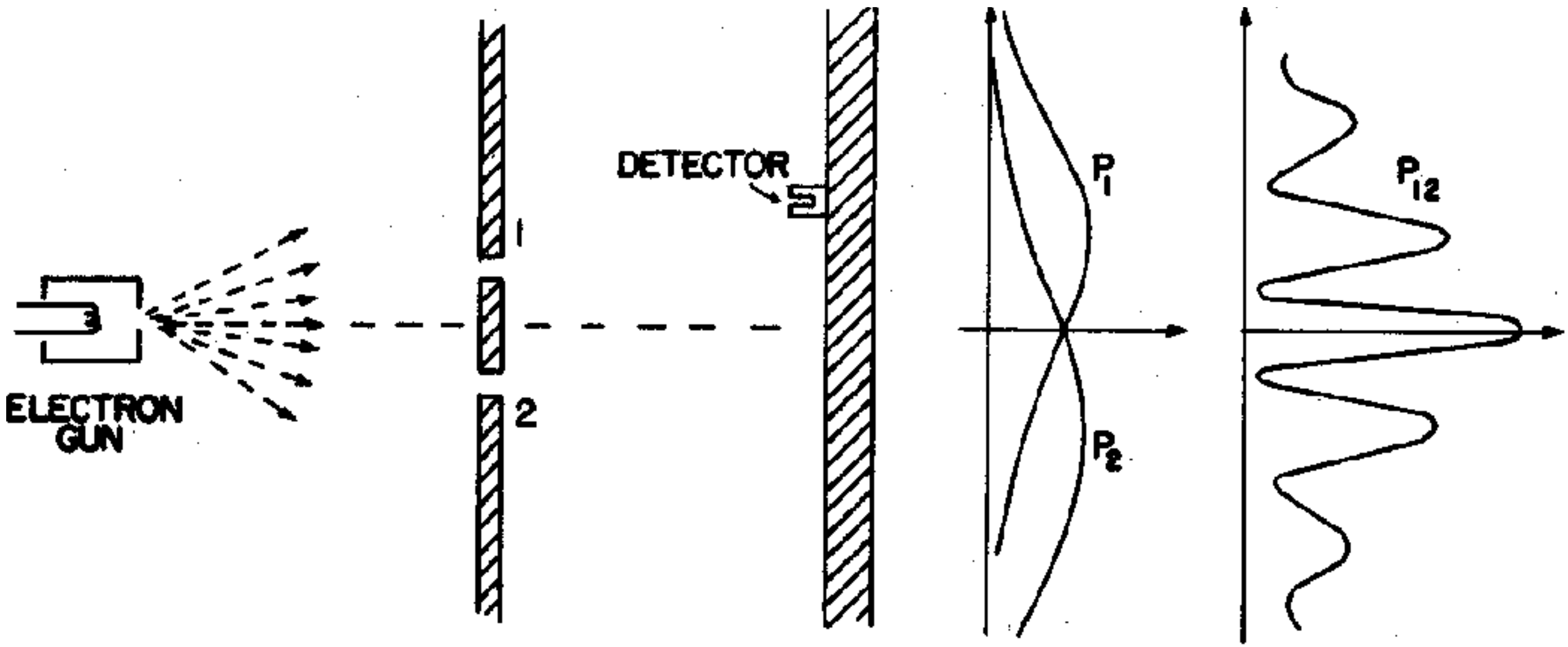
Superluminal extension of special relativity

Andrzej Dragan

UNIVERSITY OF WARSAW

NUS National University of Singapore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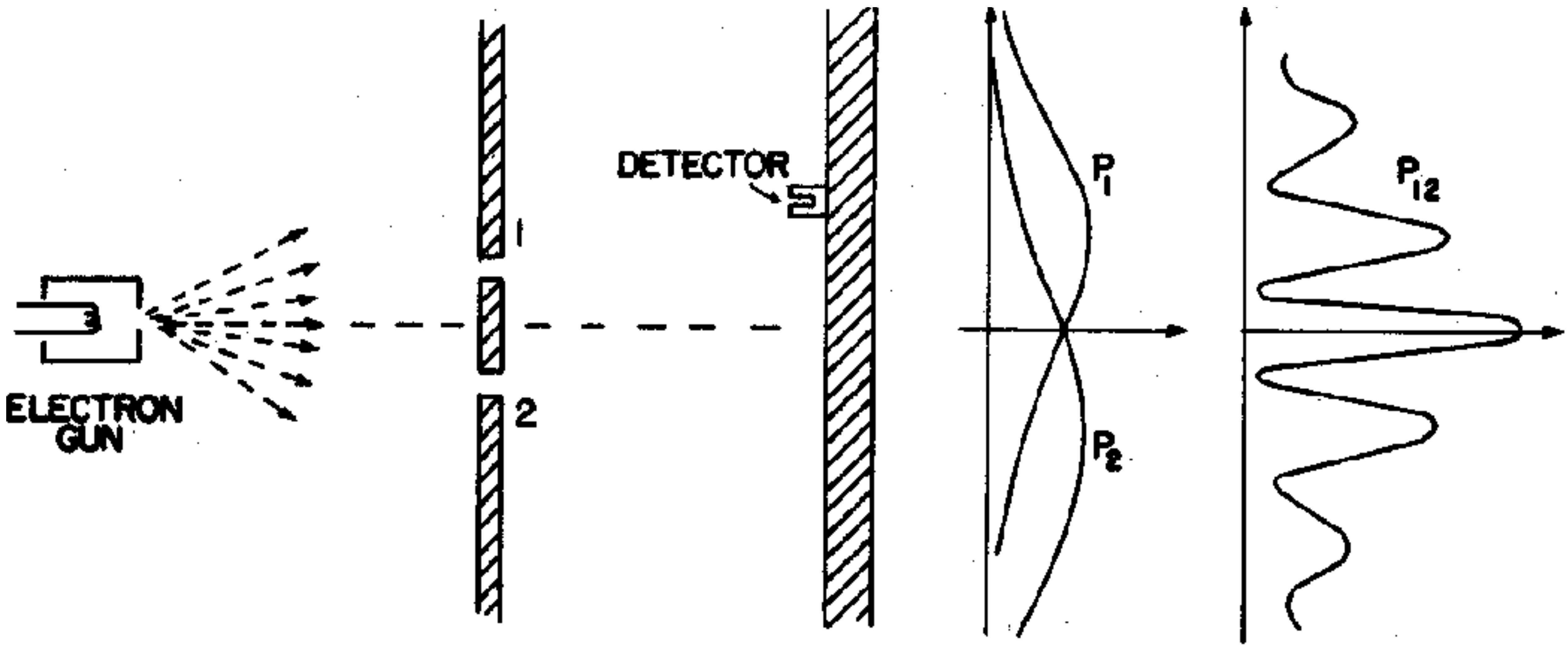

One might still like to ask: "How does it work? What is the machinery behind the law?" No one has found any machinery behind the law. No one can "explain" any more than we have just "explained." No one will give you any deeper representation of the situation. We have no ideas about a more basic mechanism from which these results can be deduced.

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Quantum principle of relativity

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New Journal of Physics, Volume 22, March 2020

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Classical and Quantum Gravity

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Relativity of superluminal observers in 1 + 3 spacetime

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Pole among candidates for Nobel Prize in physics

SCIENCE

(PAP) JCH OCTOBER 06, 2019

Artur Ekert is being considered by the Nobel committee as a result of his work on information technologies, including quantum cryptography.
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- In such an extension, the fundamental ***indeterminism*** (unpredictability) of particle decays becomes necessary.

- Particles can move not only along single trajectories. Motion along multiple trajectories ***at once*** becomes inevitable.

- The only possible probabilistic and relativistic description of such a non-classical motion involves ***complex „probability amplitudes"***.

Does Lorentz transformation break down for $V > c$?

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$$\begin{cases} x' = \dfrac{x - Vt}{\sqrt{1 - V^2/c^2}}, \\ t' = \dfrac{t - Vx/c^2}{\sqrt{1 - V^2/c^2}}. \end{cases}$$

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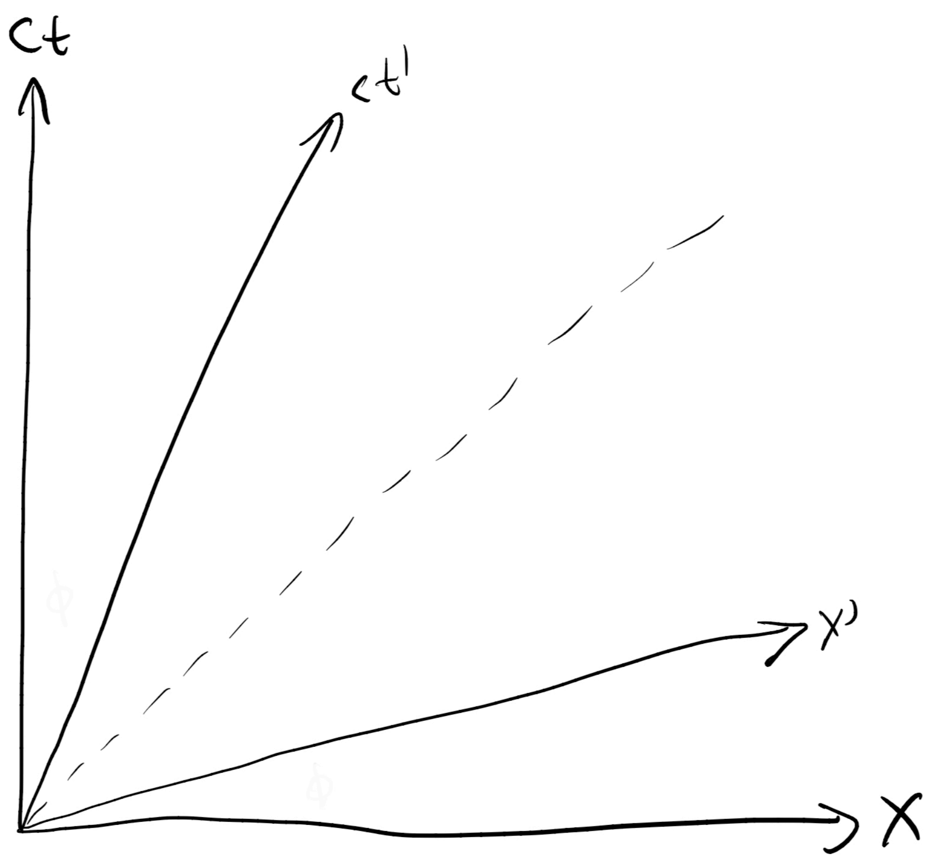

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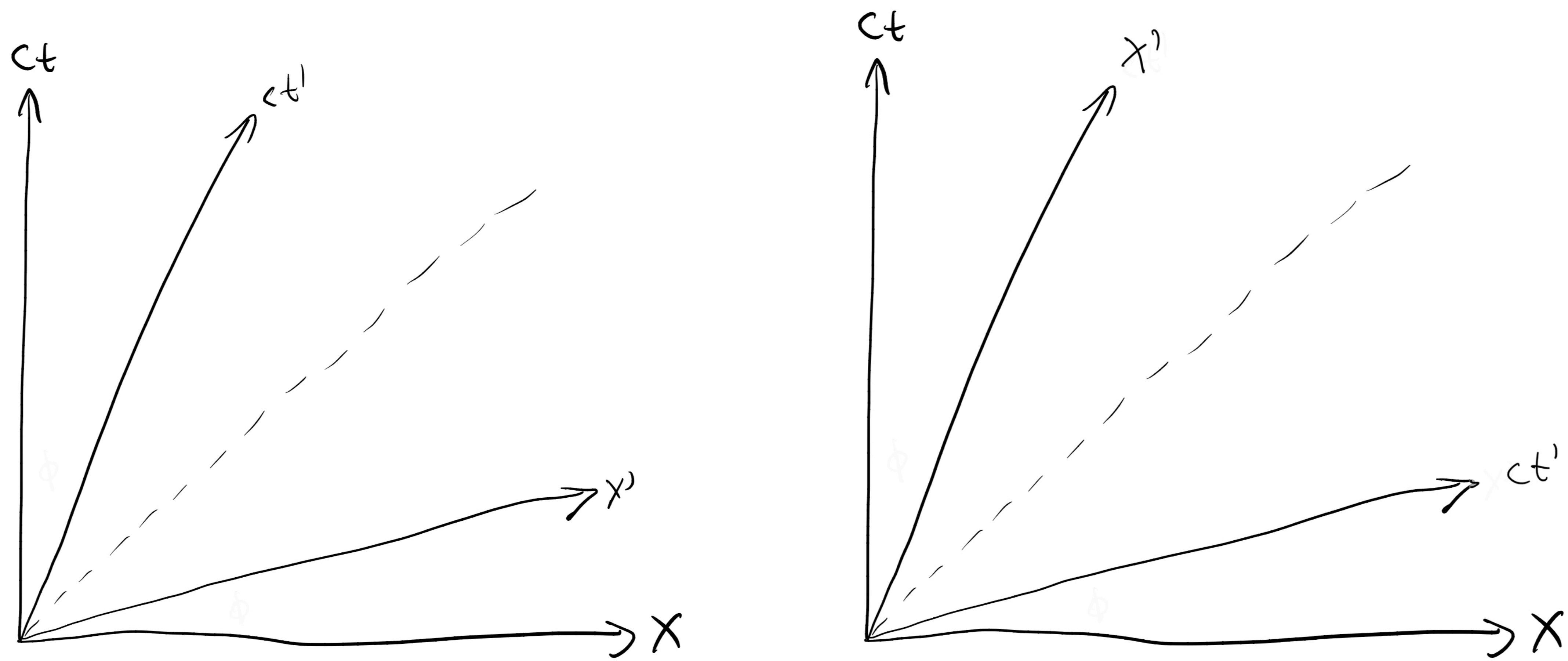

Does it take an infinite energy to exceed the speed of light?

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$$E \equiv \frac{\sigma m c^2}{\sqrt{\frac{v^2}{c^2} - 1}}$$

$$\boldsymbol{p} \equiv \frac{\sigma m \boldsymbol{v}}{\sqrt{\frac{v^2}{c^2} - 1}}$$

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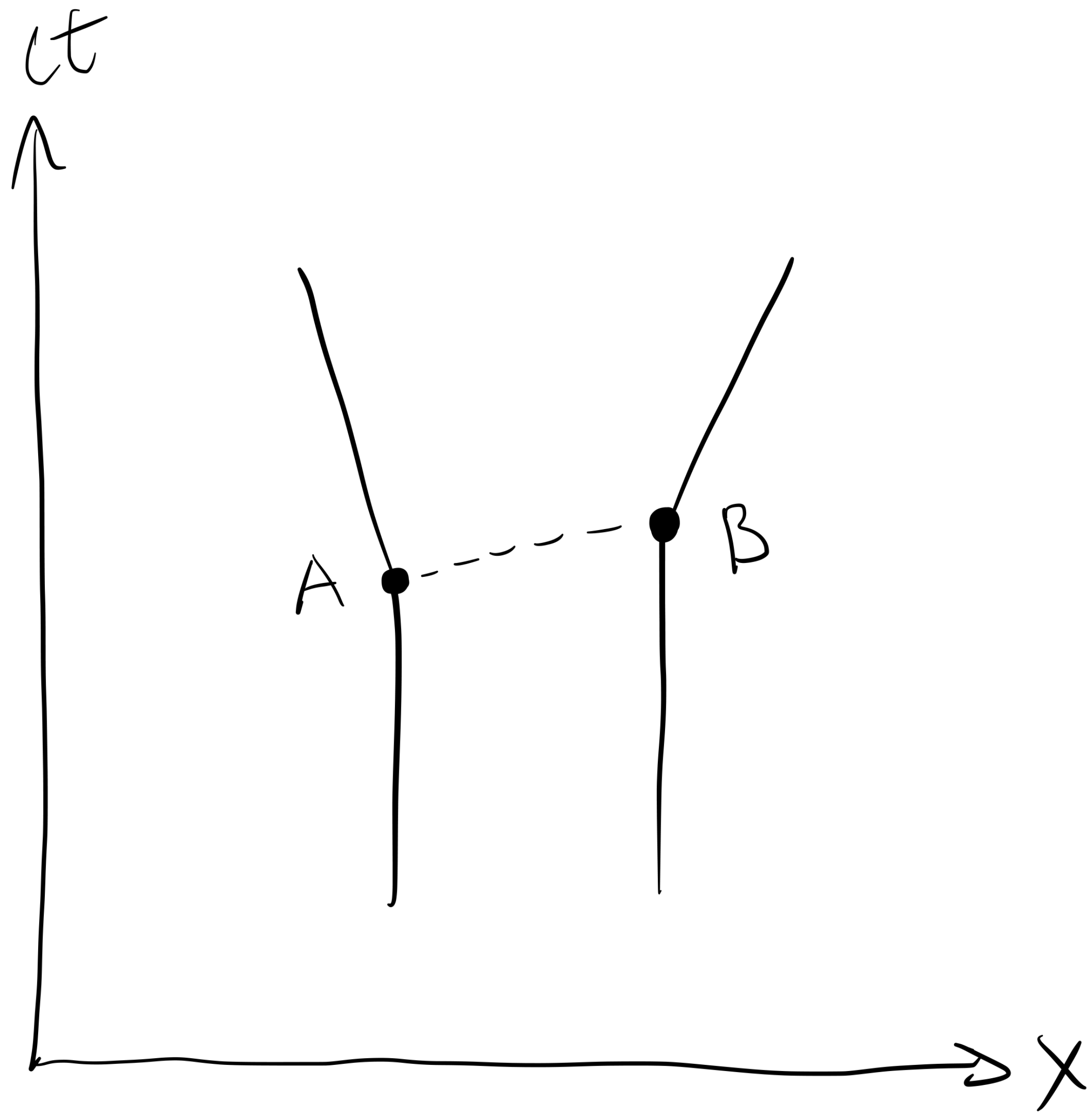
$$\sigma' = \sigma \operatorname{sgn}\left(1 - \frac{\boldsymbol{v} \cdot \boldsymbol{V}}{c^2}\right)$$

Does the superluminal propagation ruin causality?



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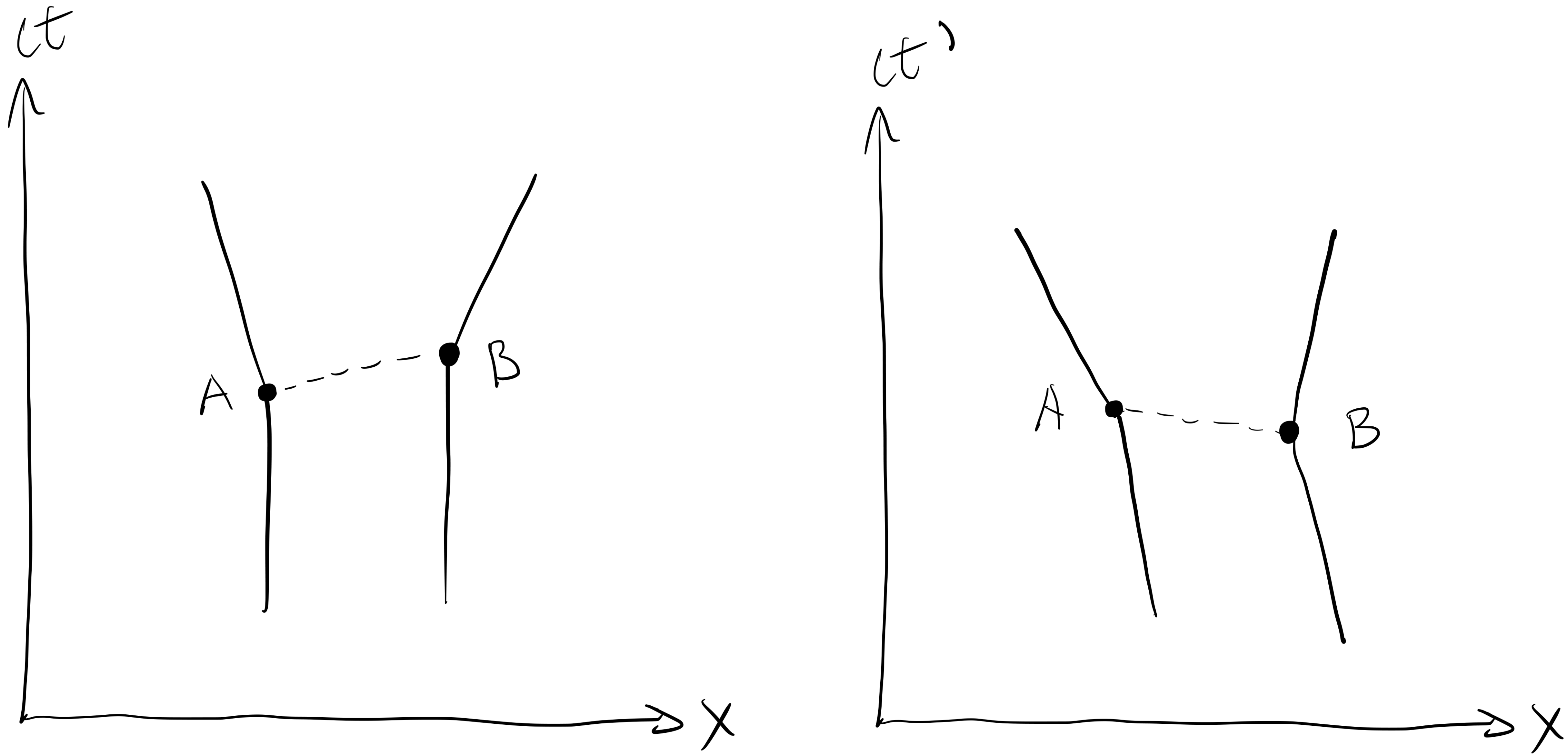

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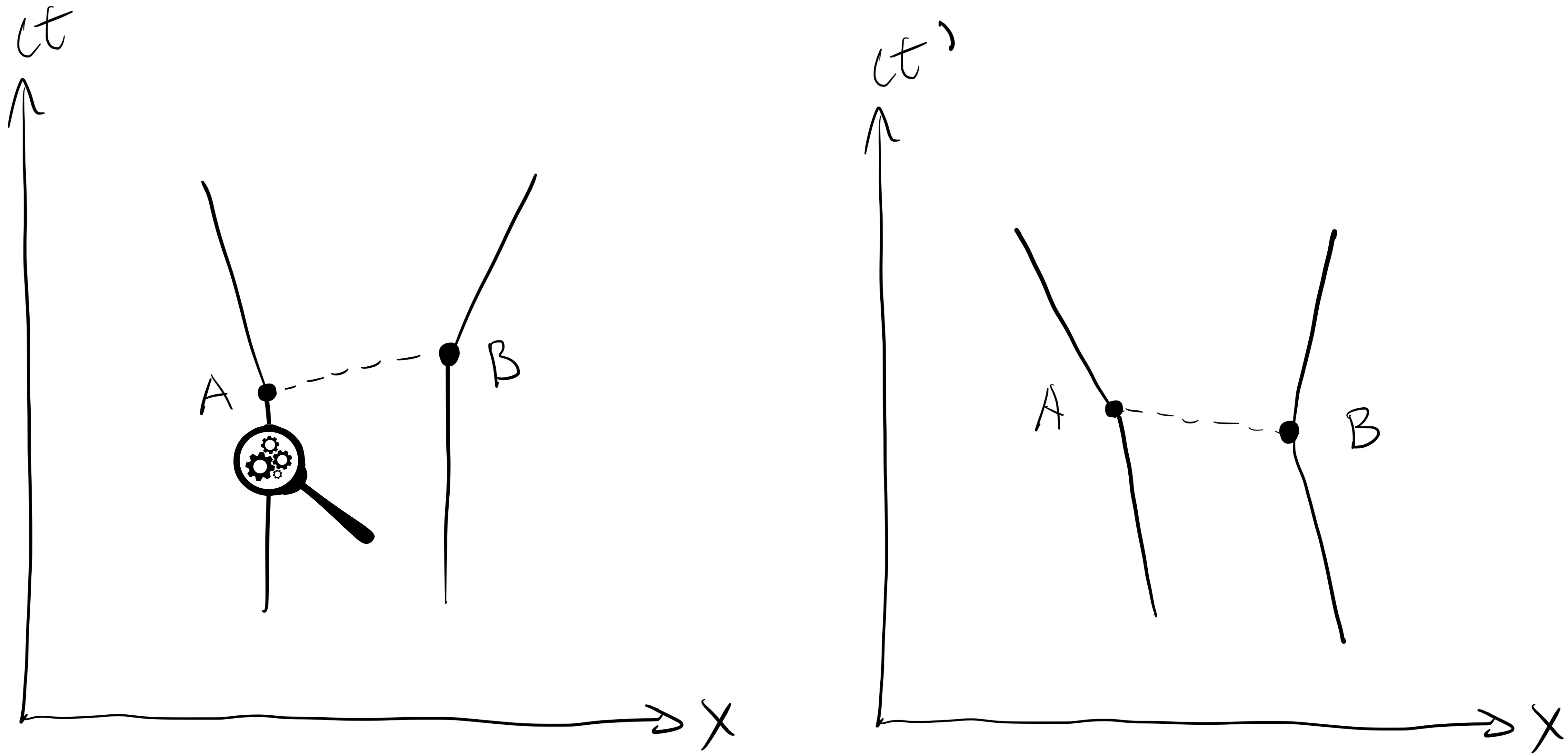

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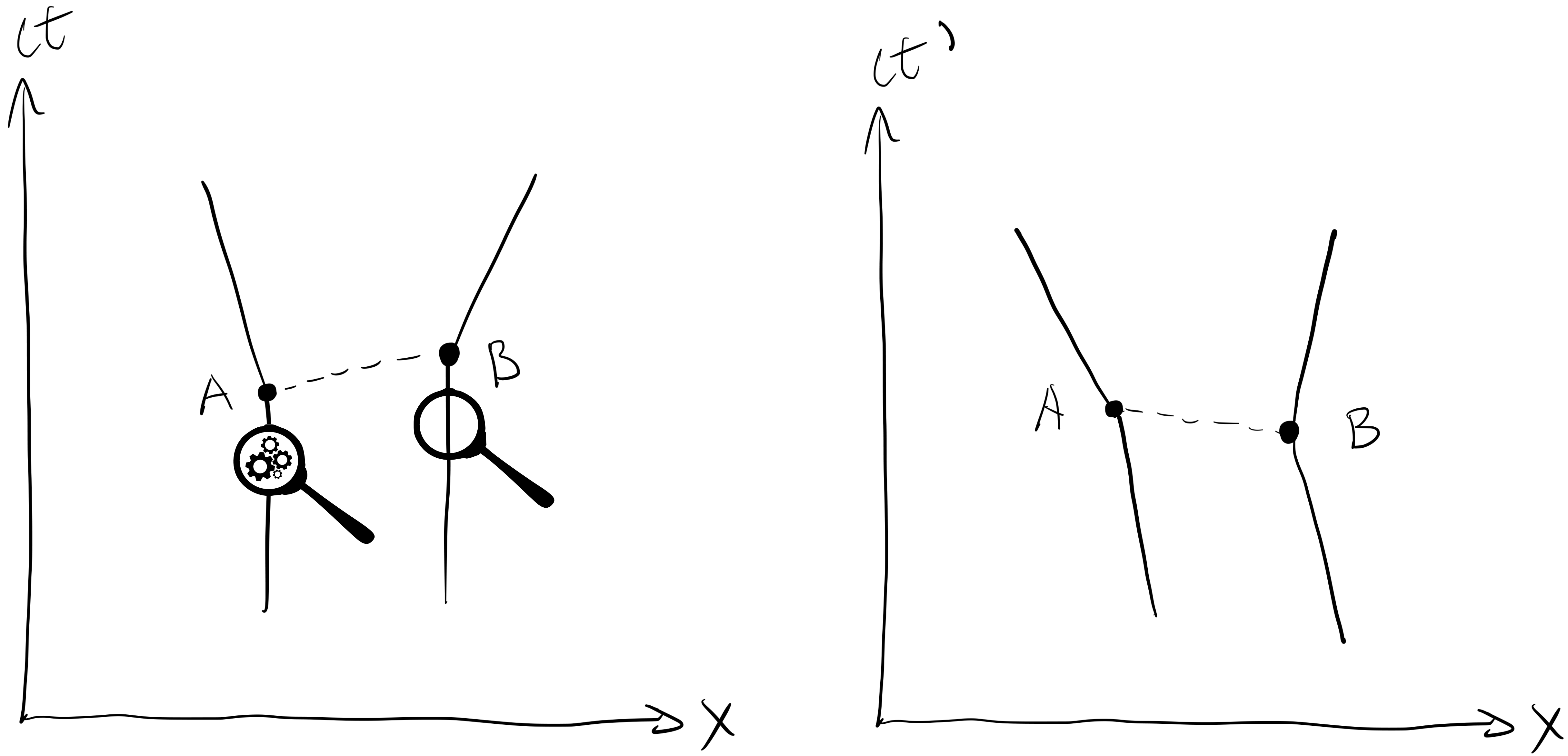

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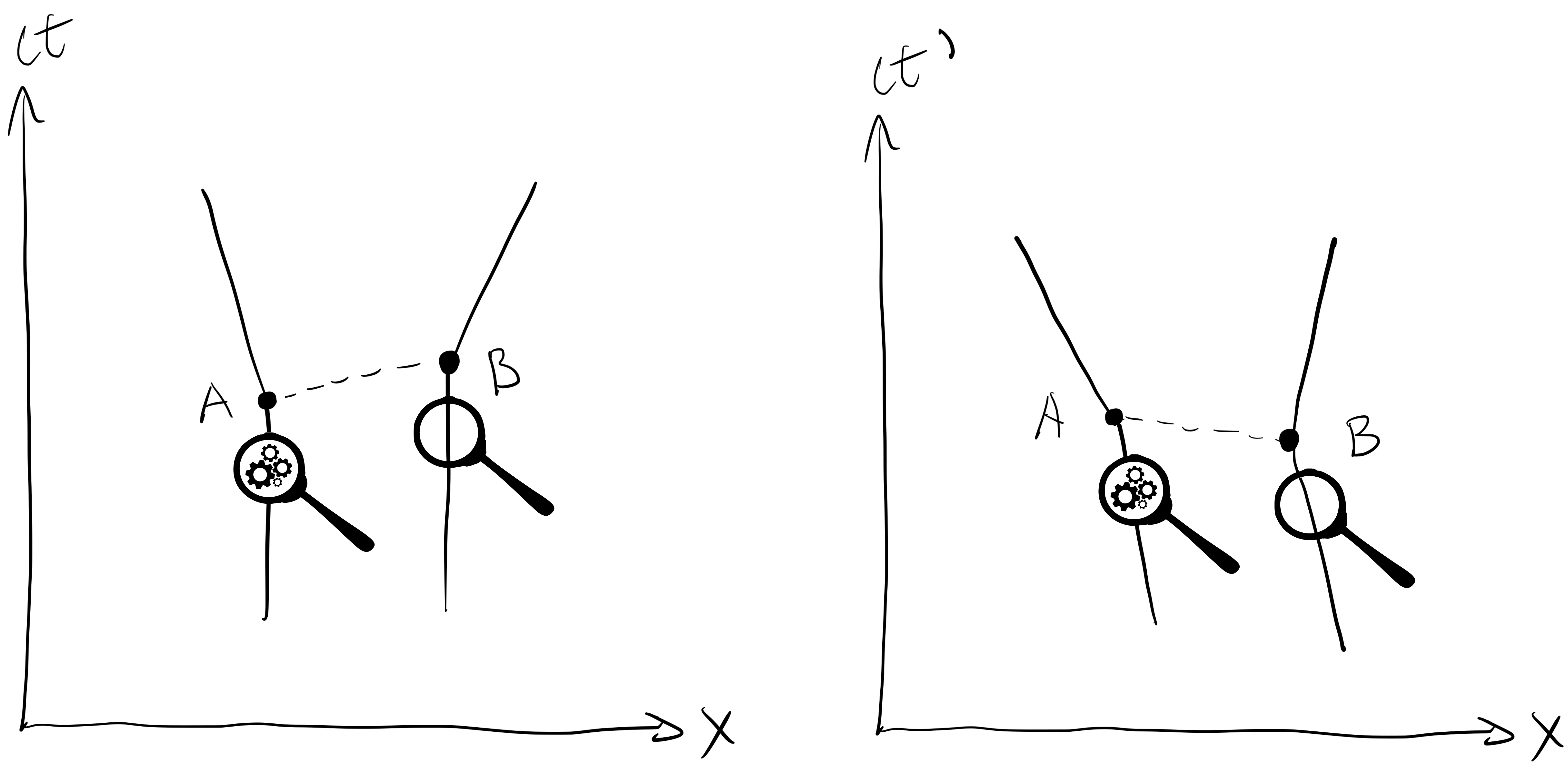

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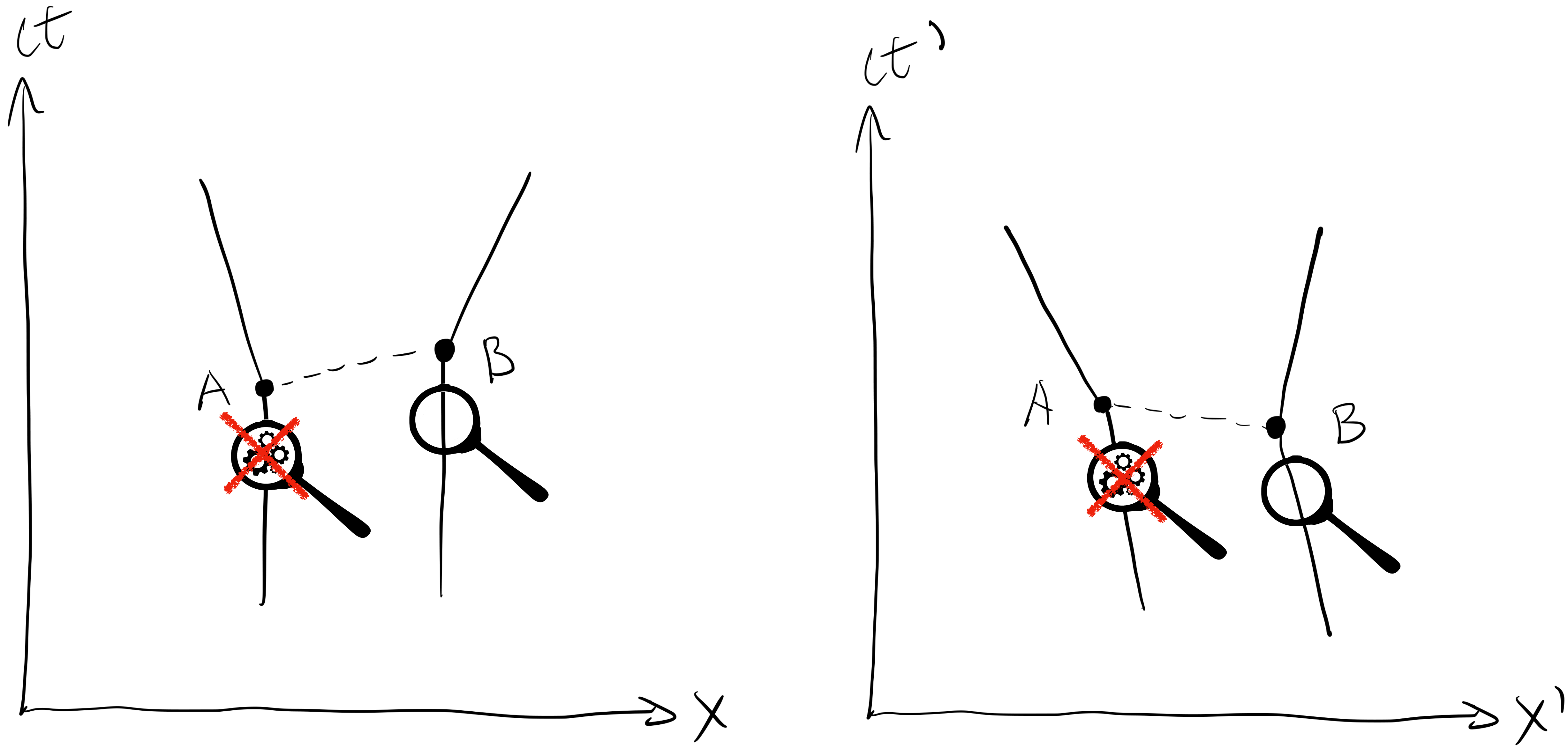

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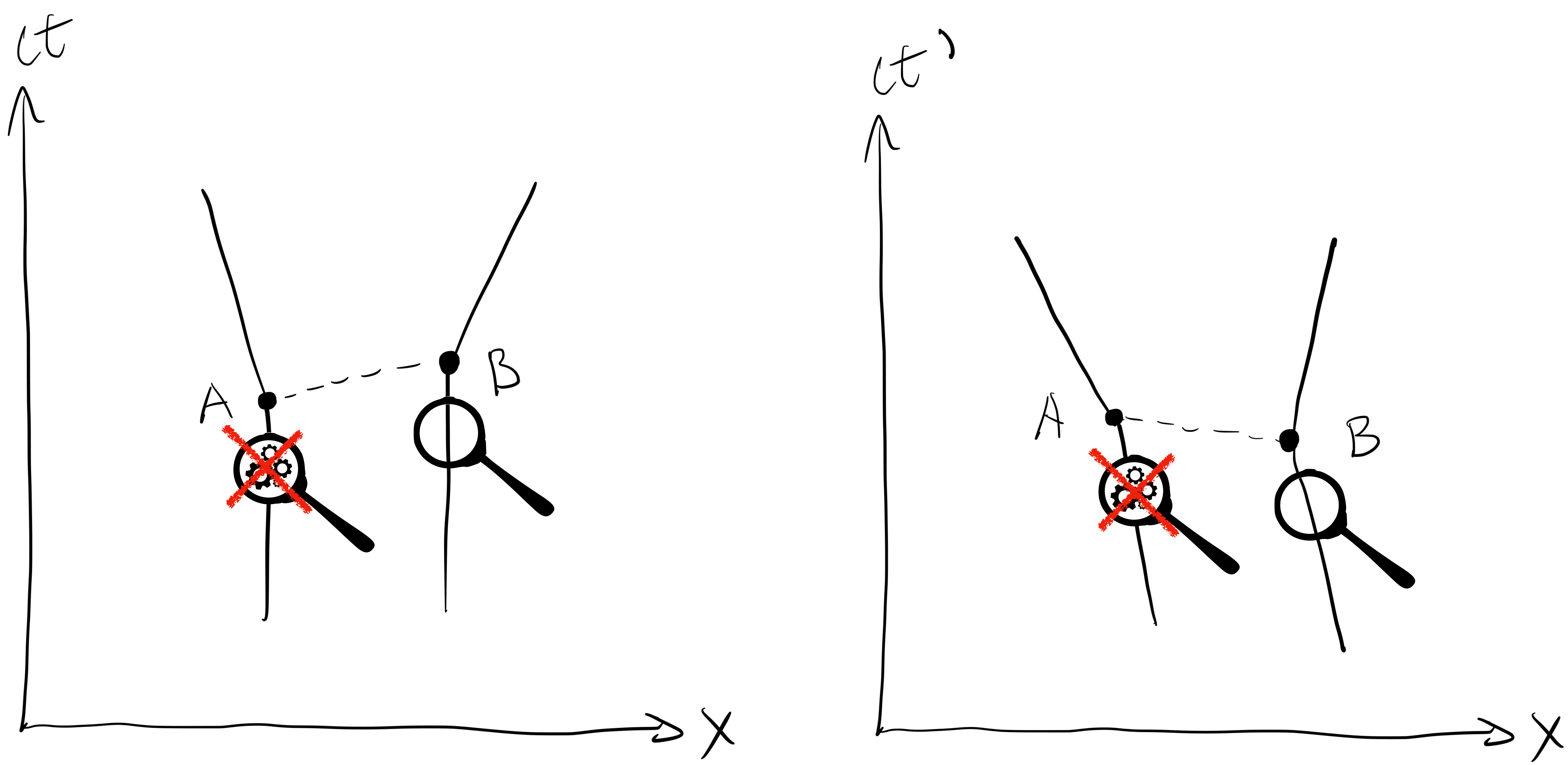
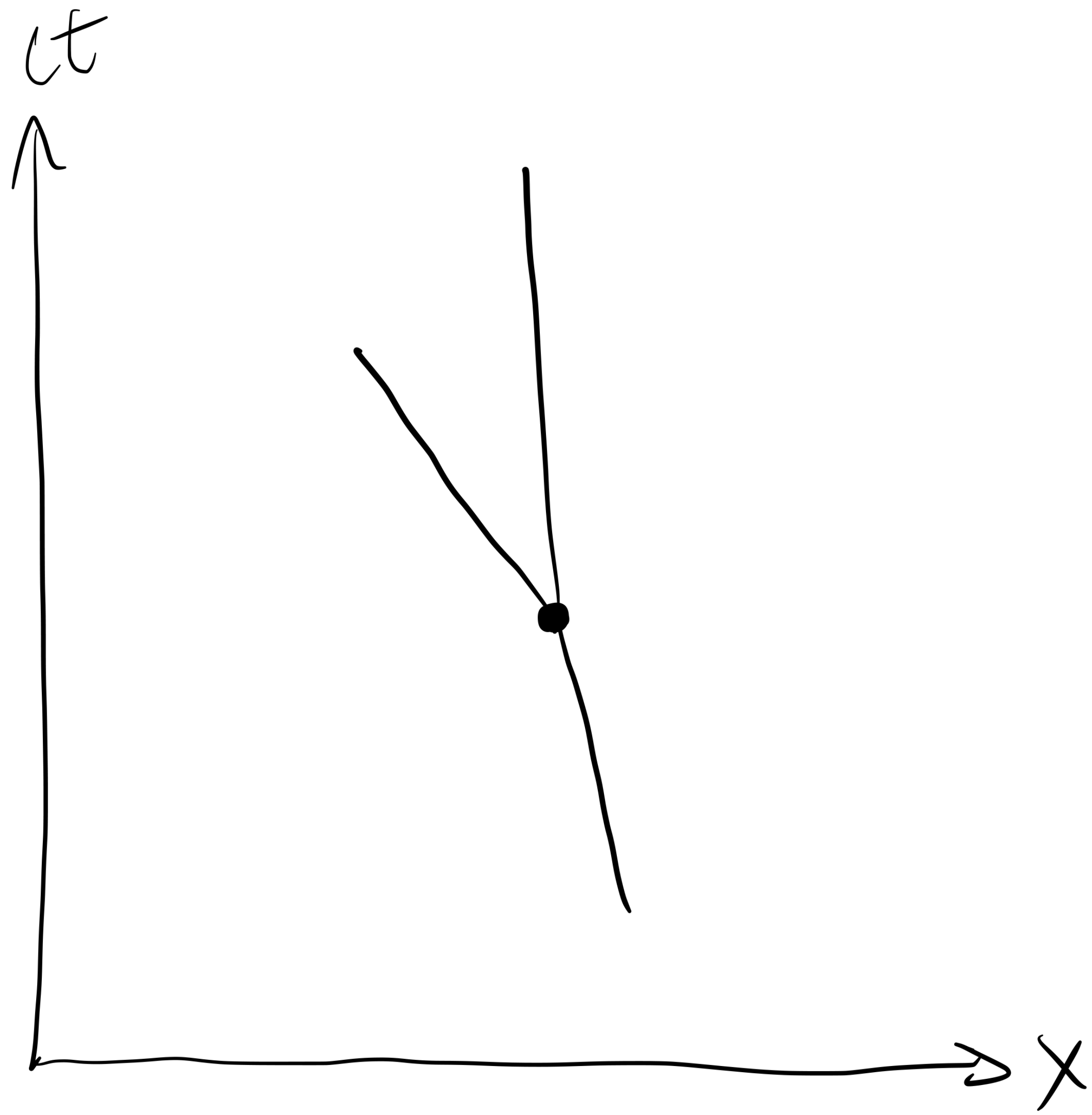


No local, deterministic and relativistic theory possible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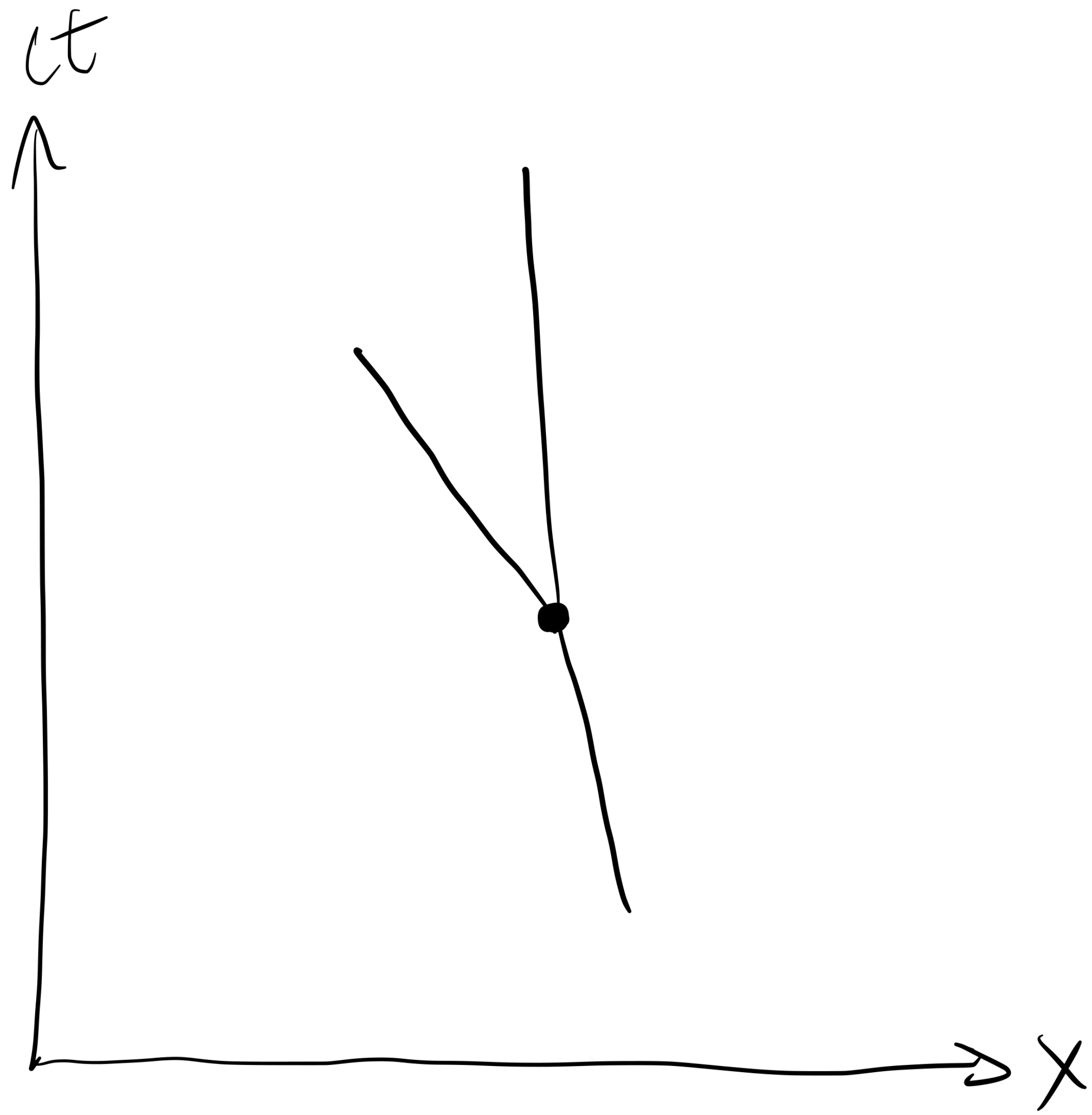
x



$$x' = ct,$$

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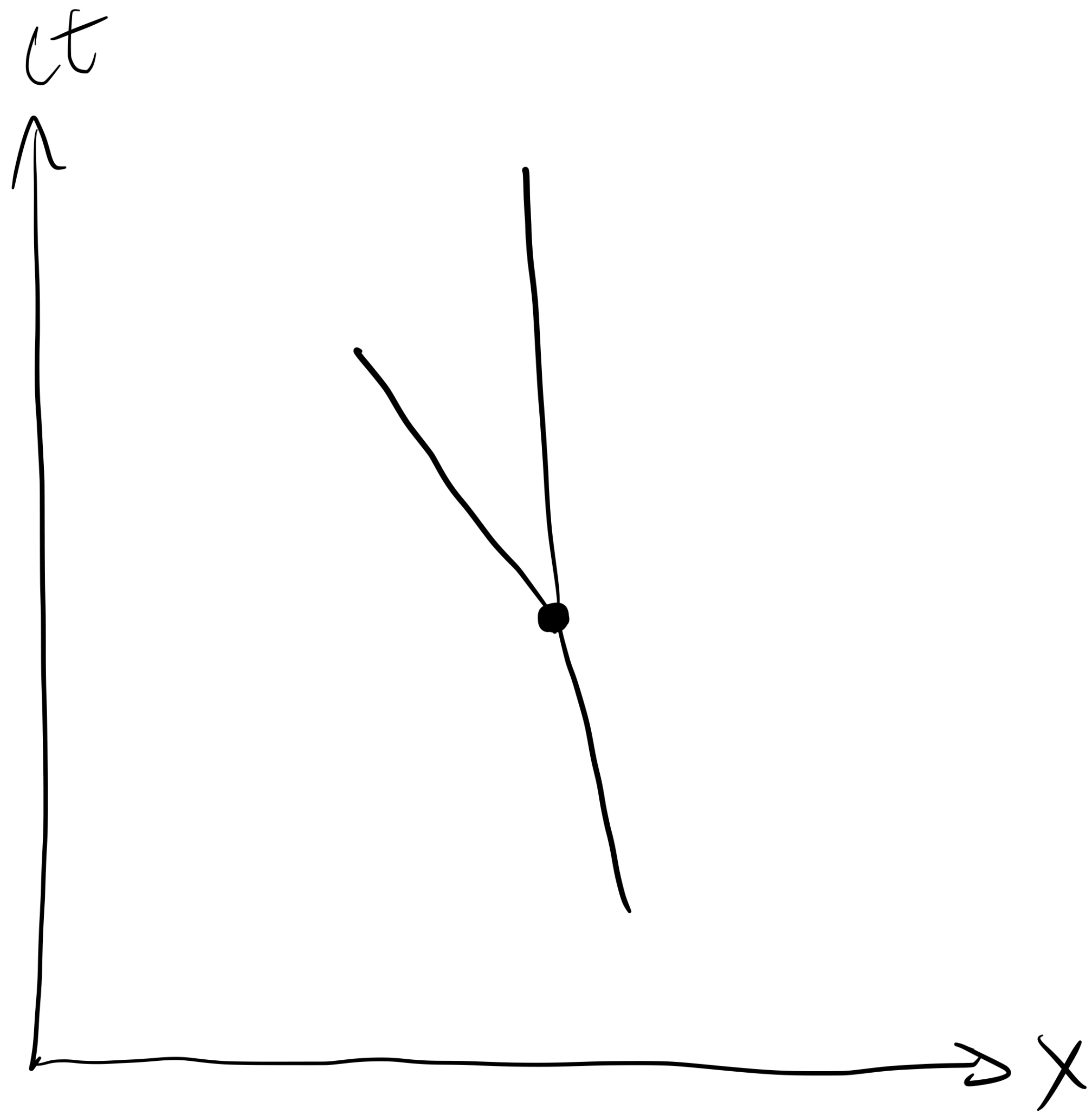
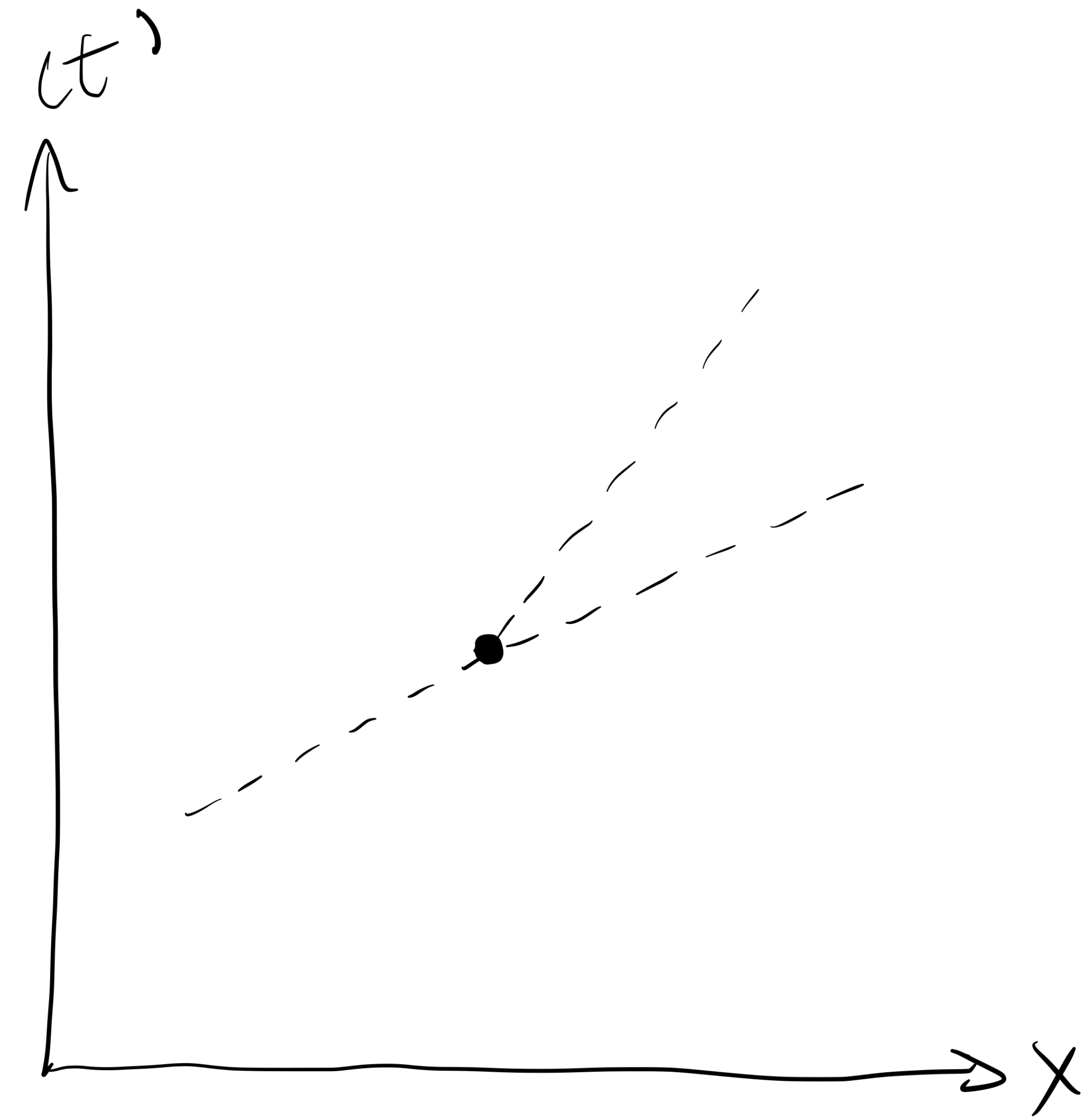
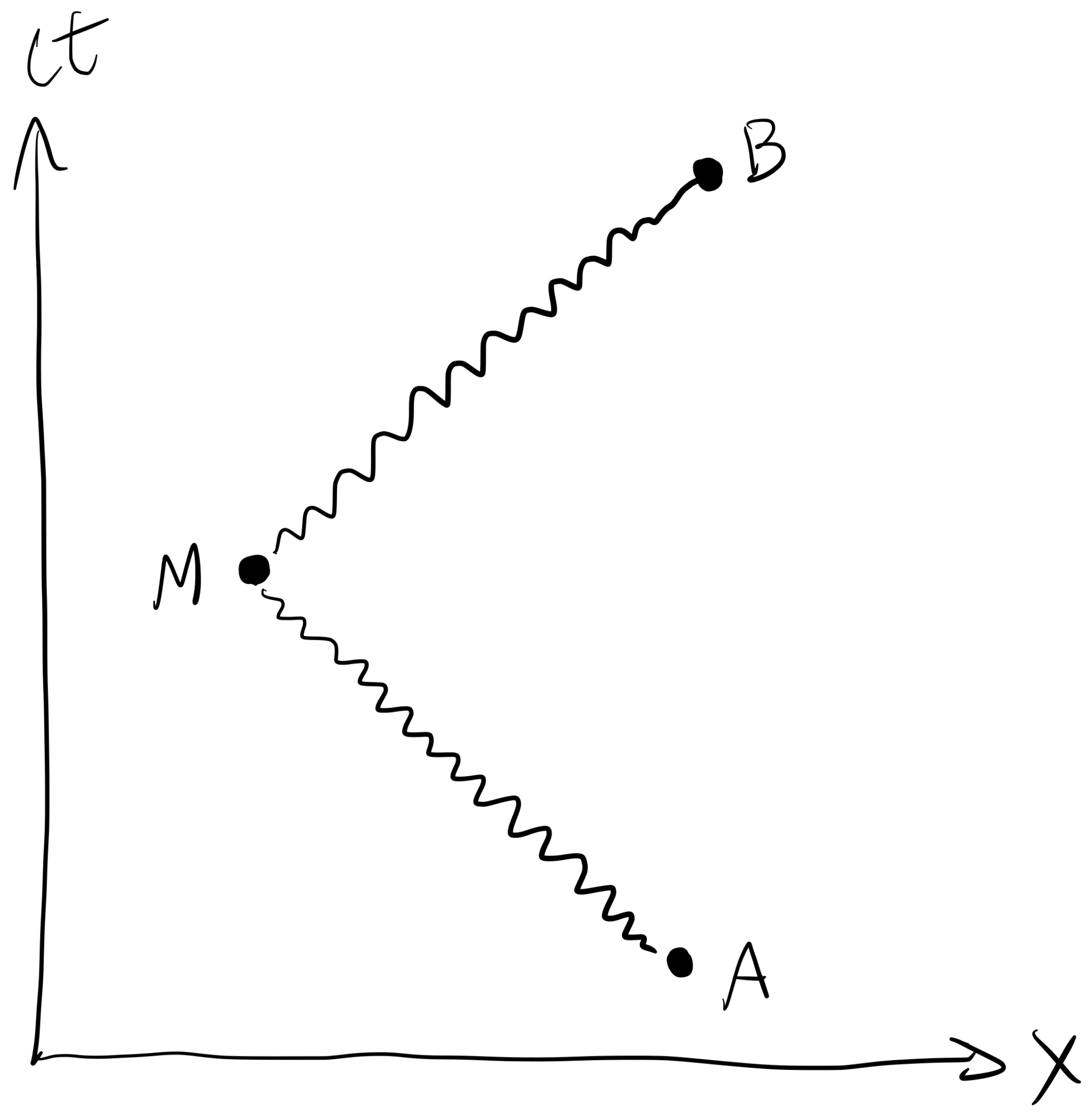

ct
x


ct'
x'



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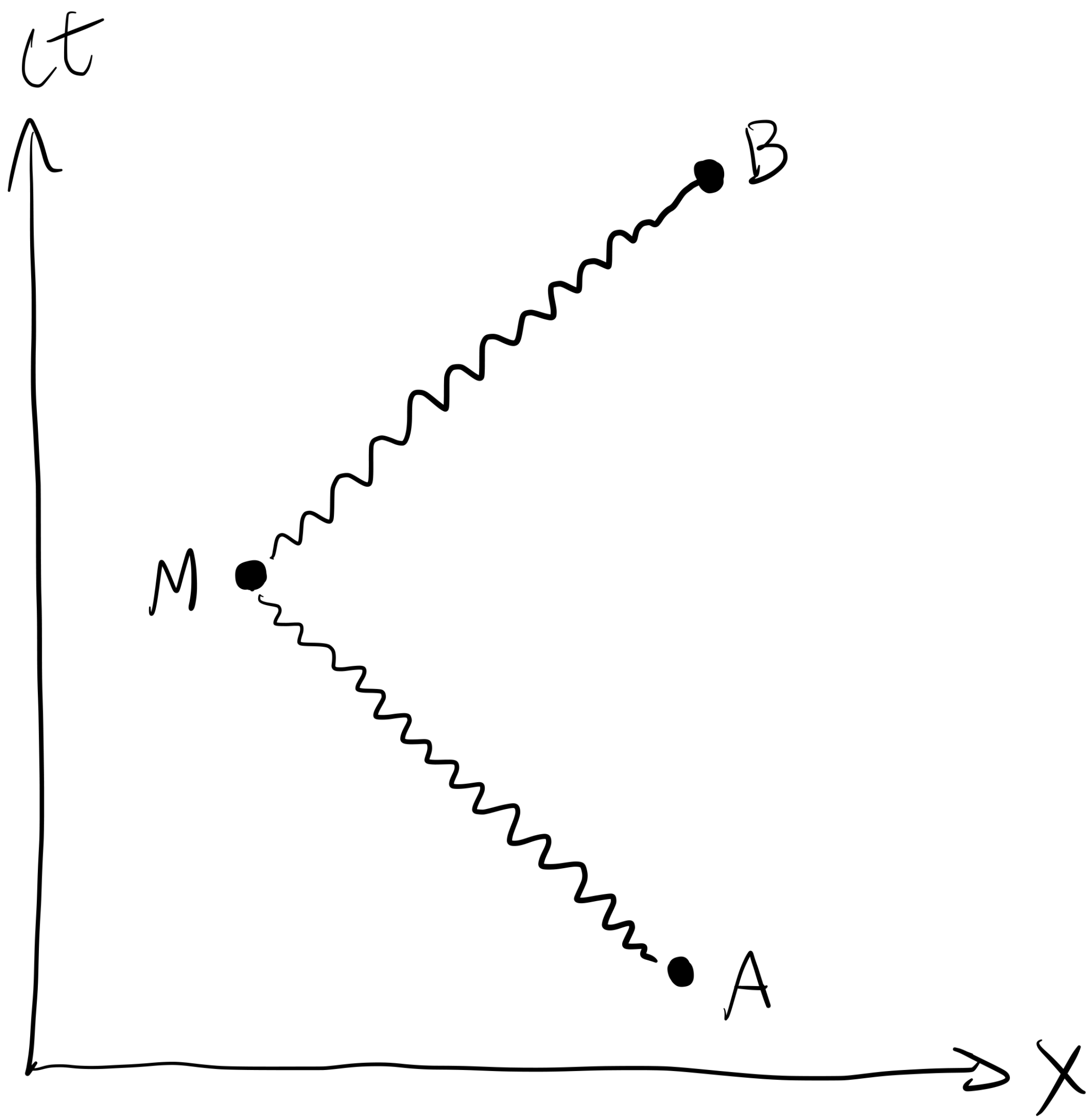

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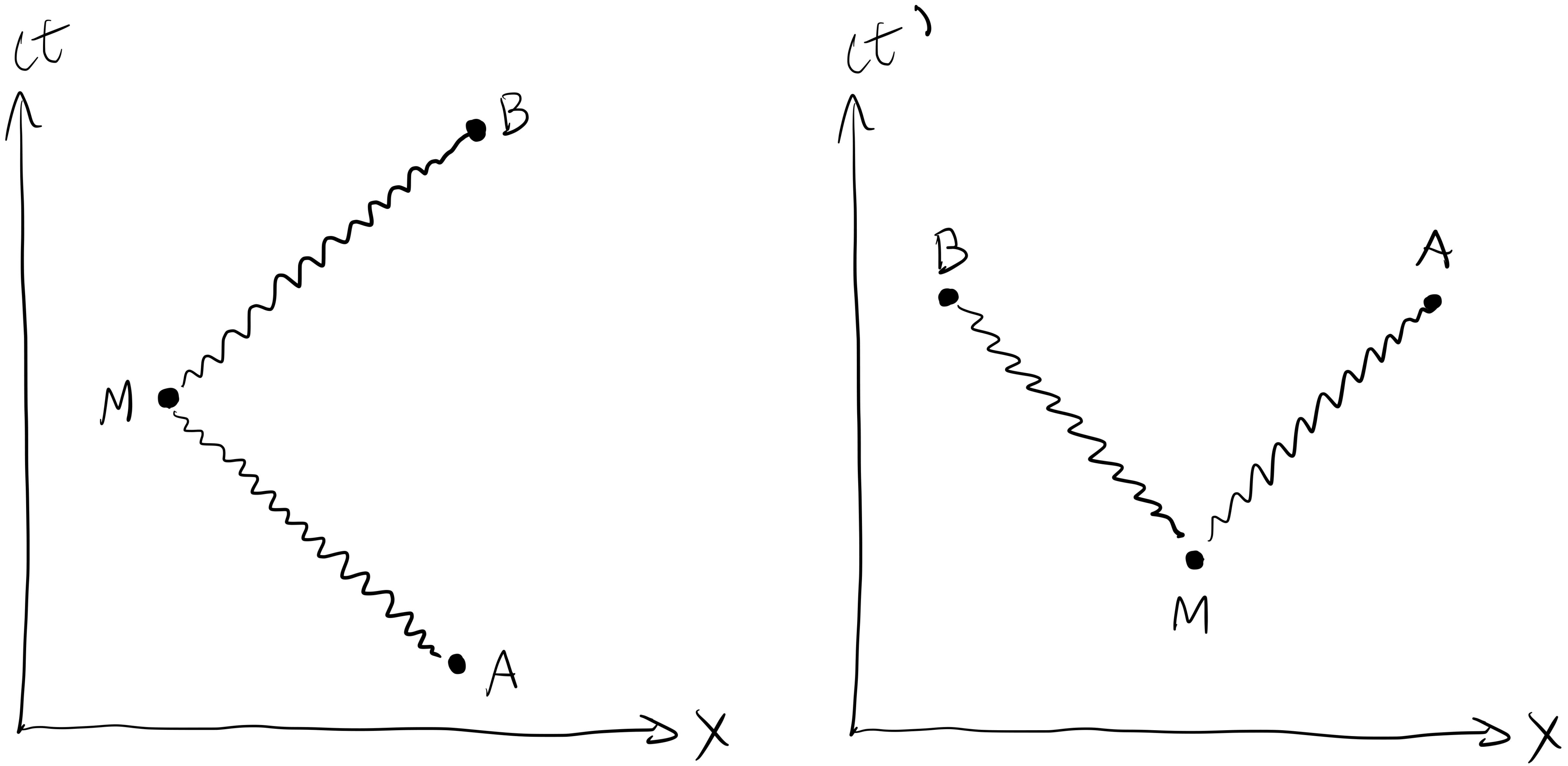

ct
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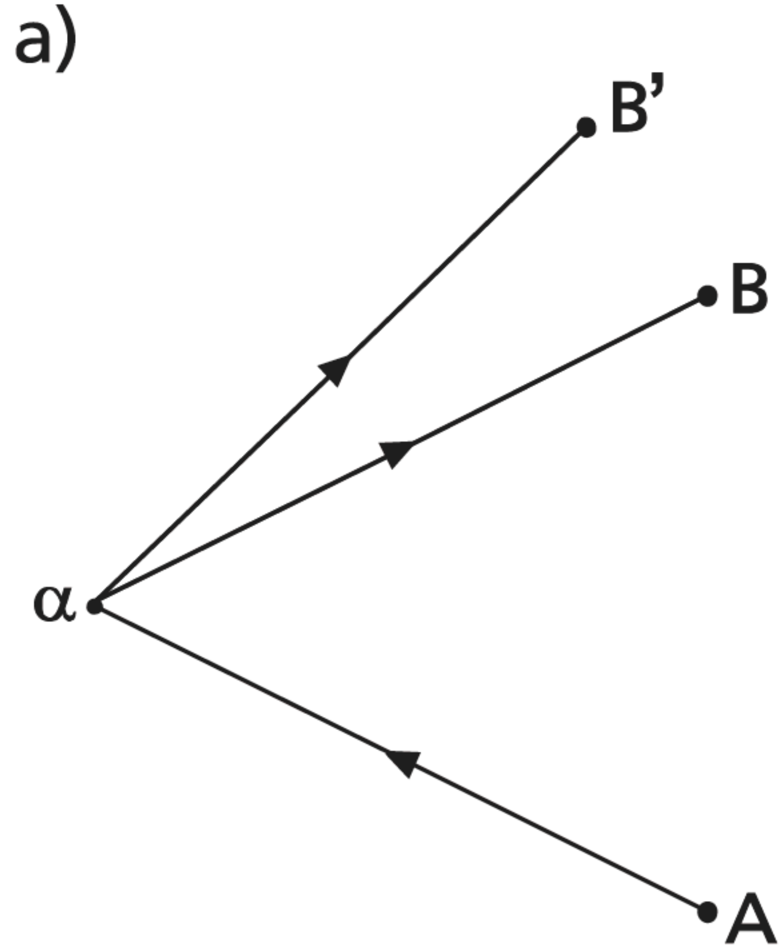
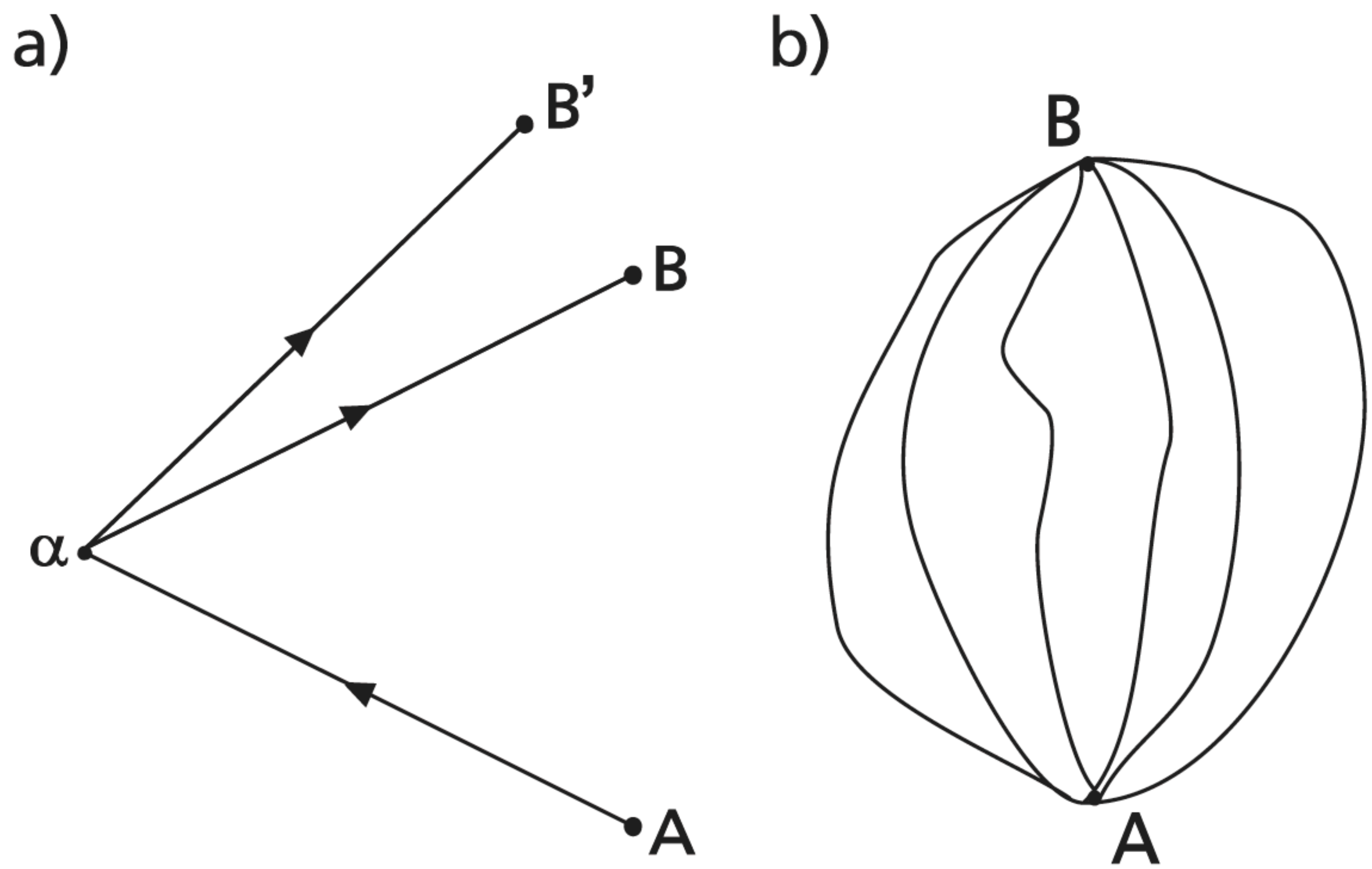
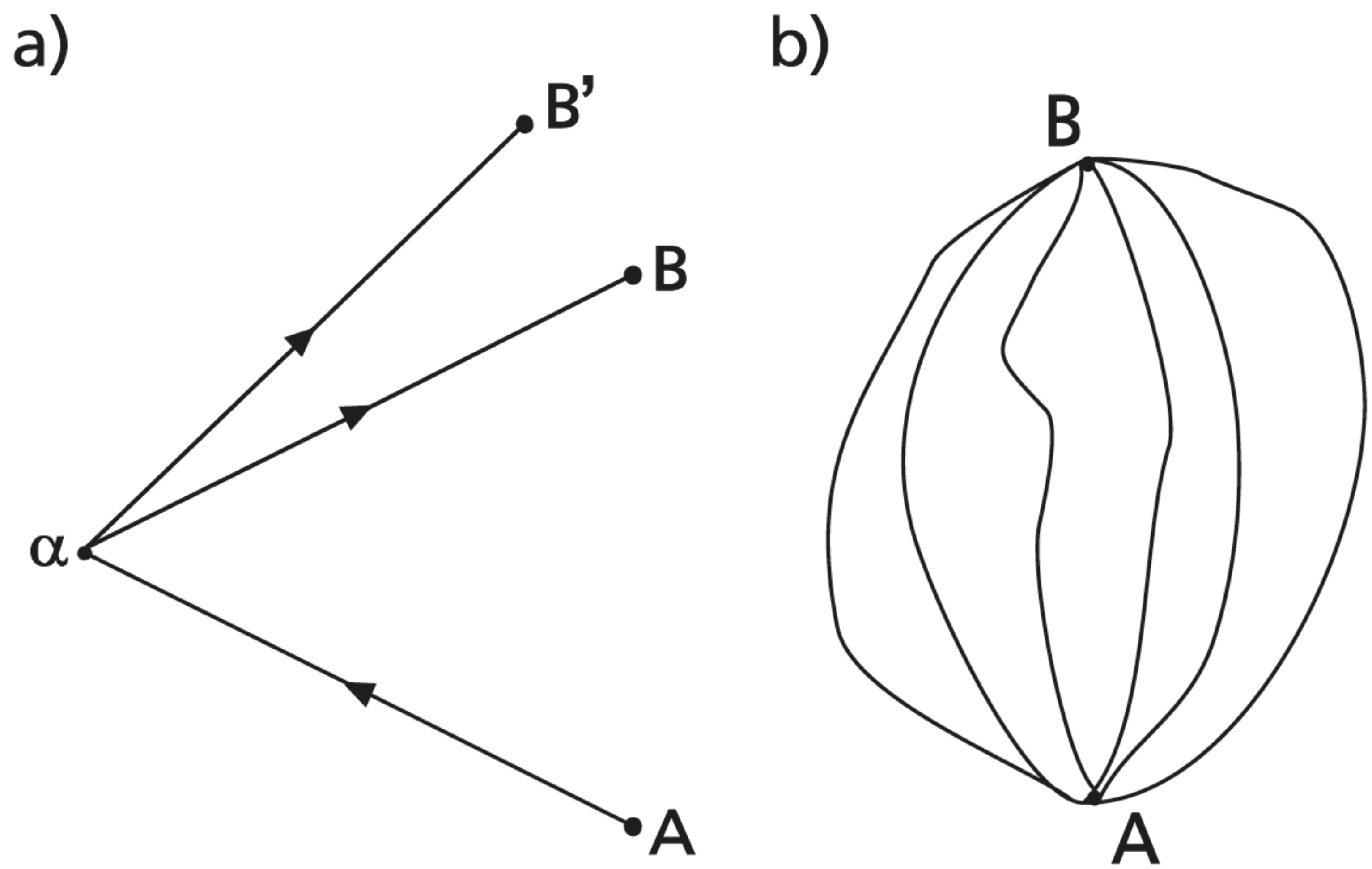
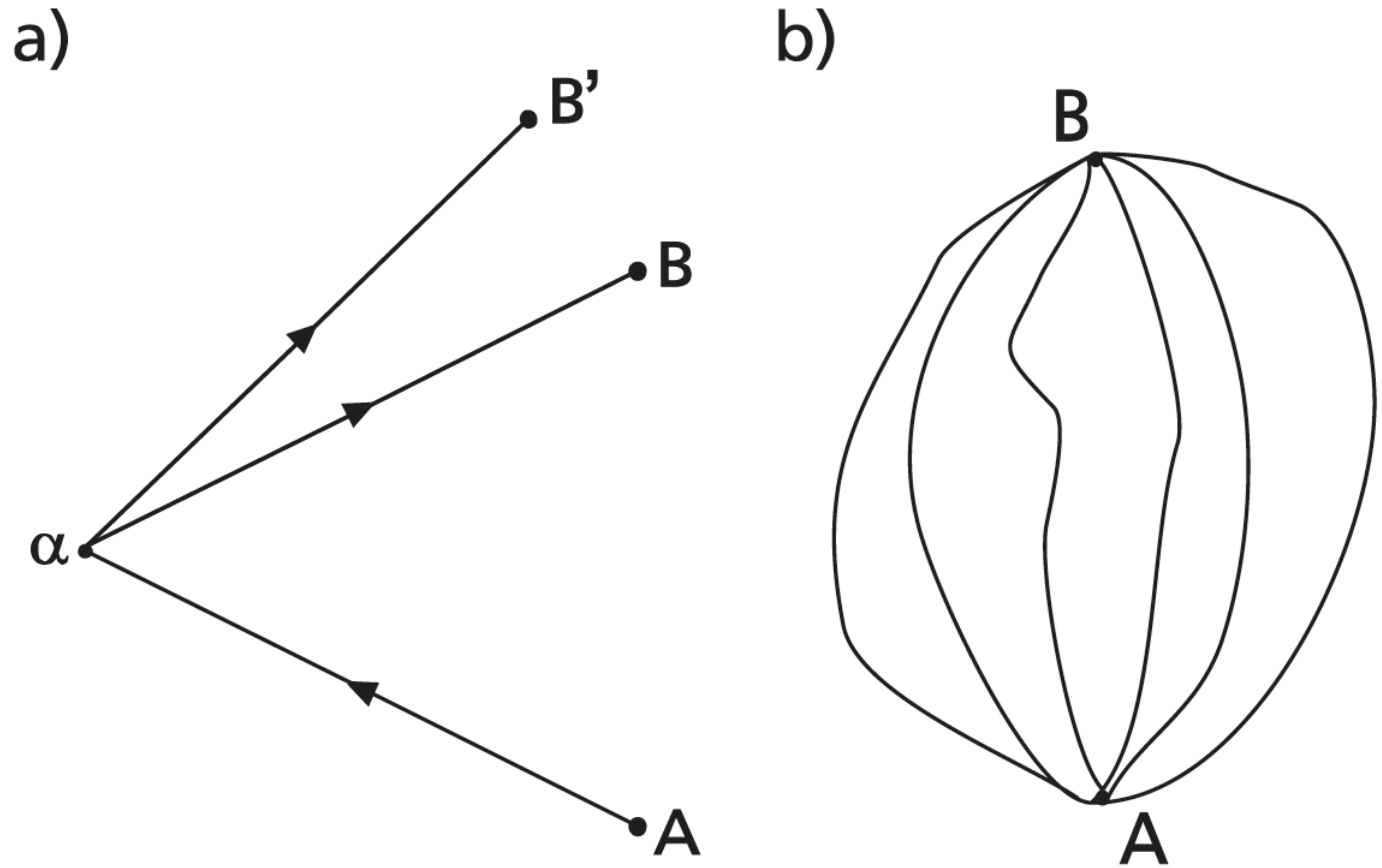

a)
B'
B
α
A


a)
B'
B
α
A
b)
B
A



$$\phi \sim \int_{\mathsf{A}}^{\mathsf{B}} \sqrt{1 - v^2/c^2}\,\mathrm{d}t$$



$$\phi \sim \int_{\mathsf{A}}^{\mathsf{B}} \sqrt{1 - v^2/c^2}\,\mathrm{d}t \sim \int_{\mathsf{A}}^{\mathsf{B}} (E\,\mathrm{d}t - p\,\mathrm{d}x)$$

$$E \sim \frac{1}{\sqrt{1-v^2/c^2}} \qquad p \sim \frac{v}{\sqrt{1-v^2/c^2}}$$

$$\mathcal{P}^{(n)}(\phi_1, \phi_2, \ldots, \phi_n) = \mathcal{P}^{(n)}(\phi_{\pi(1)}, \phi_{\pi(2)}, \ldots, \phi_{\pi(n)})$$

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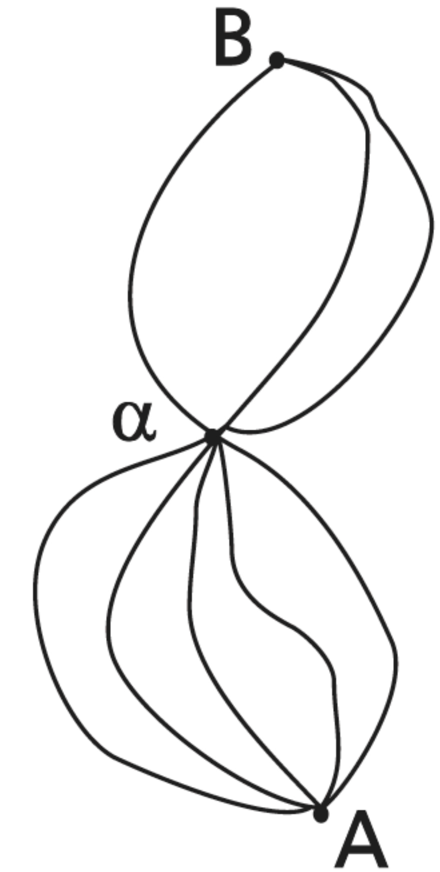

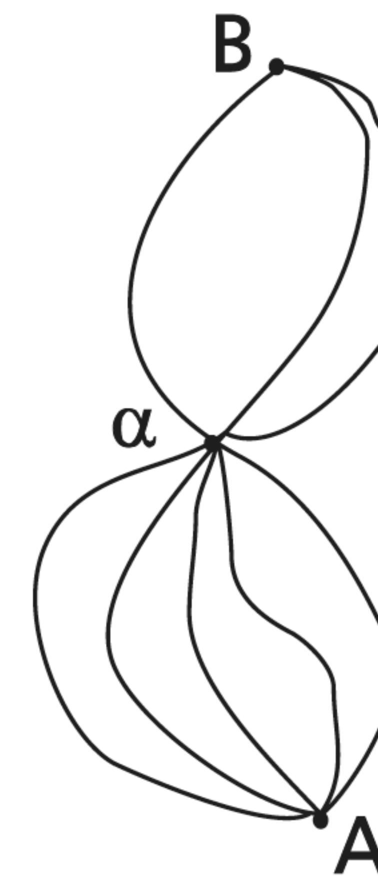

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$$\mathcal{P}^{(nm)}(\phi_1 + \xi_1, \phi_1 + \xi_2, \phi_1 + \xi_3, \ldots, \phi_n + \xi_m) = \mathcal{P}^{(n)}(\phi_1, \phi_2, \ldots, \phi_n)\mathcal{P}^{(m)}(\xi_1, \xi_2, \ldots, \xi_m)$$

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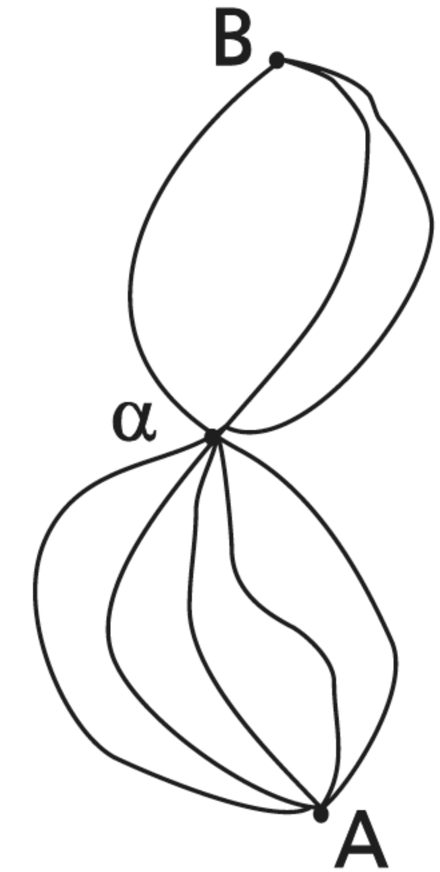

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$$\mathcal{P}^{(n)}(\phi_1, \phi_2, \ldots, \phi_n) = \frac{1}{n^\beta}\left(e^{\alpha\phi_1} + e^{\alpha\phi_2} + \ldots + e^{\alpha\phi_n}\right)^\gamma \left(e^{-\alpha\phi_1} + e^{-\alpha\phi_2} + \ldots + e^{-\alpha\phi_n}\right)^\gamma$$

Does it all break down in 1+3 spacetime?

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$$c^2 \mathrm{d}t^2 - \mathrm{d}\boldsymbol{r} \cdot \mathrm{d}\boldsymbol{r} =$$

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$$c^2 \mathrm{d}t^2 - \mathrm{d}\boldsymbol{r} \cdot \mathrm{d}\boldsymbol{r} = -c^2 \mathrm{d}t'^2 + \mathrm{d}x'^2 - \mathrm{d}\xi'^2 - \mathrm{d}\chi'^2$$

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Published 30 December 2022 •

Classical and Quantum Gravity, Volume 40, Number 2

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$$\begin{cases} r' = \dfrac{Vt - \frac{\boldsymbol{r}\cdot\boldsymbol{V}}{V}}{\sqrt{\frac{V^2}{c^2} - 1}}, \\ c\boldsymbol{t}' = \boldsymbol{r} - \dfrac{\boldsymbol{r}\cdot\boldsymbol{V}}{V^2}\boldsymbol{V} + \dfrac{\frac{\boldsymbol{r}\cdot\boldsymbol{V}}{Vc} - \frac{ct}{V}}{\sqrt{\frac{V^2}{c^2} - 1}}\boldsymbol{V} \end{cases}$$

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$$\boxed{\boldsymbol{v}' = \frac{\mathrm{d}r'}{\mathrm{d}t'}\frac{\mathrm{d}\boldsymbol{t}'}{\mathrm{d}t'}}$$

Does it all break down in 1+3 spacetime?

$$\left(1 - \frac{c^2}{v'^2}\right) = \frac{\left(1 - \frac{c^2}{V^2}\right)\left(1 - \frac{v^2}{c^2}\right)}{\left(1 - \frac{\boldsymbol{v}\cdot\boldsymbol{V}}{V^2}\right)^2}$$

Do superluminal particles exist?

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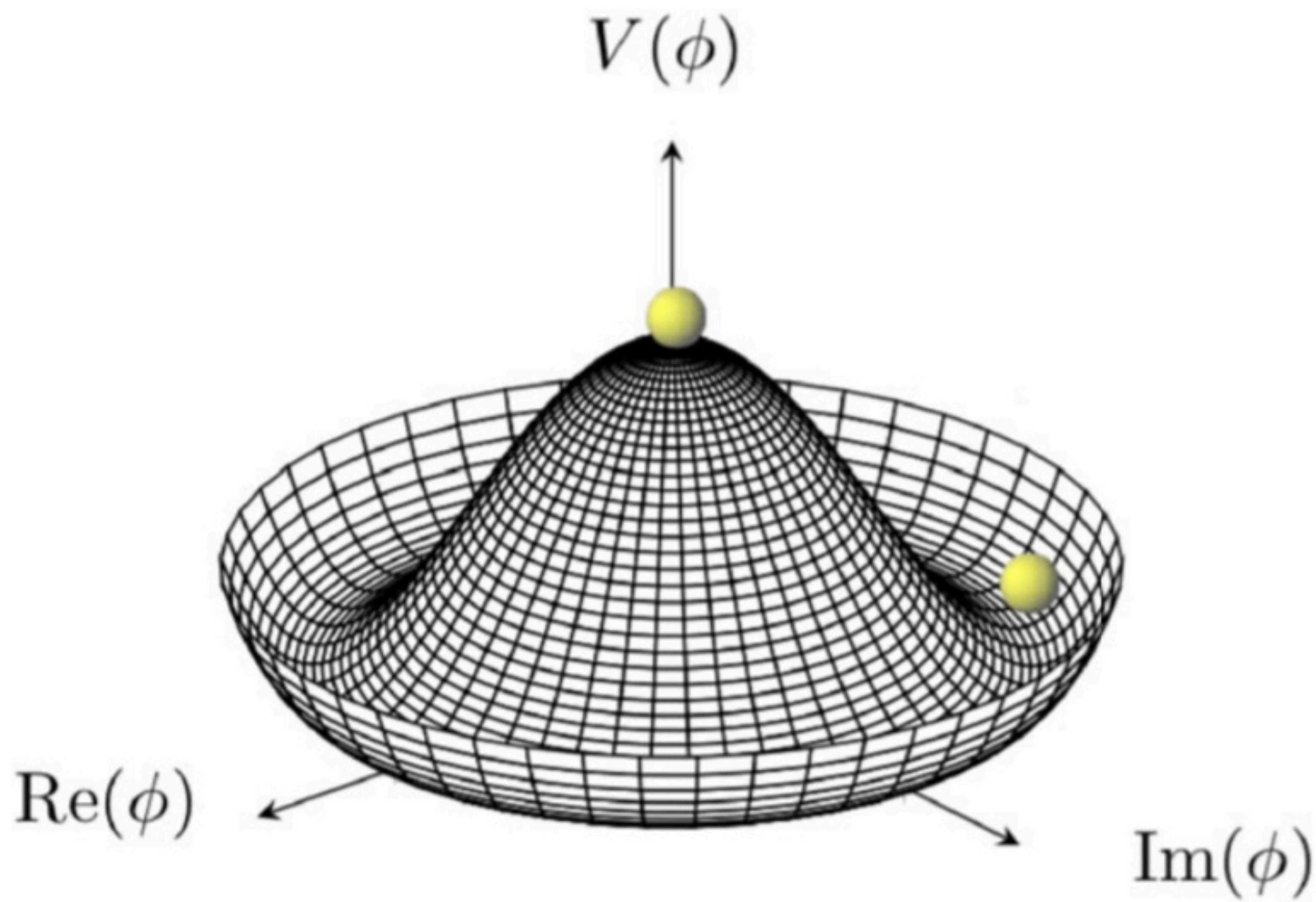

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