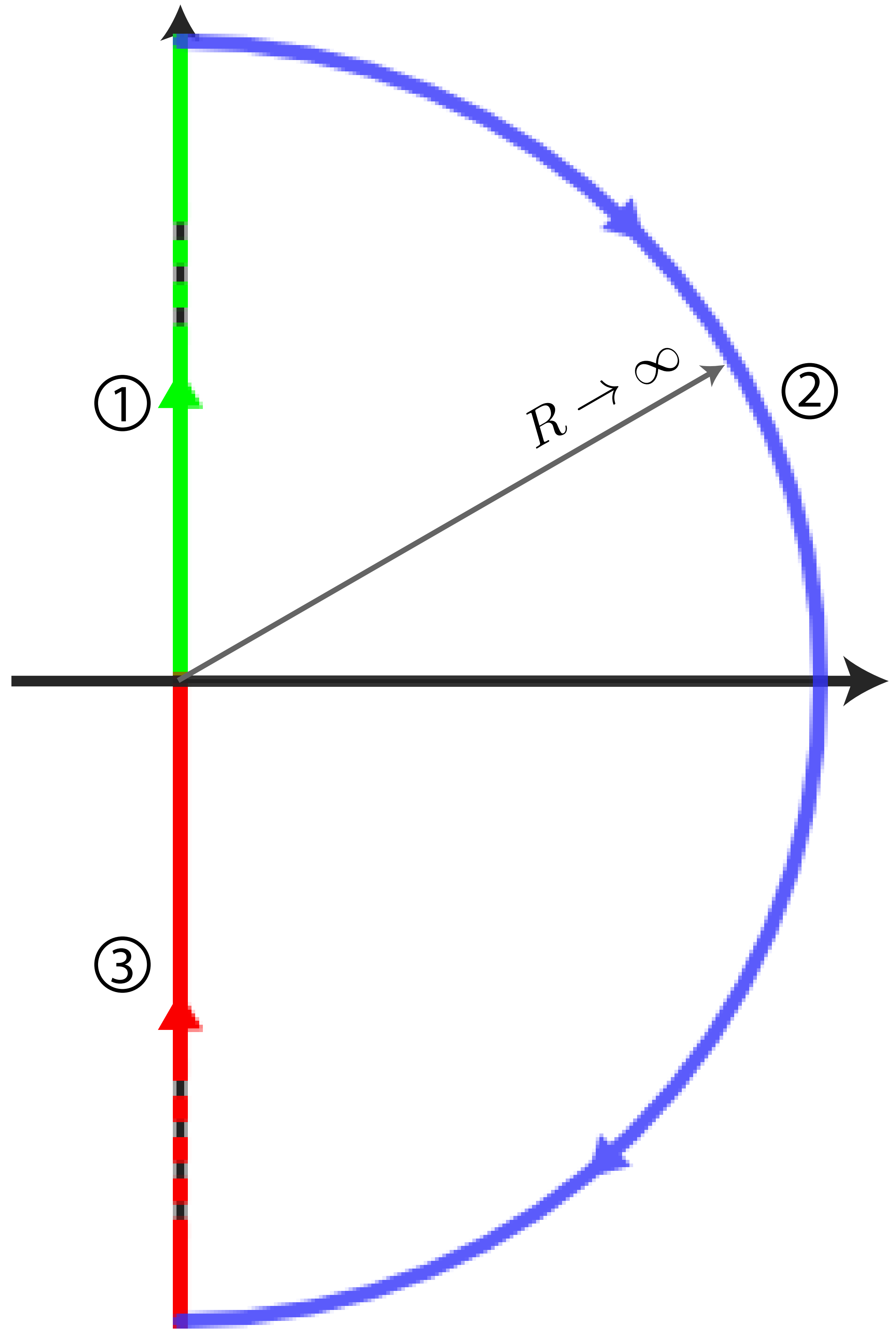

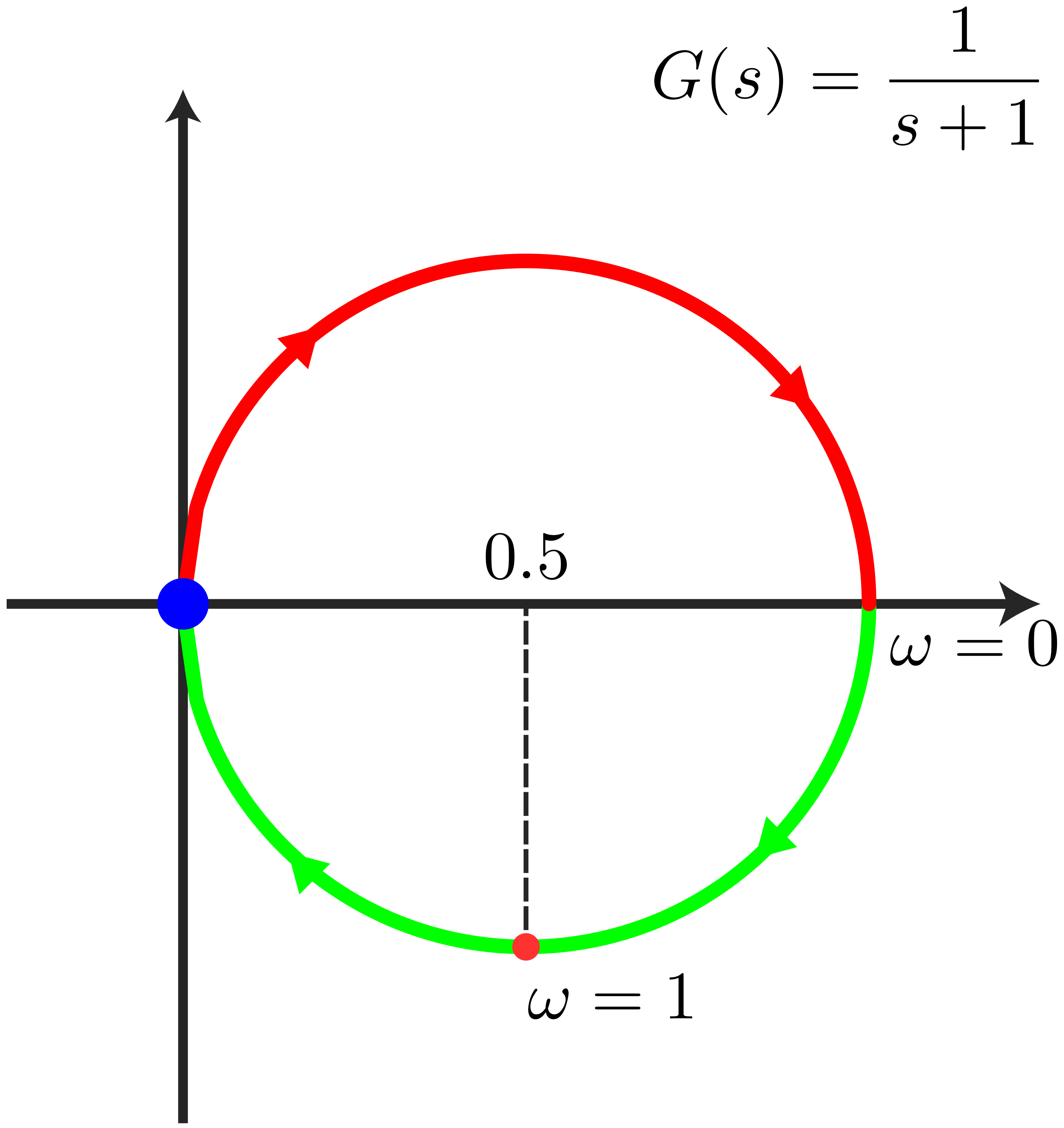

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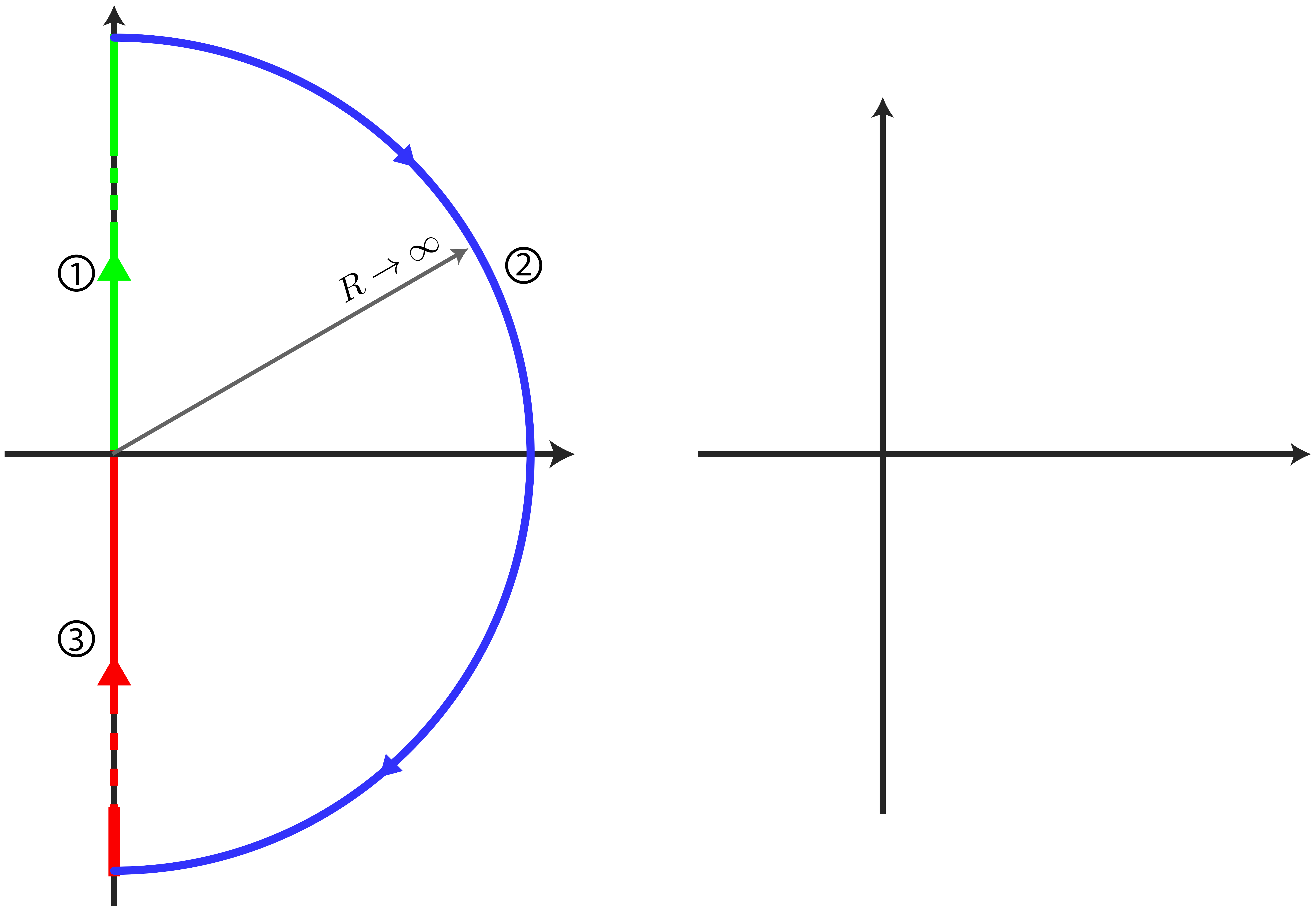

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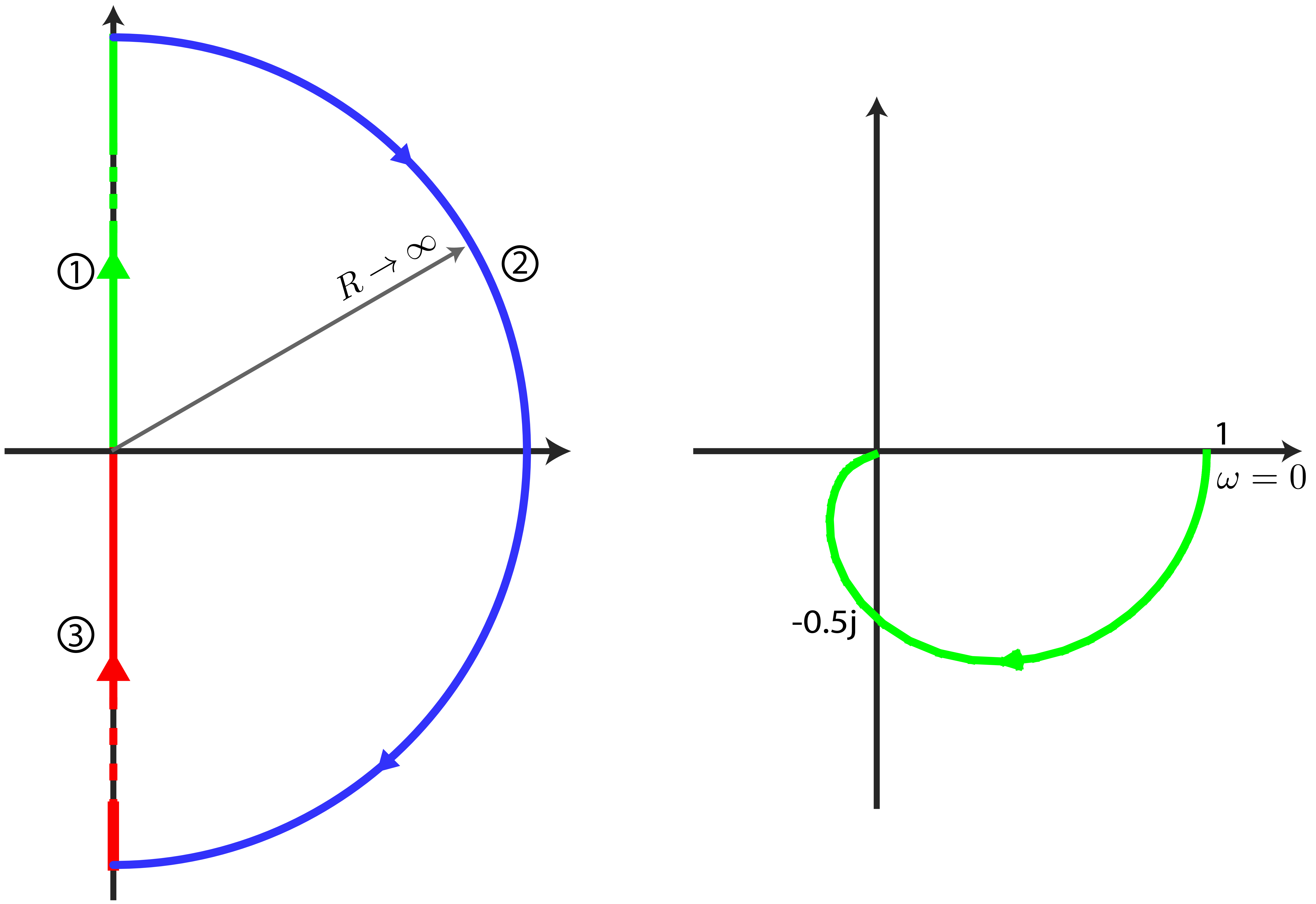

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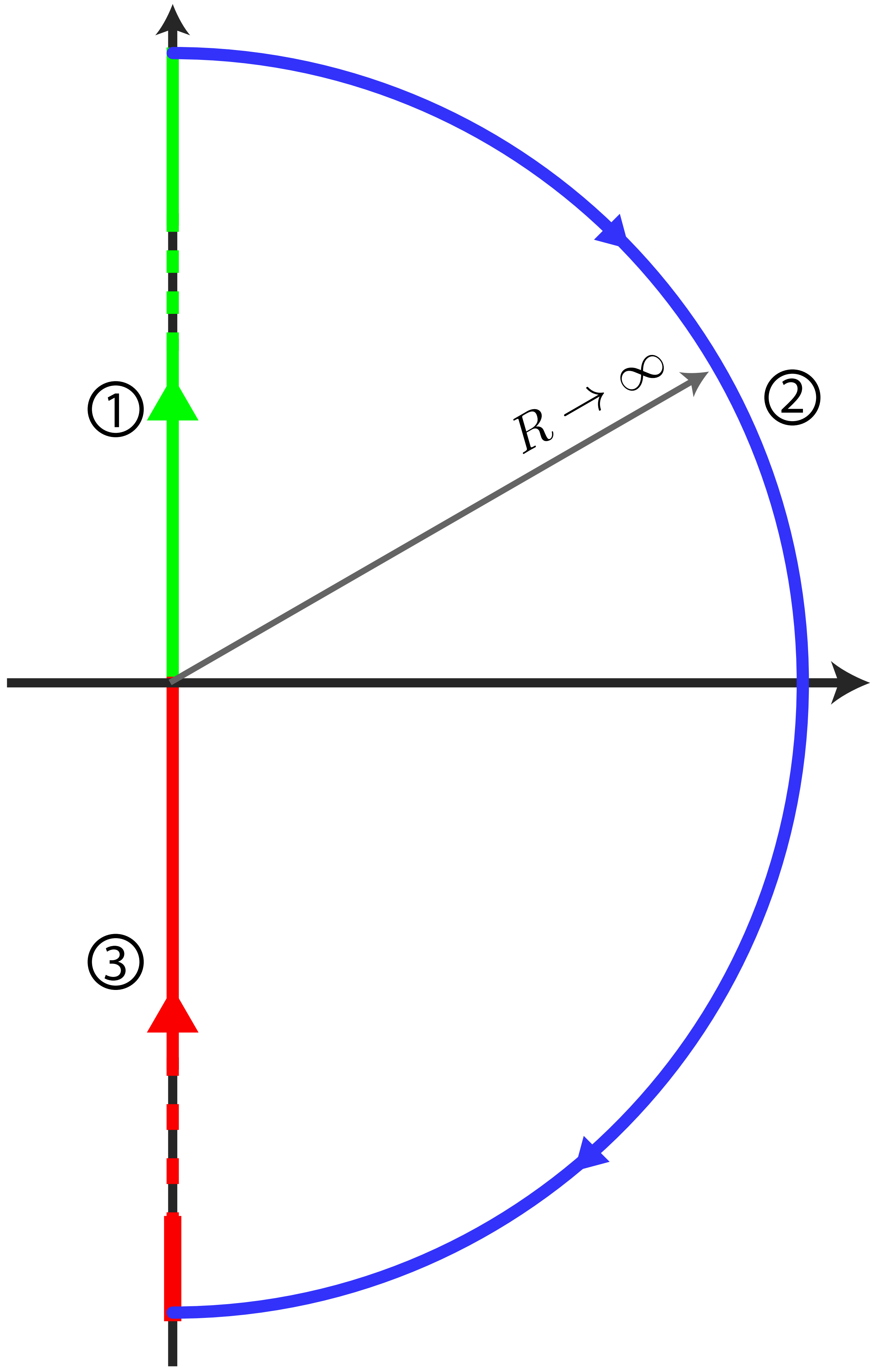
$s = Re^{j\theta}$

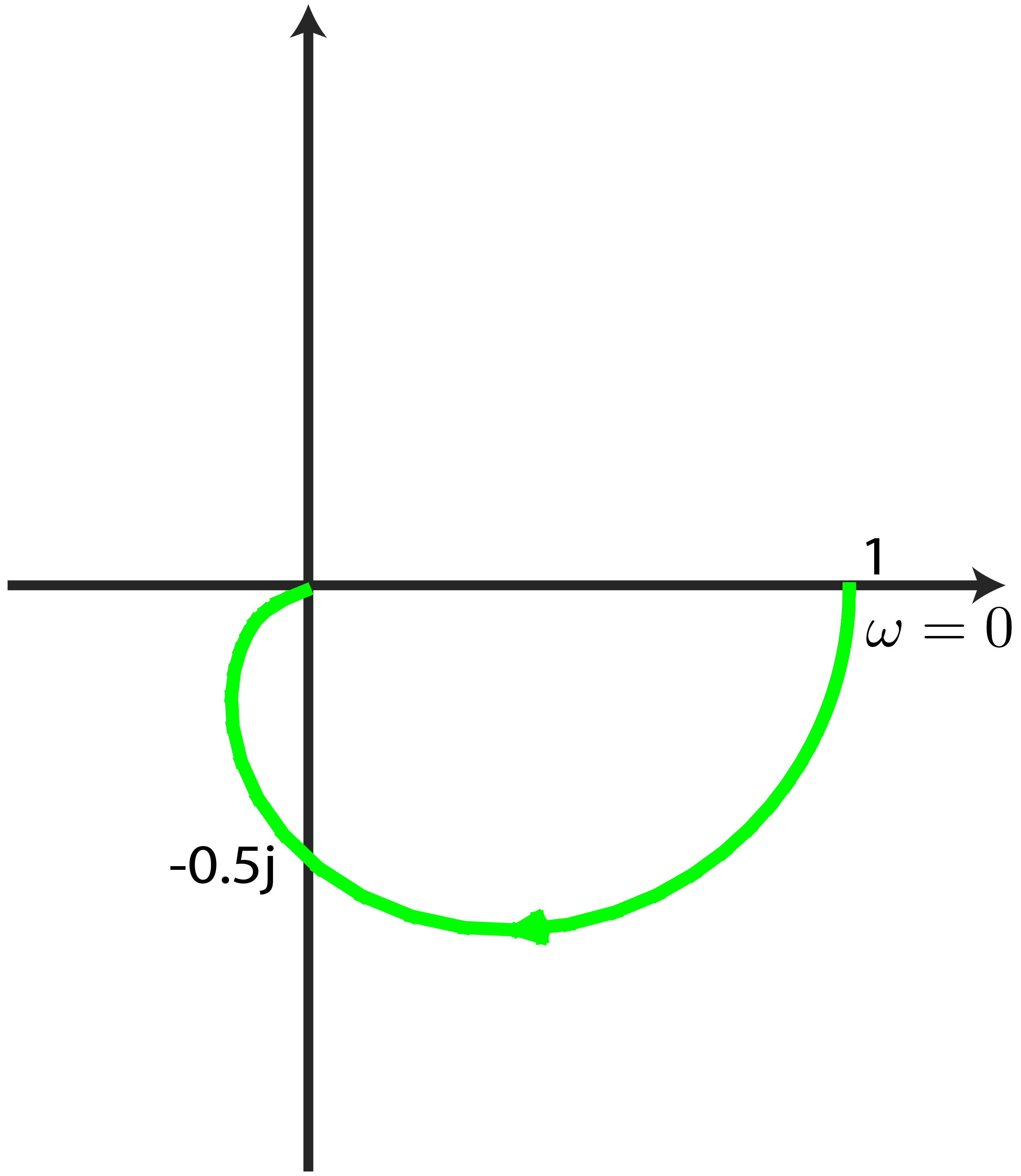
$R \rightarrow \infty$

$\theta: \pi/2 \rightarrow -\pi/2$

$$G(Re^{j\theta}) \approx \frac{e^{-j2\theta}}{R^2}$$

$$|G(Re^{j\theta})| \approx 0$$





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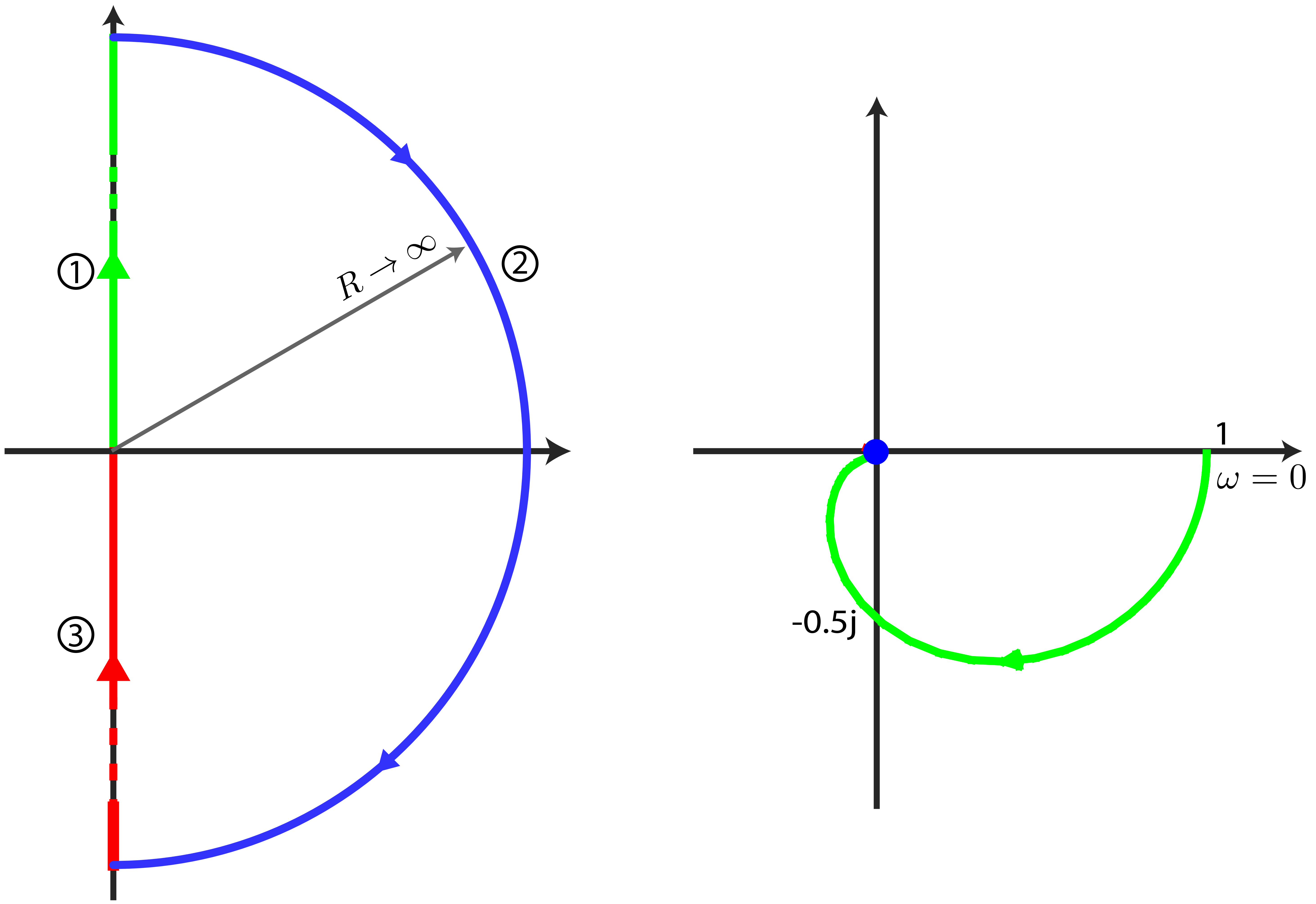

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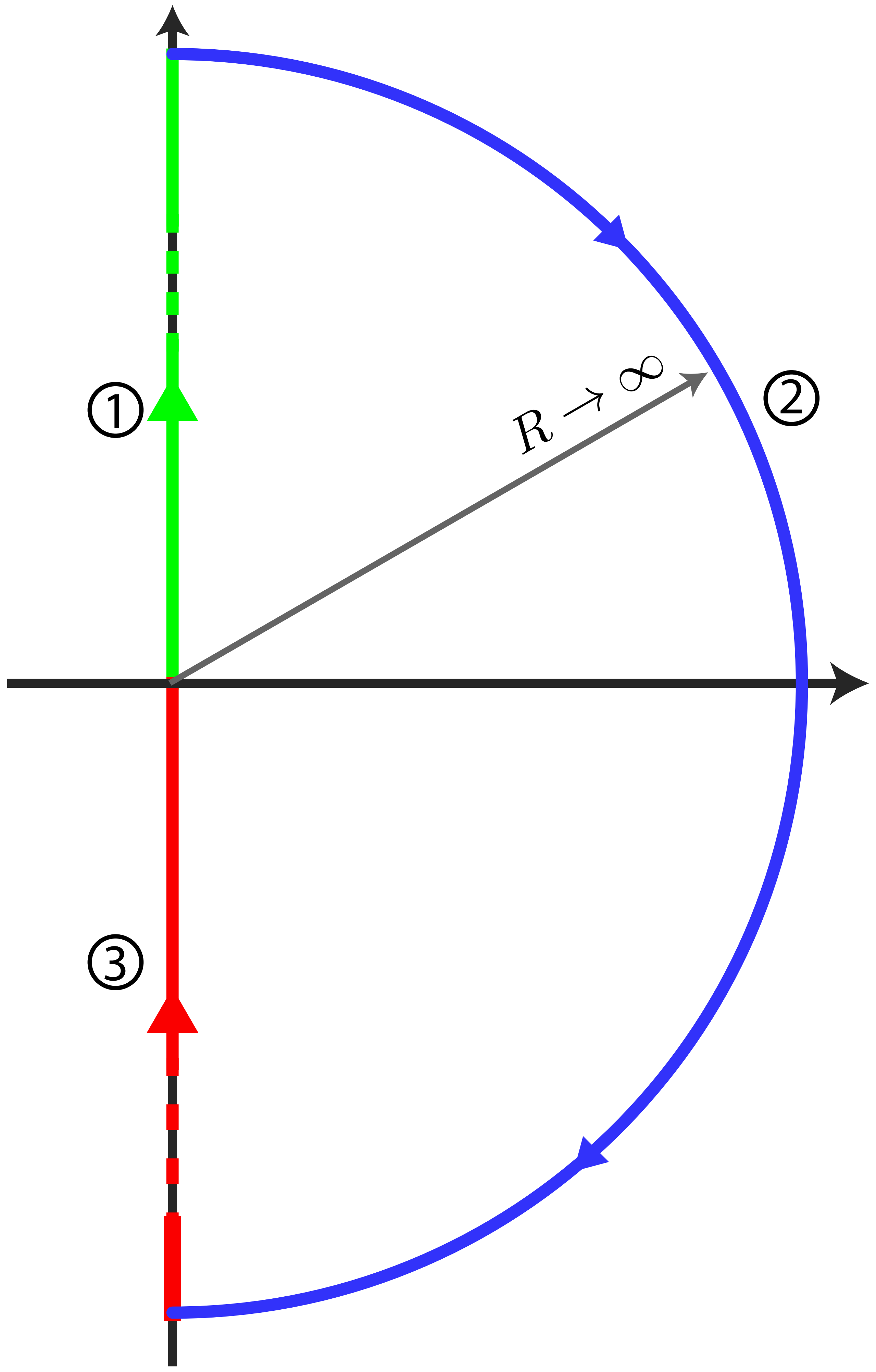

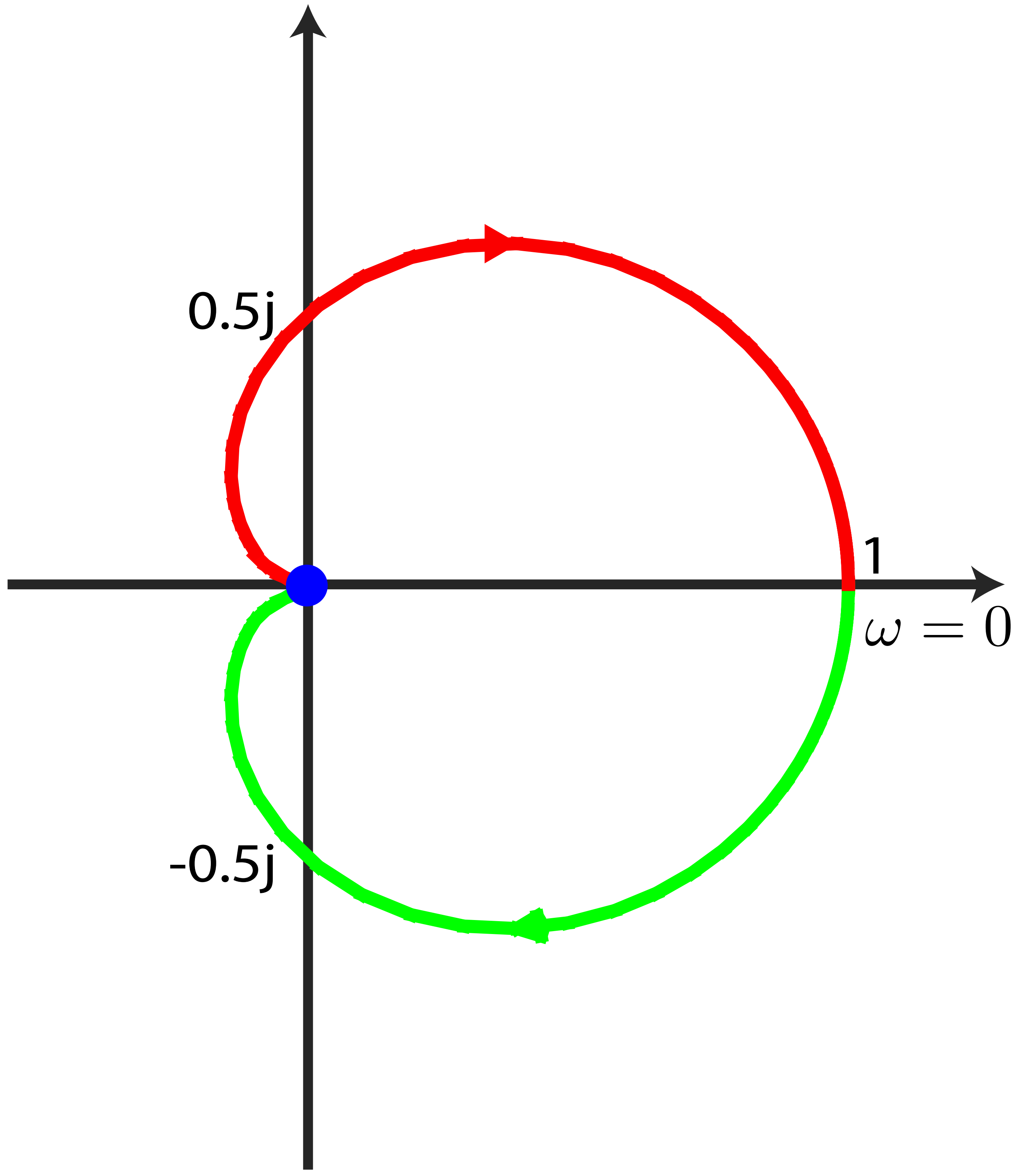

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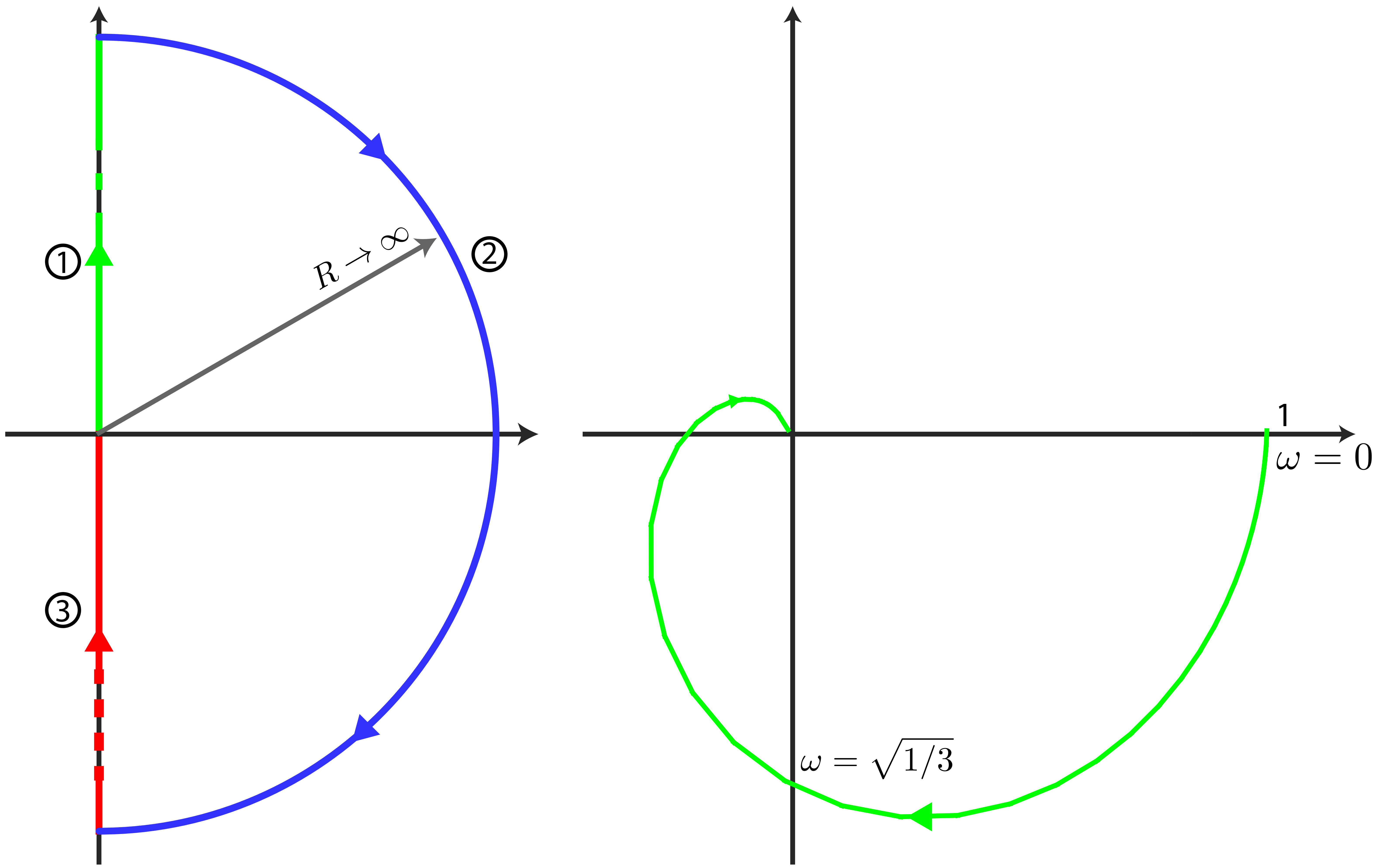

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$$G(Re^{j\theta}) \approx \frac{e^{-j3\theta}}{R^3}$$

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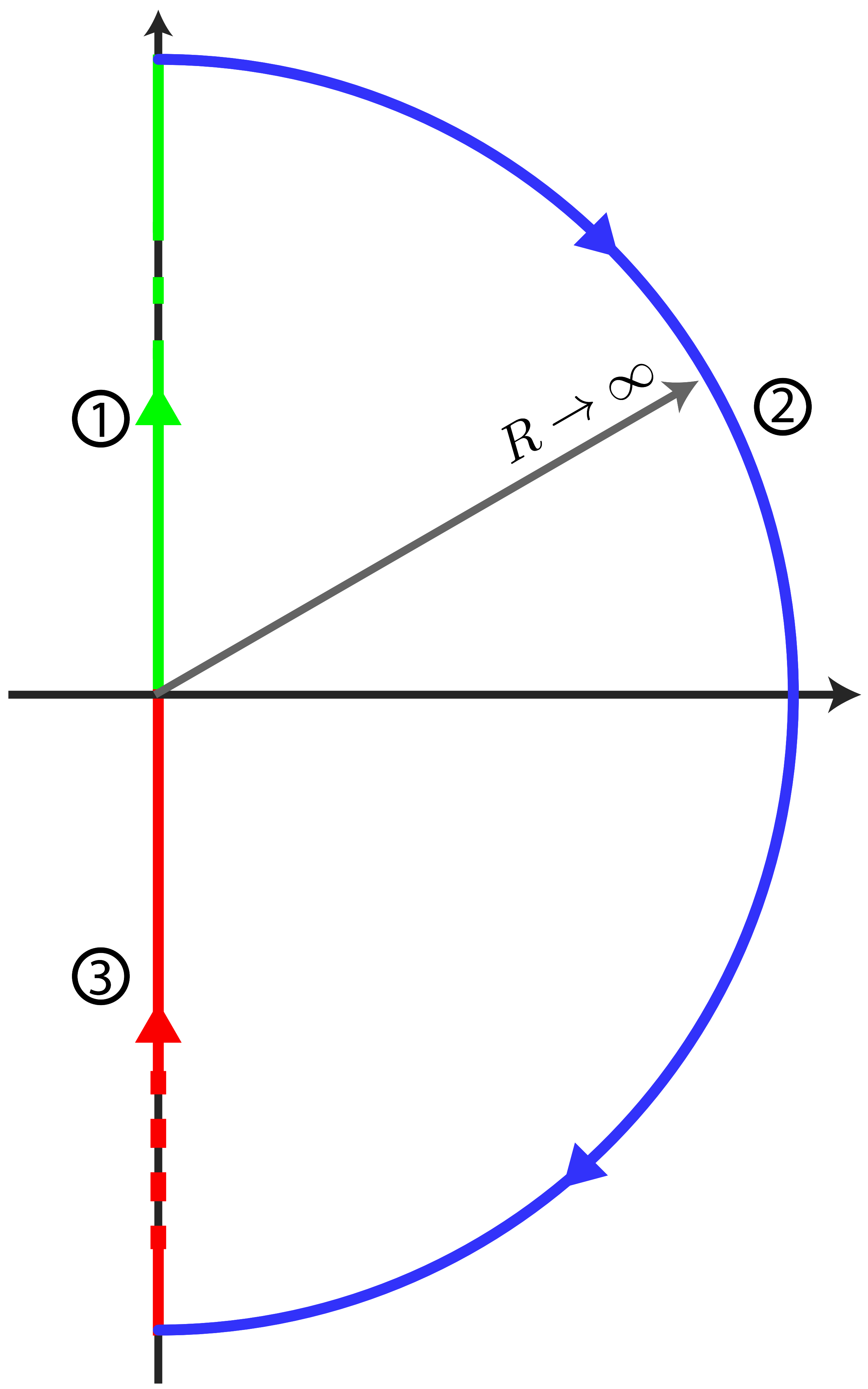

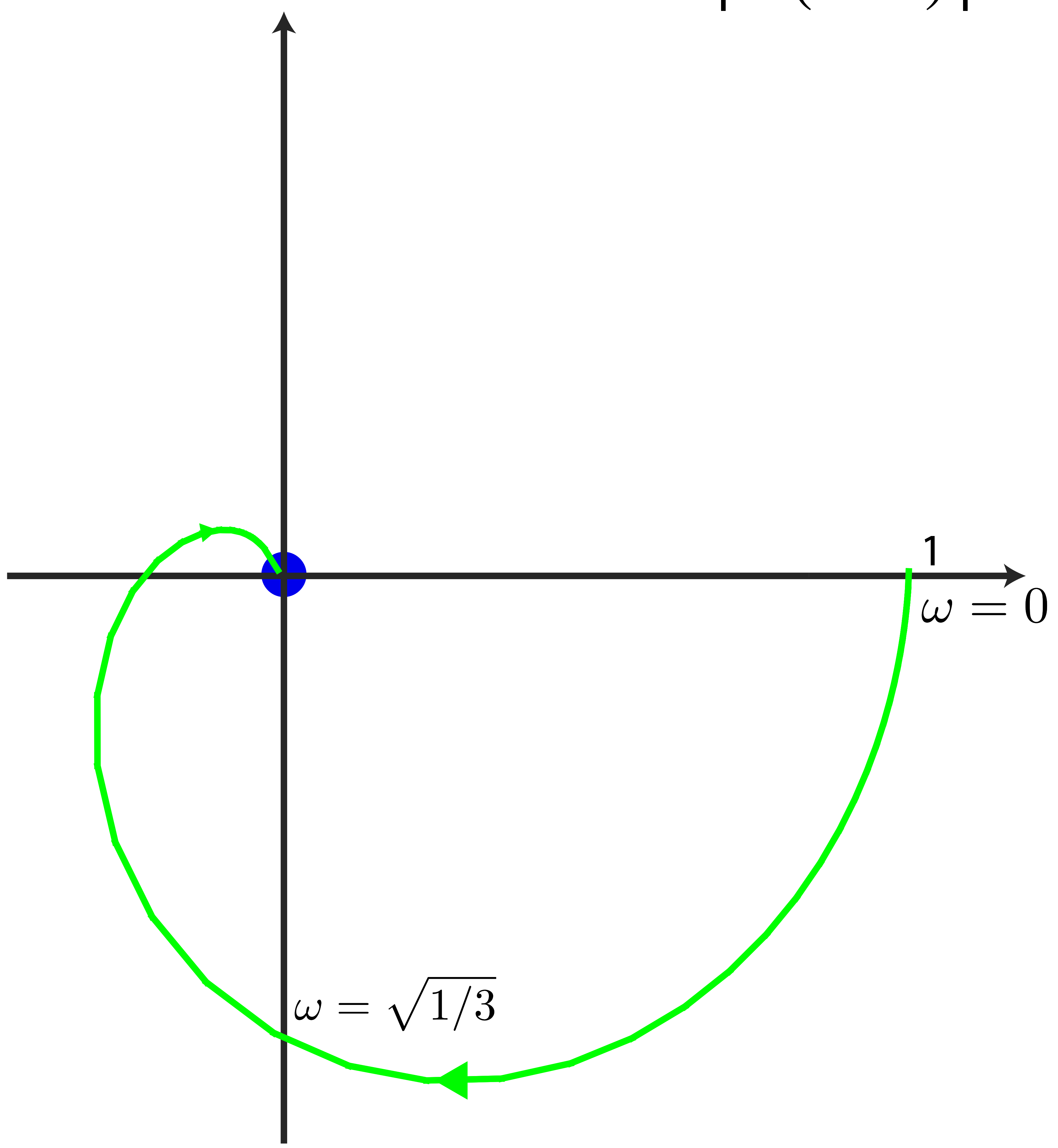

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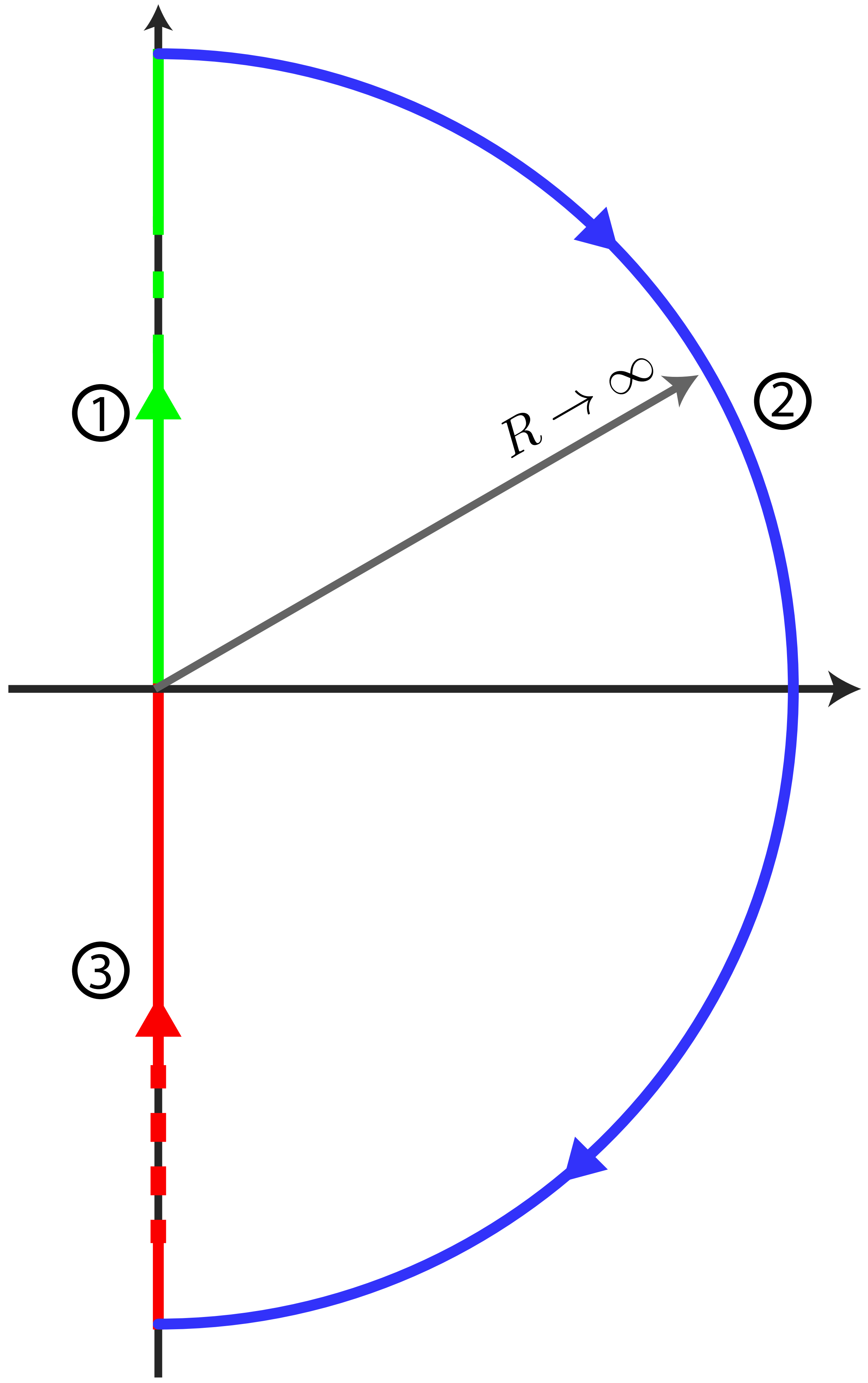

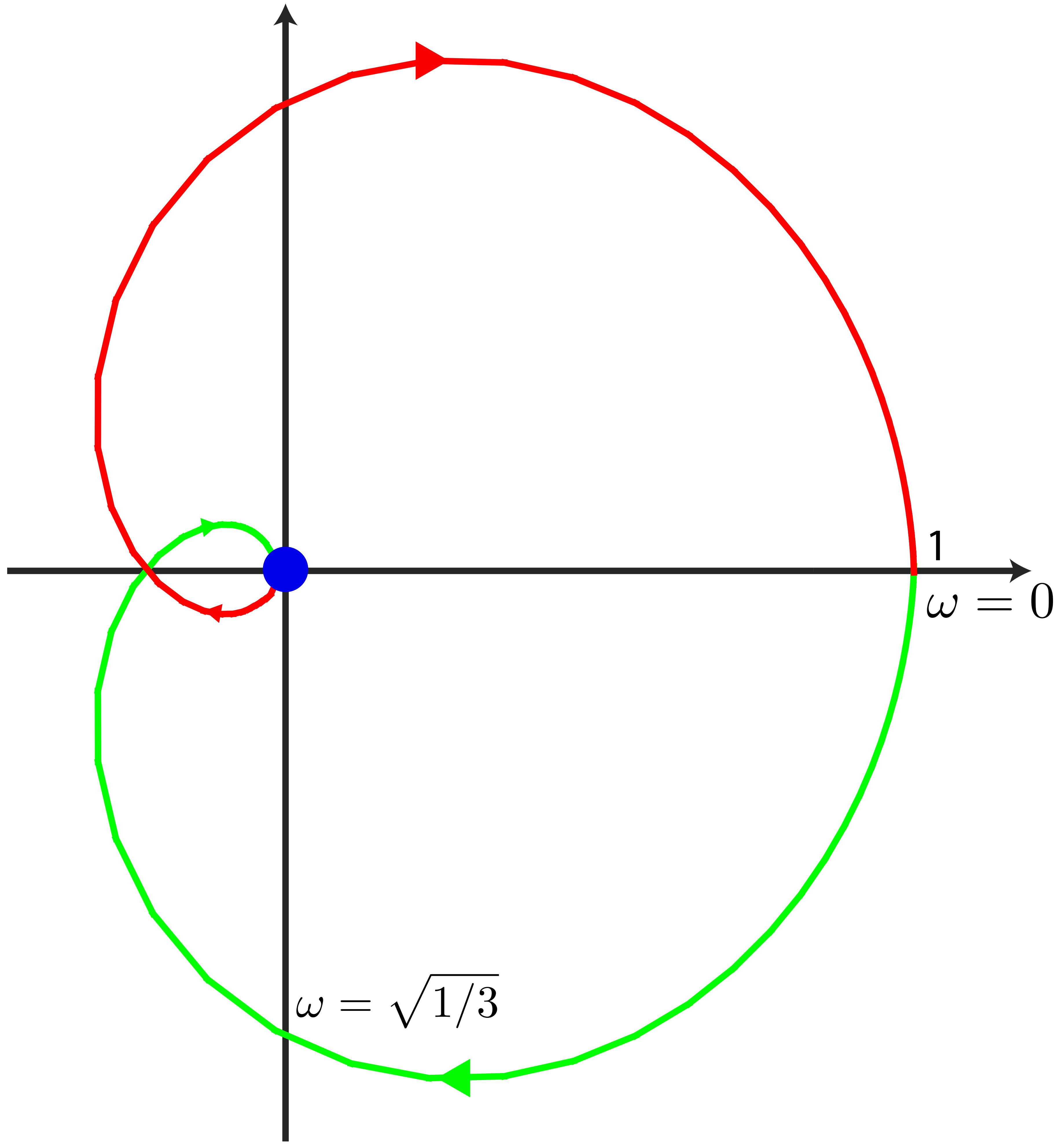

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