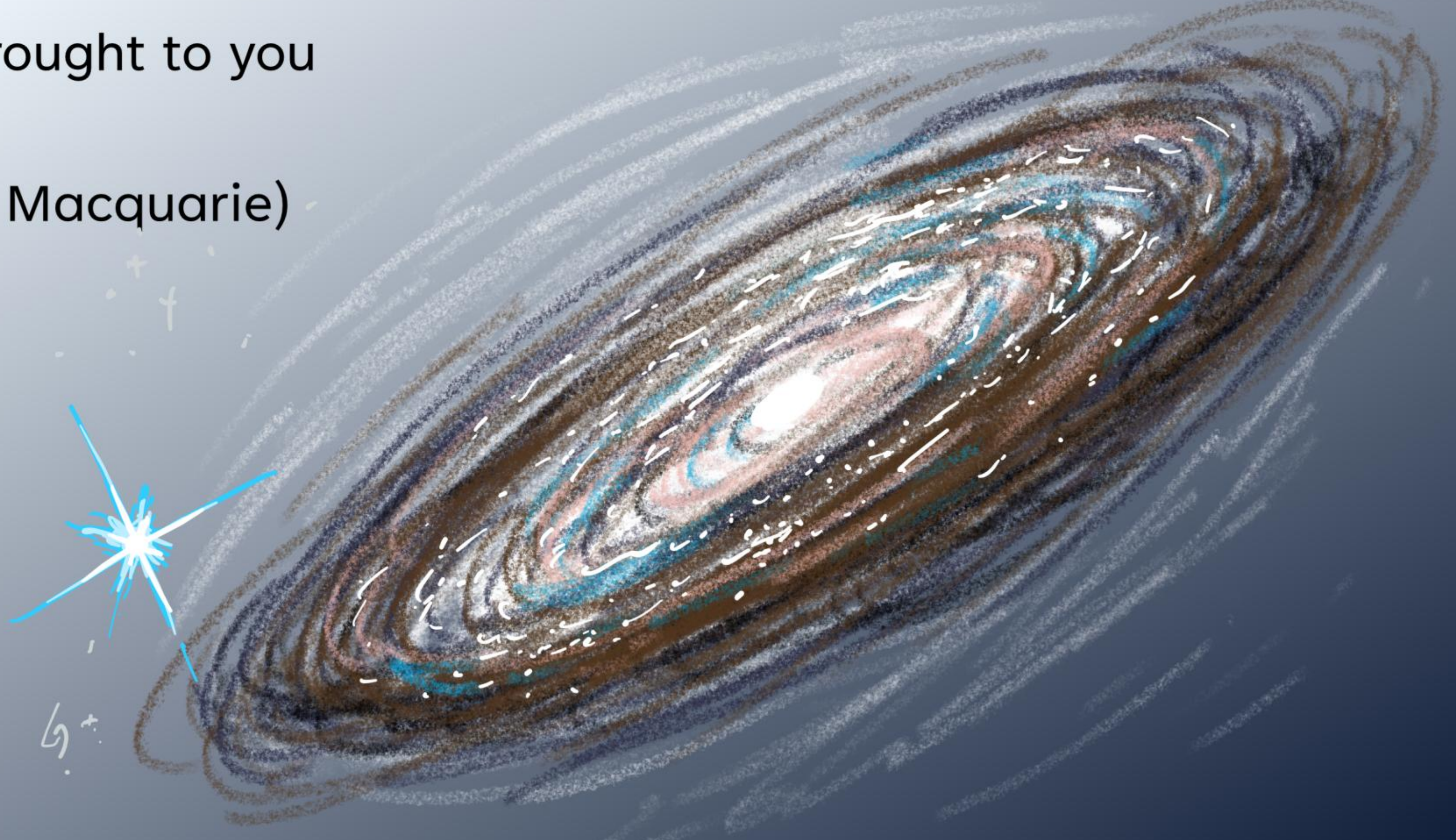
Does time *slow down* at the **edge of the Universe**?

An explosive mystery brought to you by Ryan White,

(a grad student here at Macquarie)



...yes.

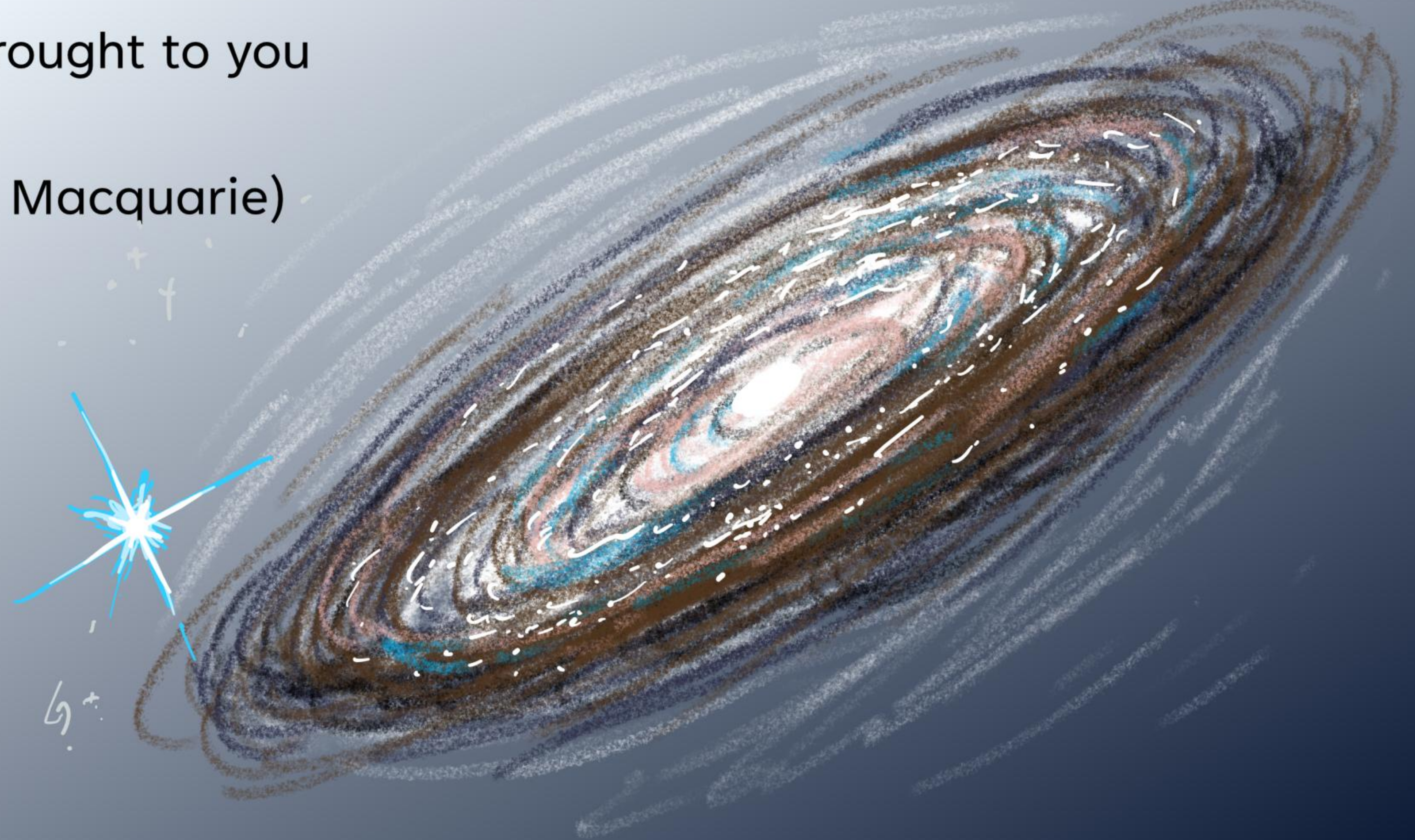
An explosive mystery solved
by Ryan White,

(a grad student here at Macquarie)

Why does time *slow down* at the **edge of the Universe**?

An explosive mystery brought to you by Ryan White,

(a grad student here at Macquarie)



...I'll get to it.

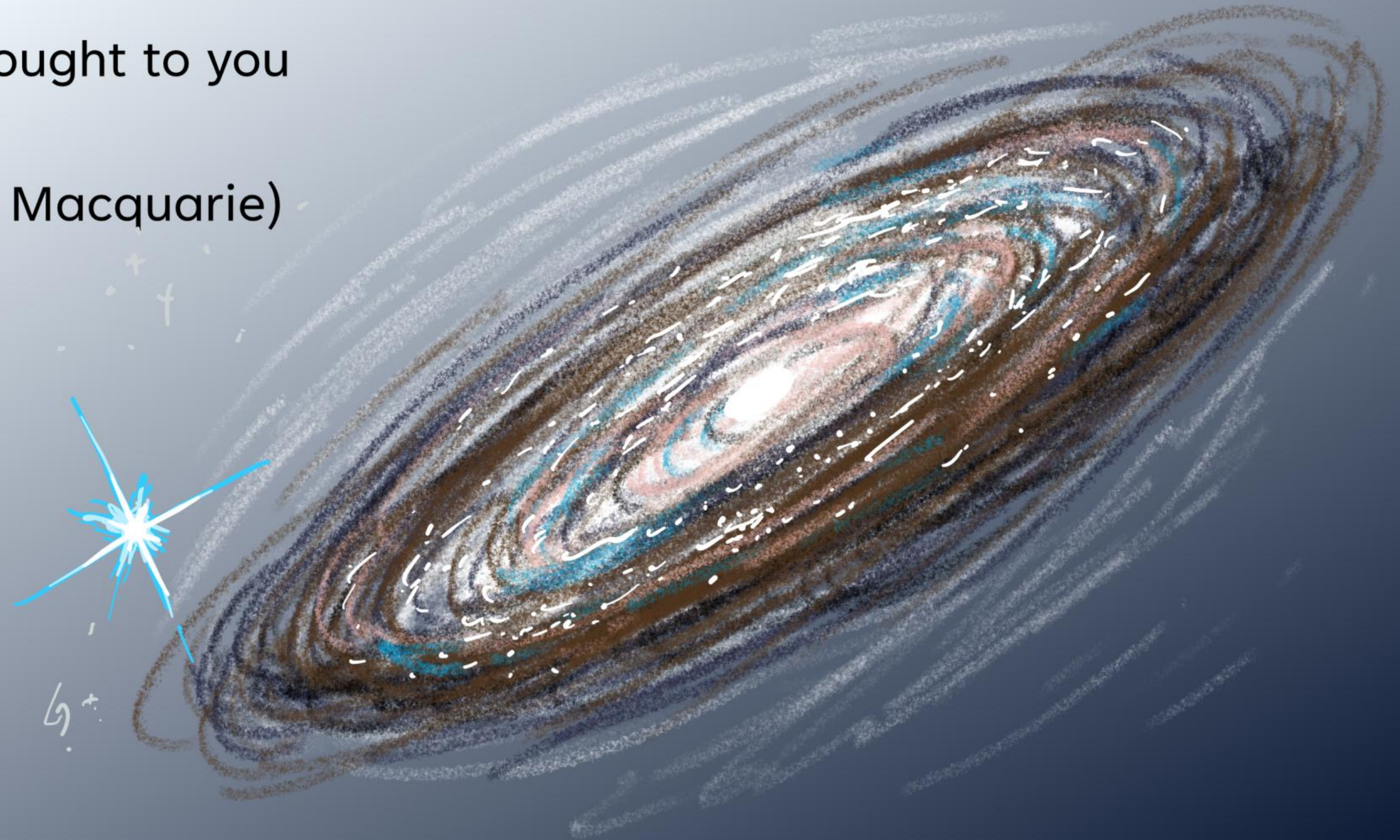
An explosive mystery delayed to you
by Ryan White,

(a grad student here at Macquarie)

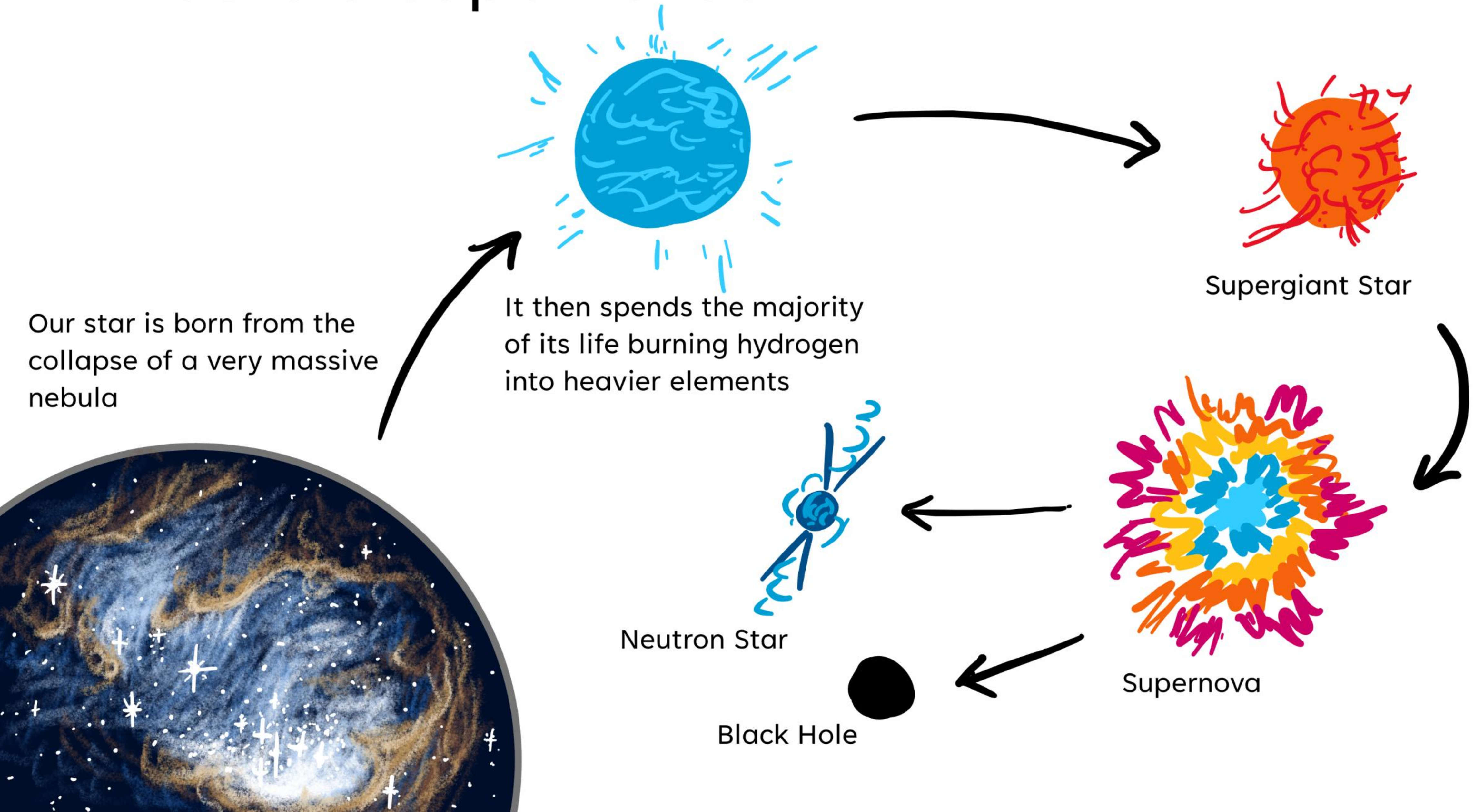
How do *we* know time *slows down* at the **edge of the Universe**?

A scientific art show brought to you by Ryan White,

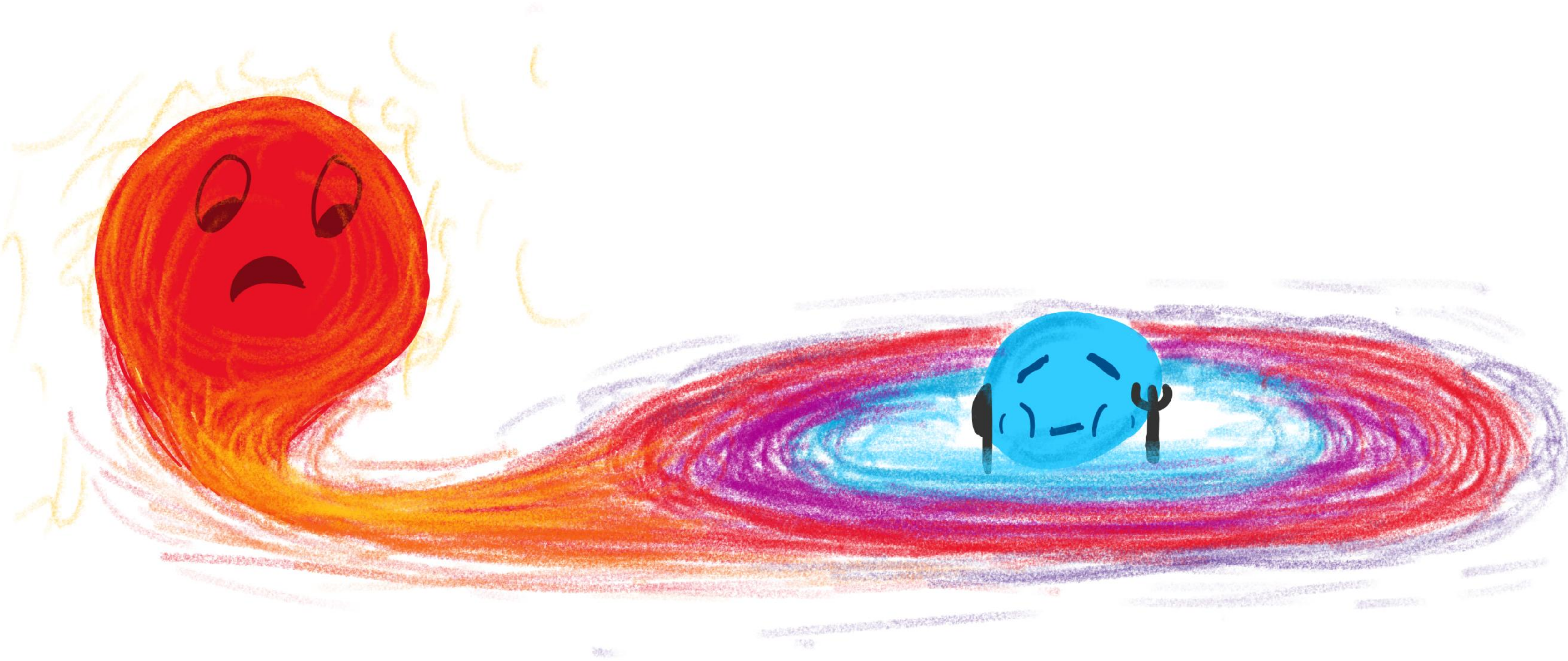
(a grad student here at Macquarie)



What is a supernova?



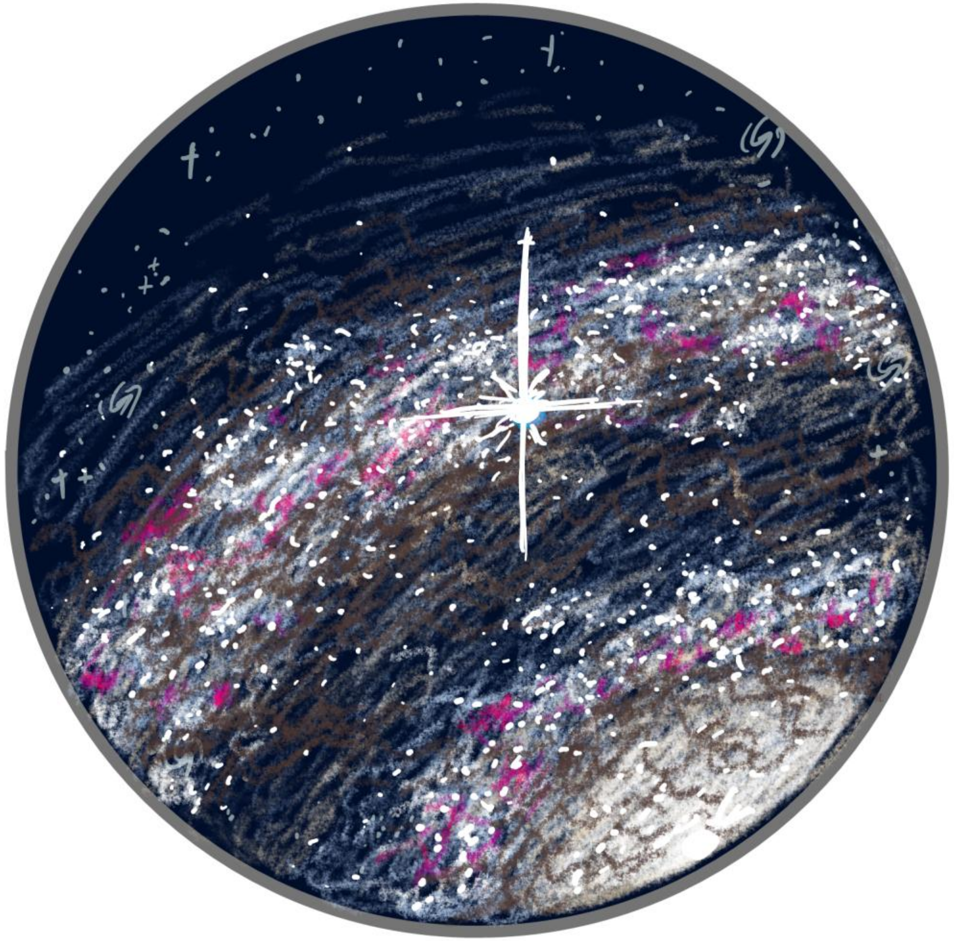
What is a Type Ia supernova?



What do supernovae look like?

If they're nearby

What do supernovae look like?



If they’re across the Galaxy

What do supernovae look like?

If they're in a different galaxy

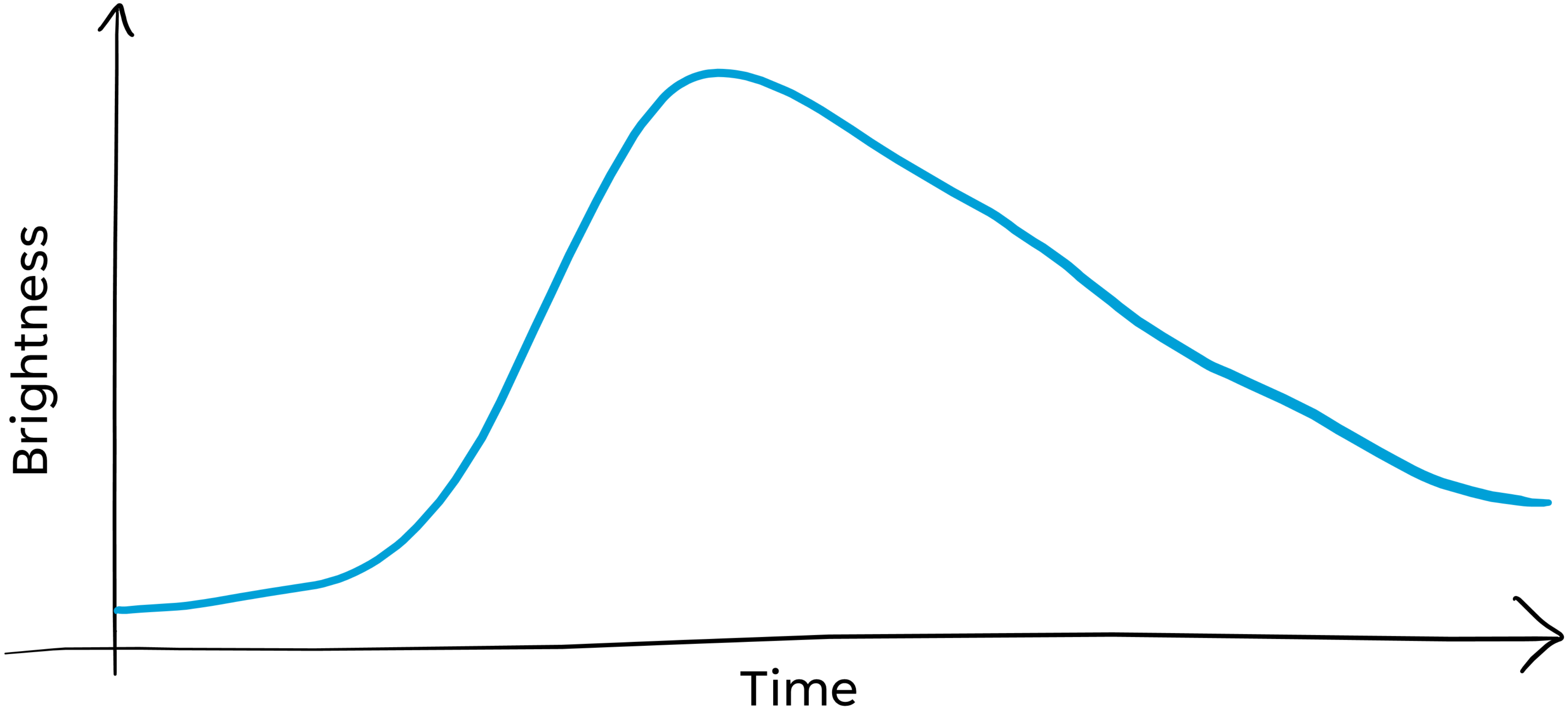
What do supernovae look like?

If they're nearby

If they're far away

What do Type Ia supernovae look like?

- We can’t get nice pictures, but we can get a ‘light curve’



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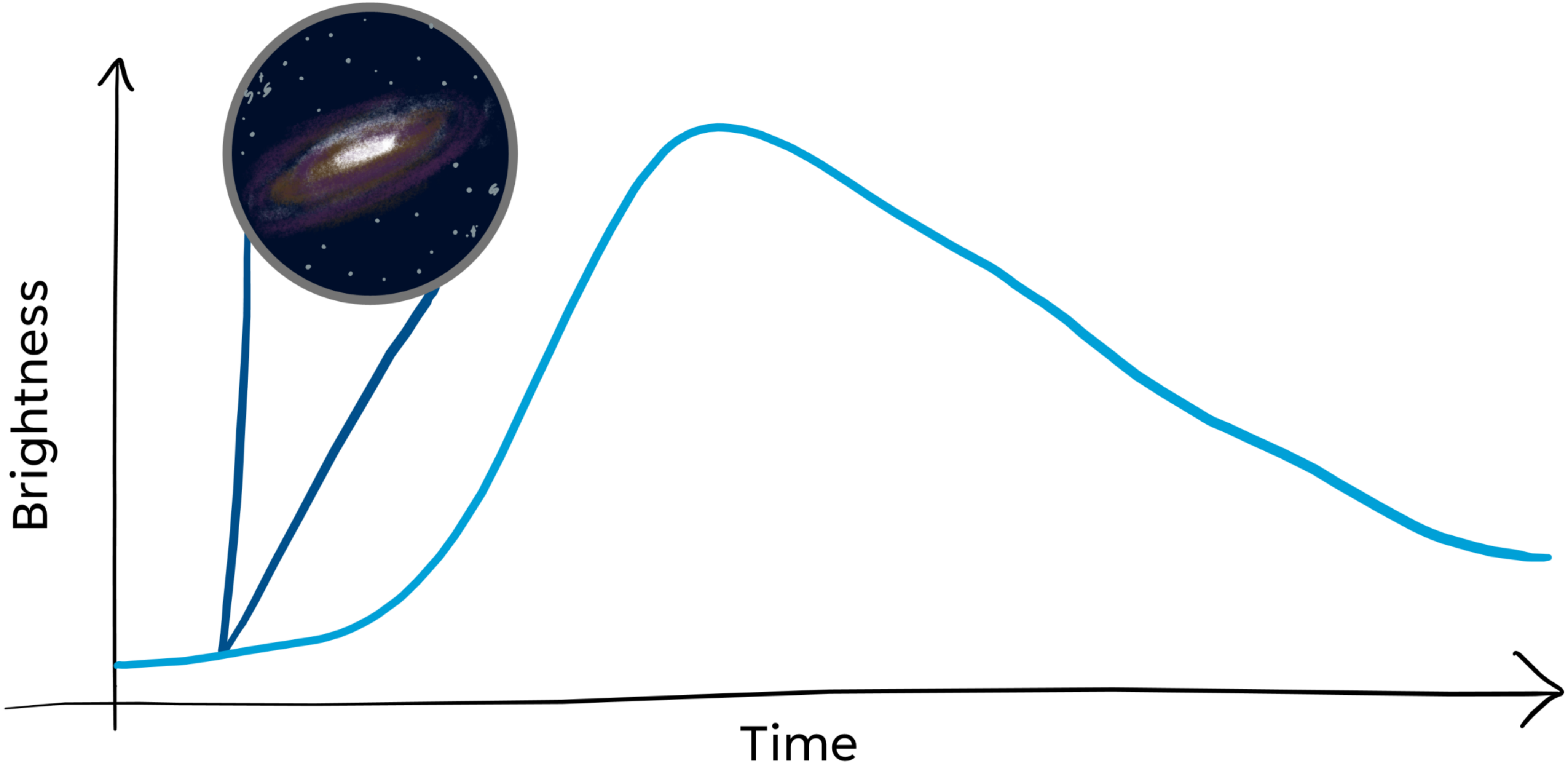

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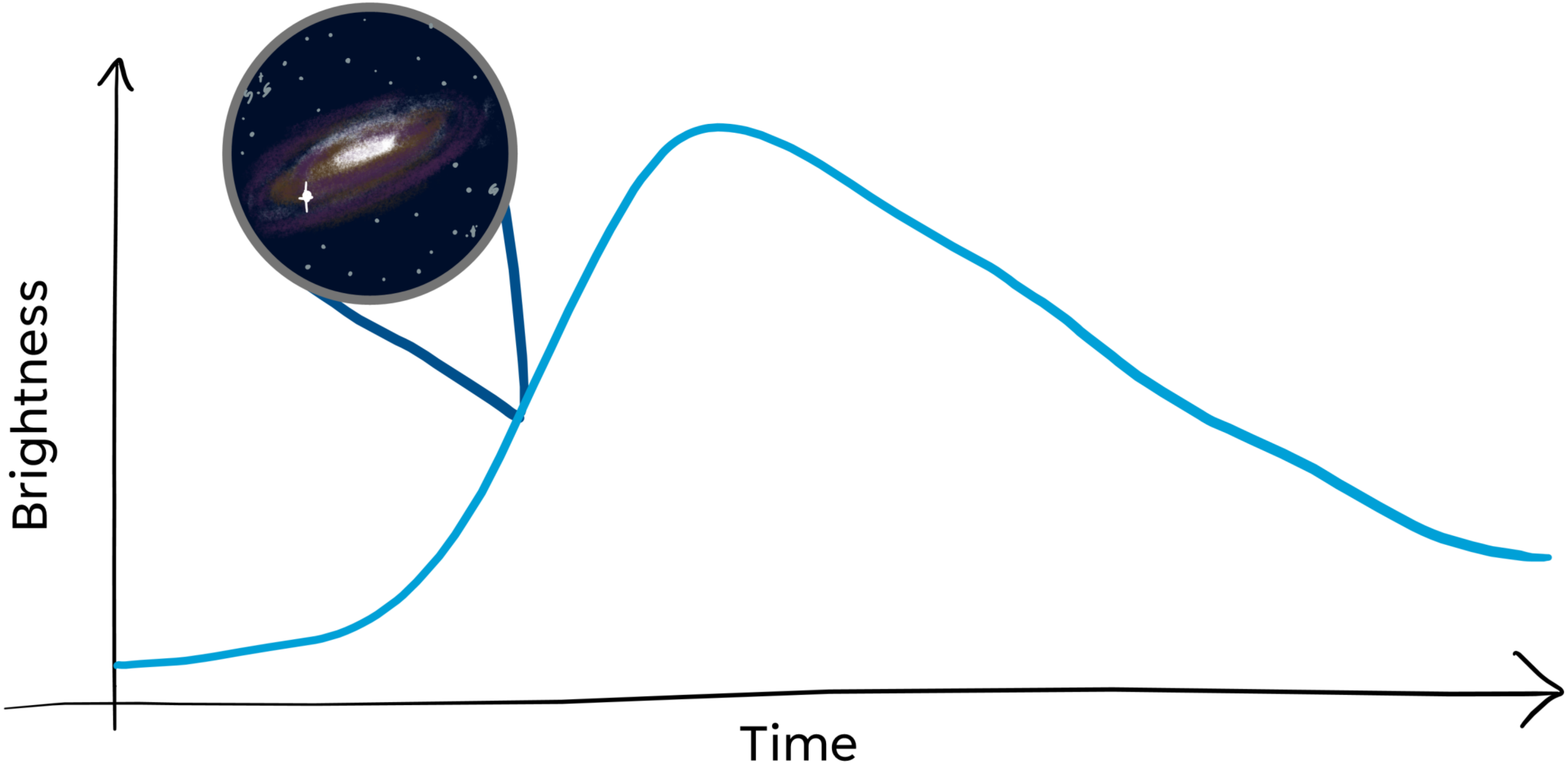

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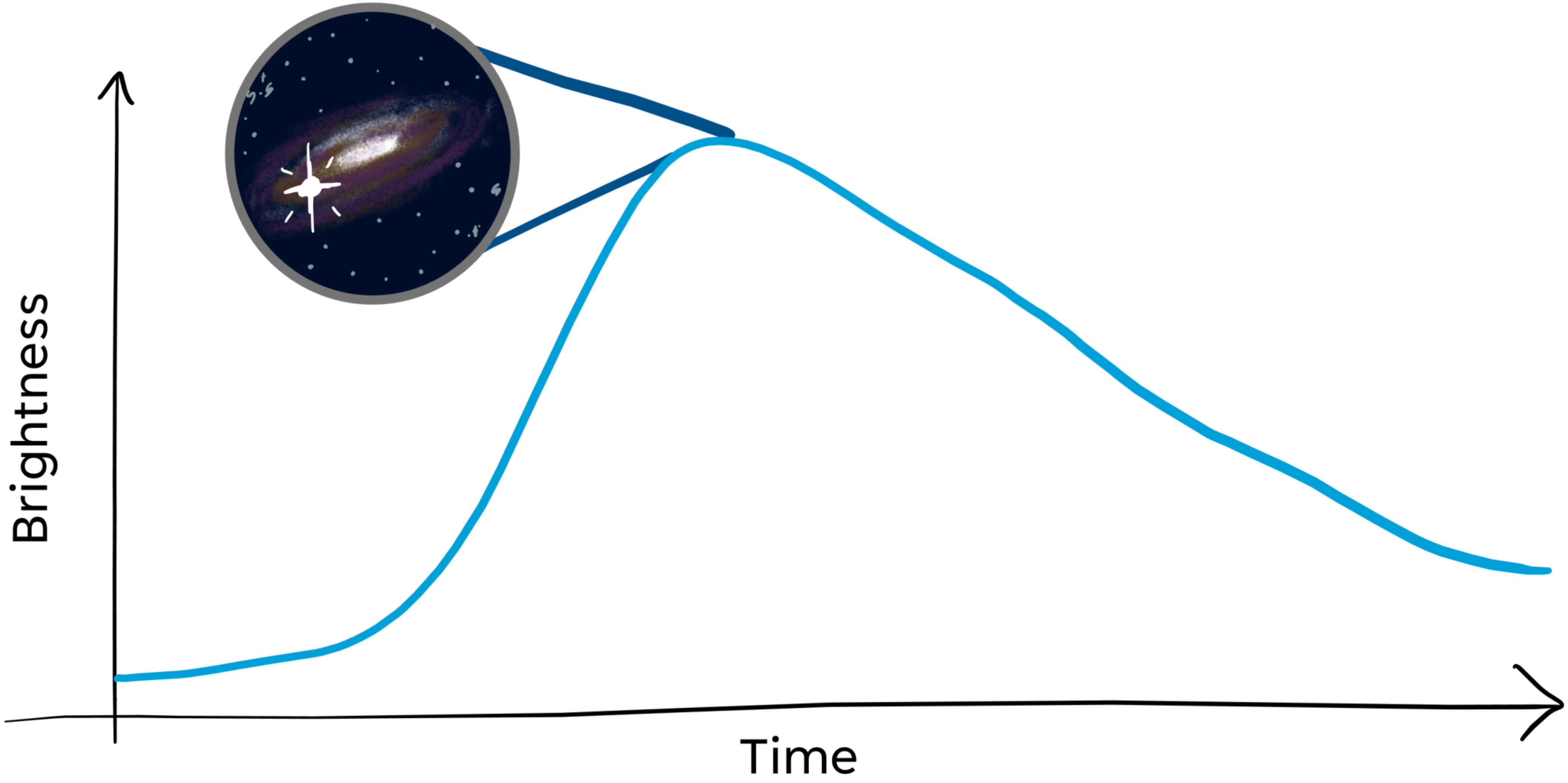

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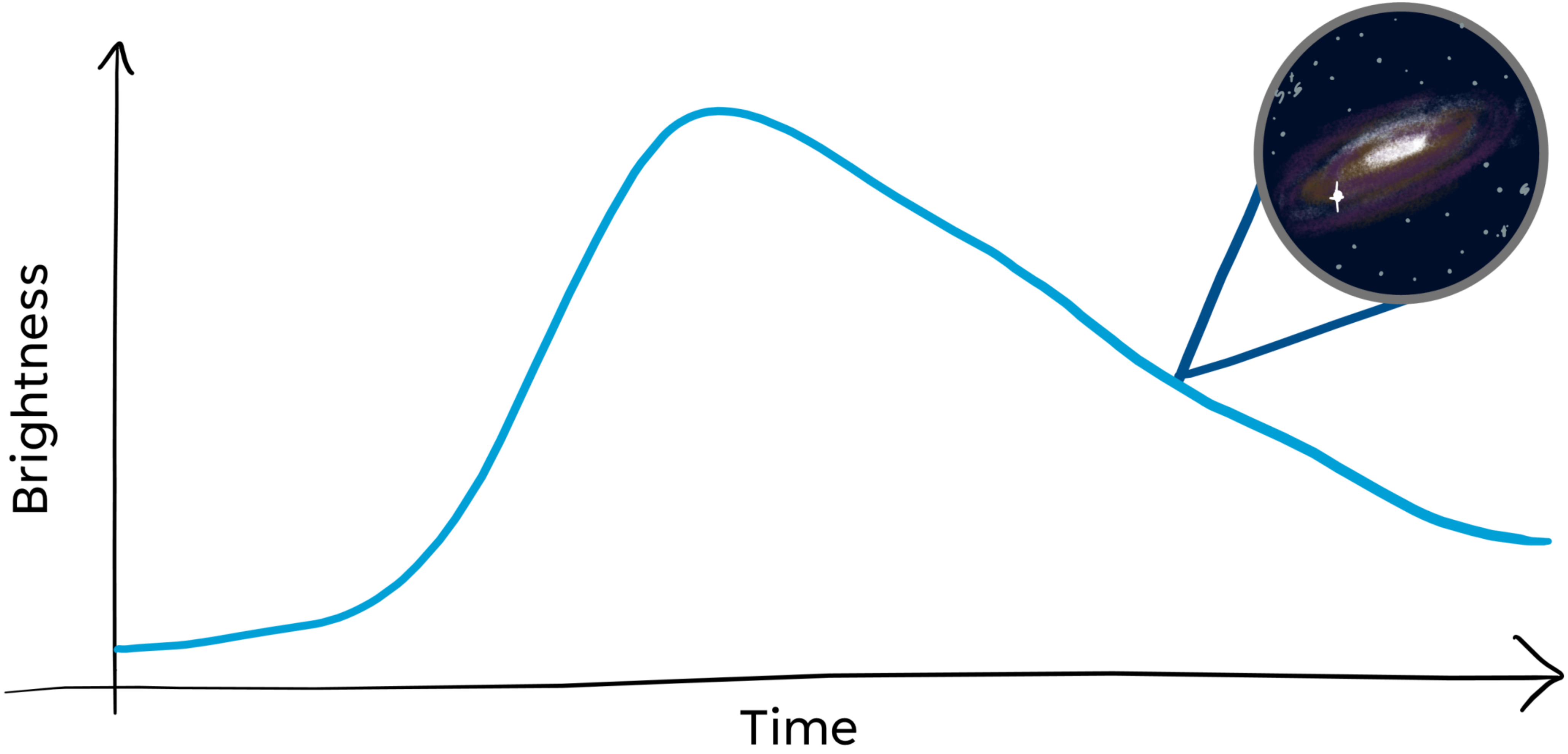


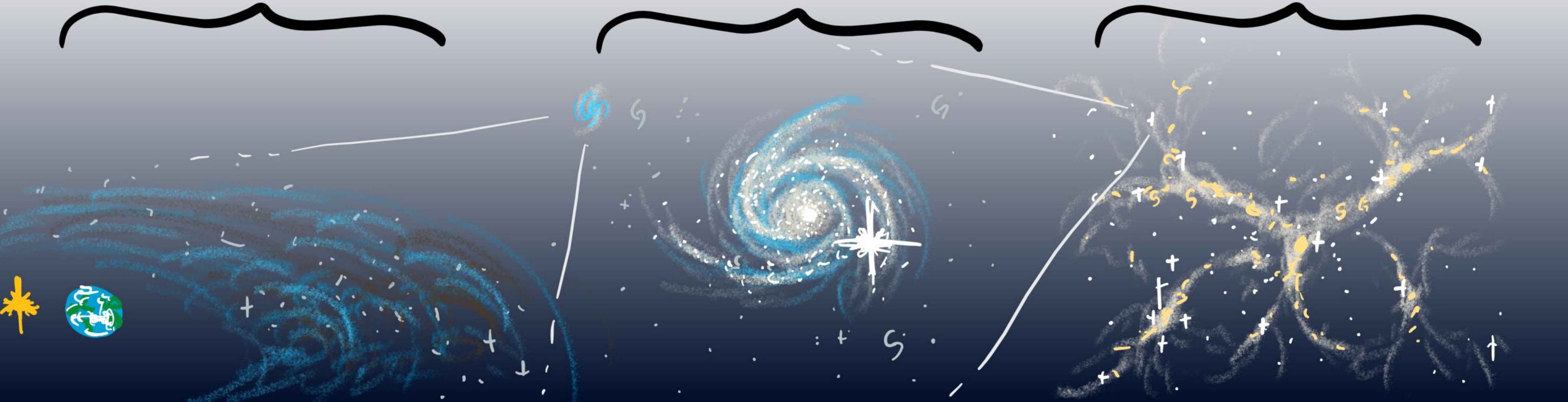
What happens as we look further out?

- Supernovae are very common when we zoom out to look at the Universe!

In our Milky Way, every 100yrs or so

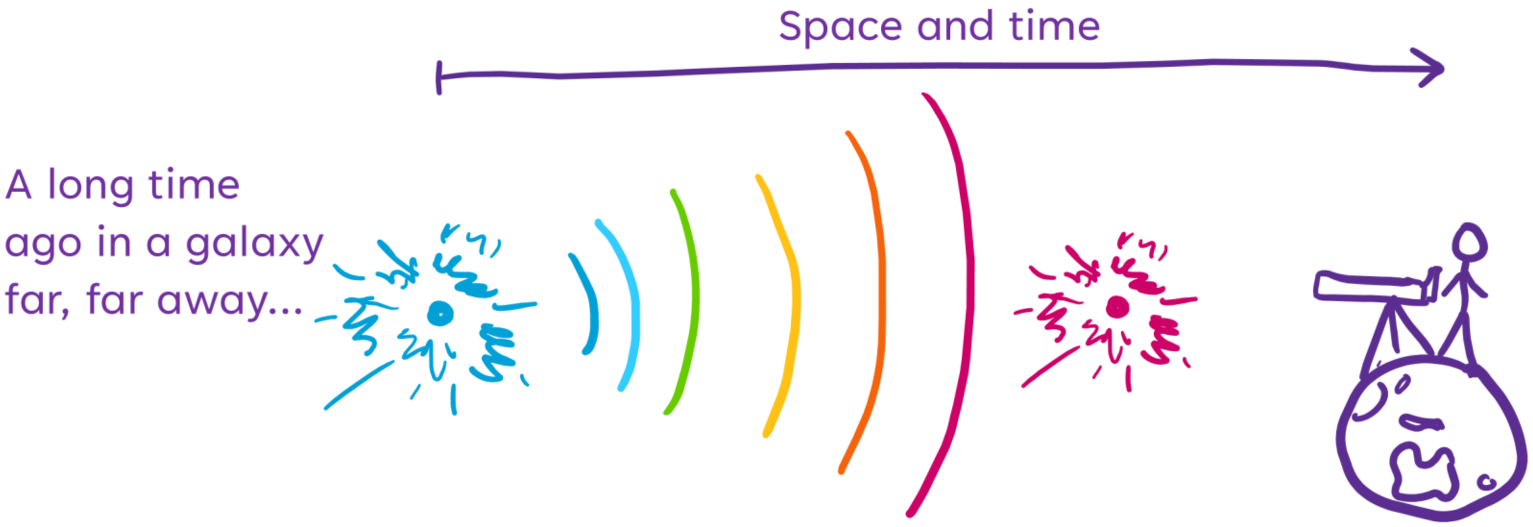
In nearby galaxies, every year or few

In the wider universe, every day



What happens as we look further out?

- Light from supernovae get ‘redshifted’
  - Blue goes to green
  - Green to yellow
  - Yellow to red…



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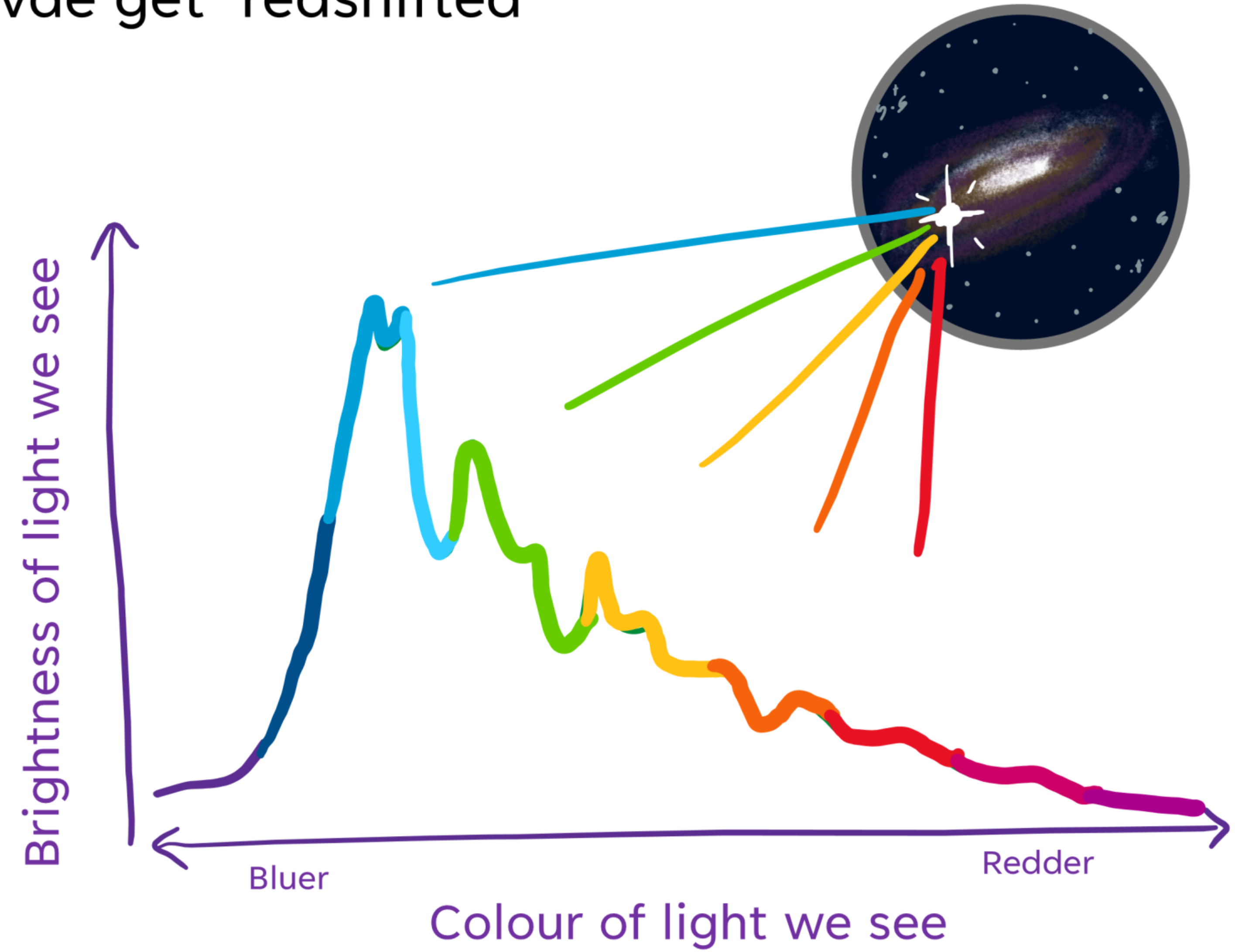

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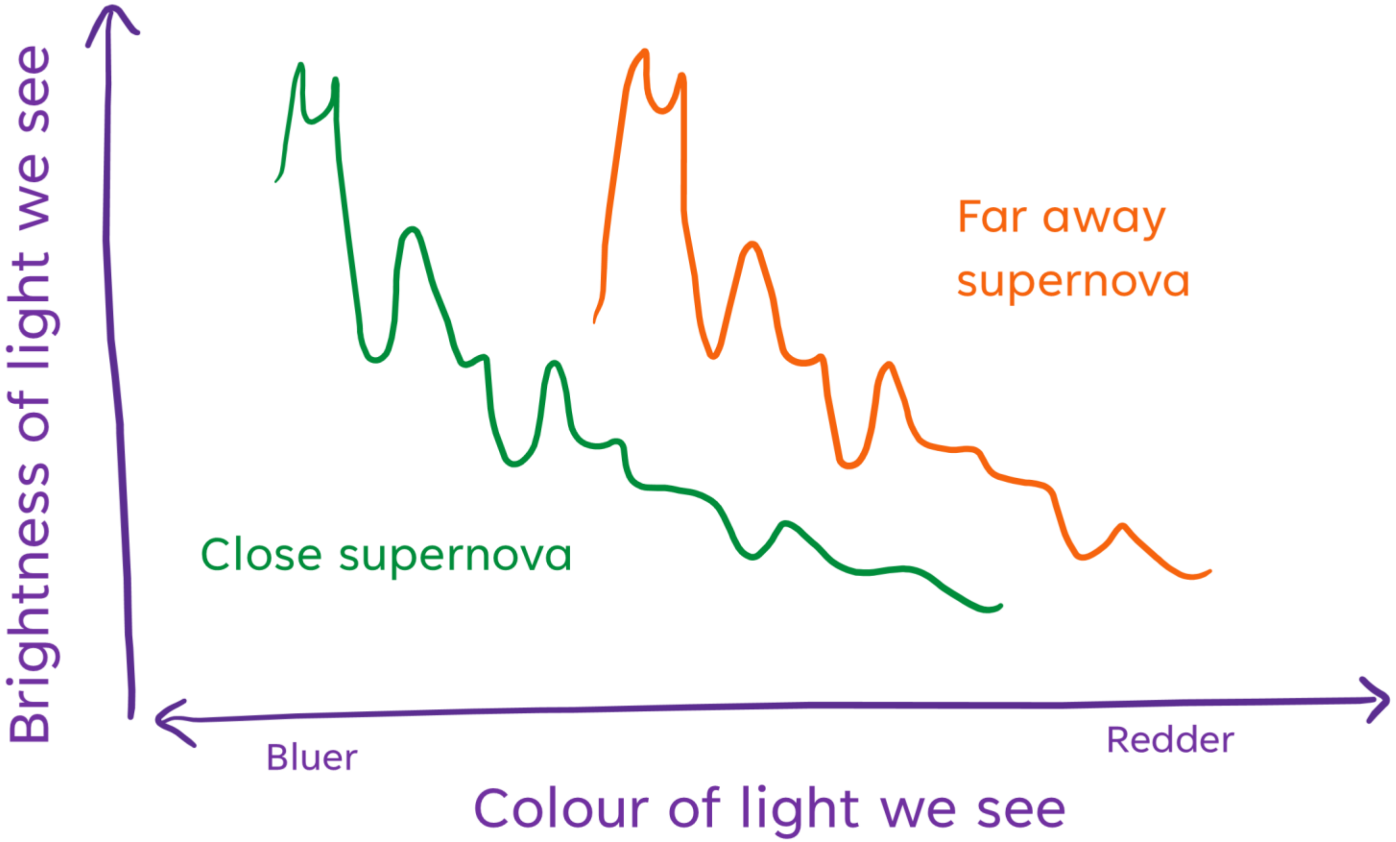

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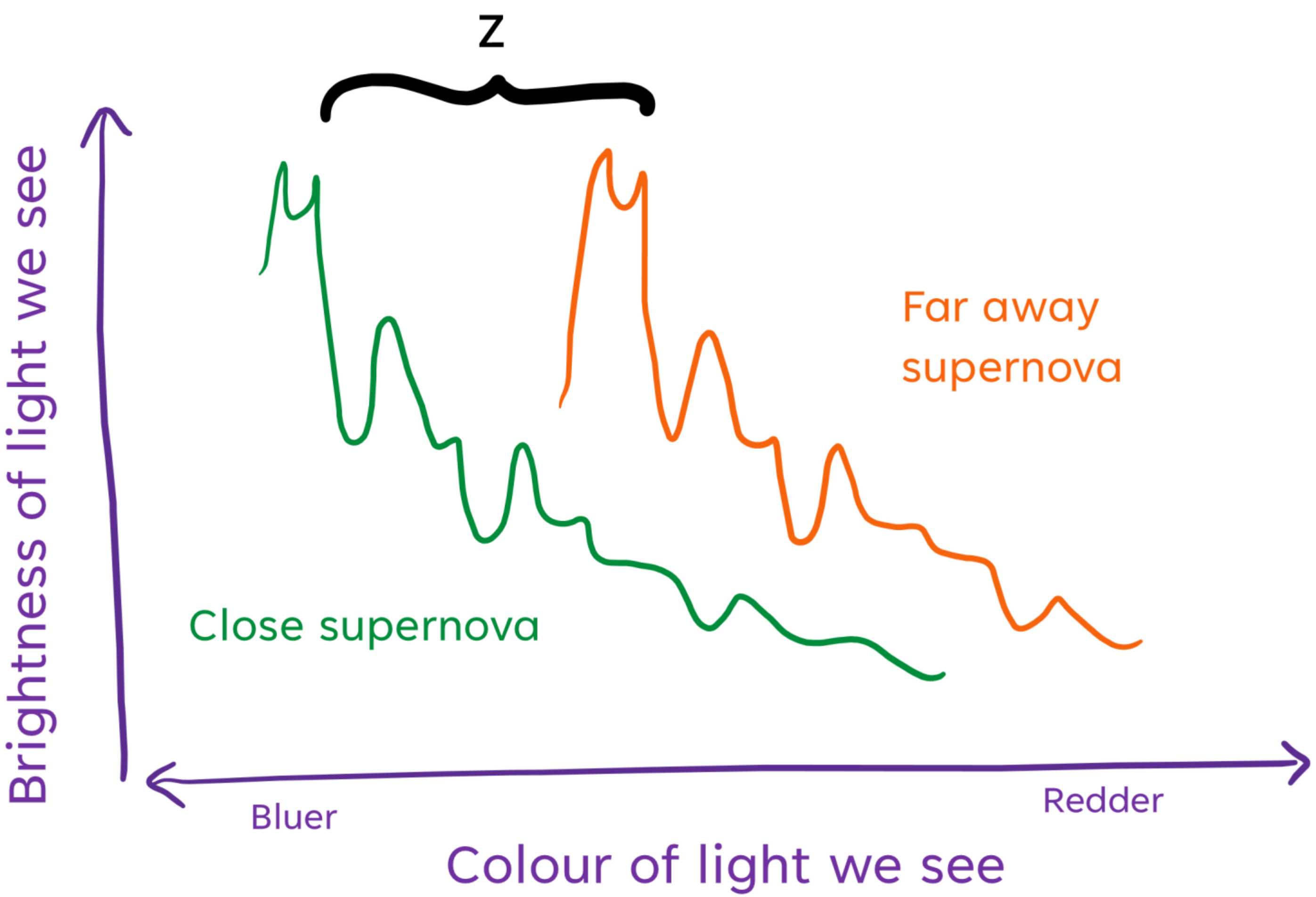


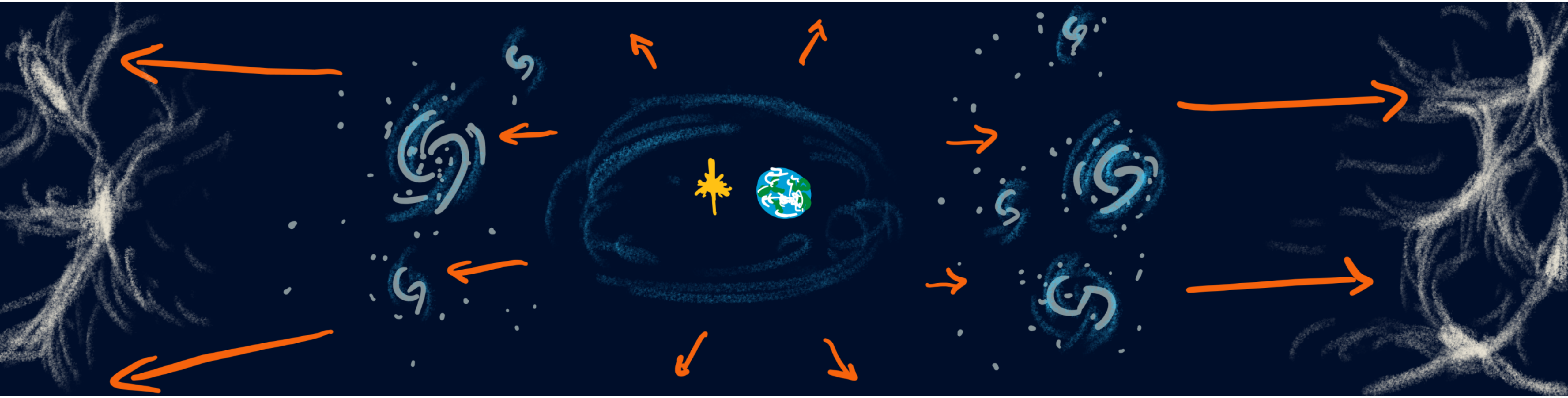
What happens as we look further out?

- Light from supernovae get ‘redshifted’

z ~ 0 z ~ 0.5 z ~ 2

What happens as we look further out?

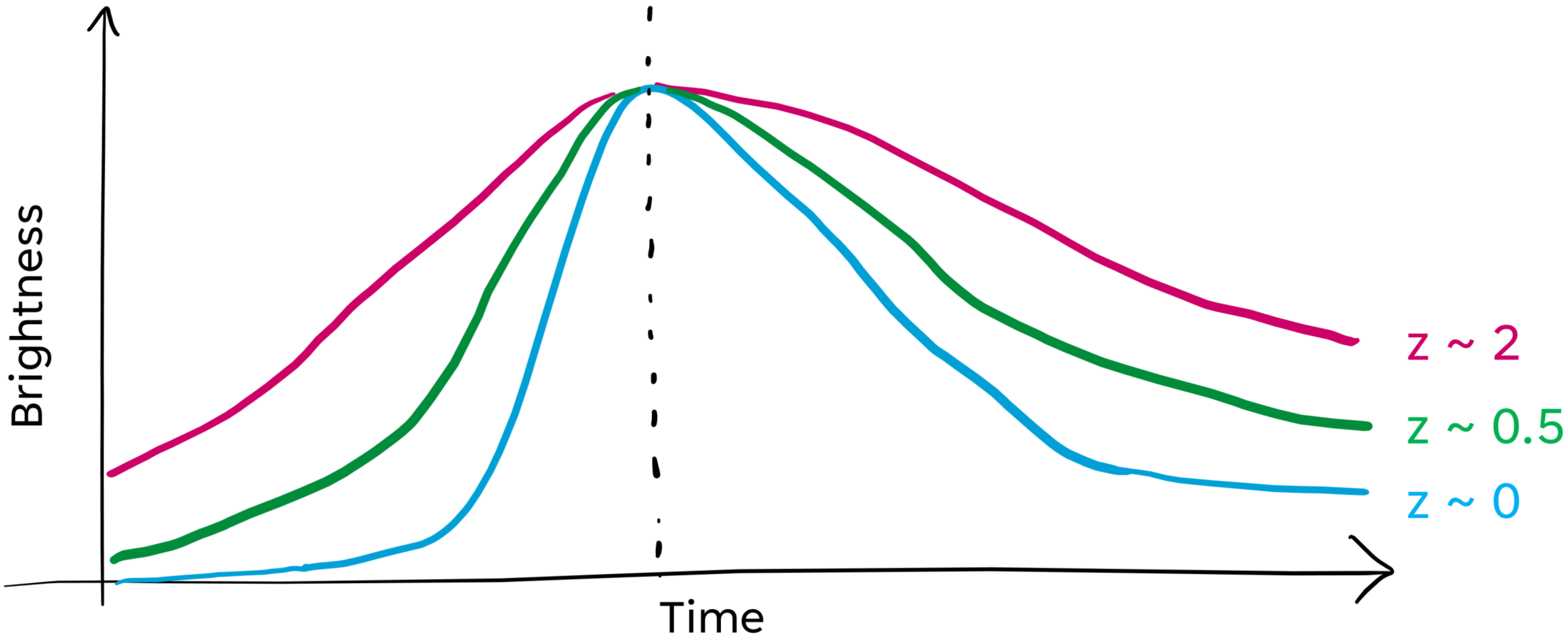
- This is because the Universe is expanding, and further away stuff is moving away faster



- But light always wants to go at the same speed… so it loses ‘energy’ so that it can maintain its speed

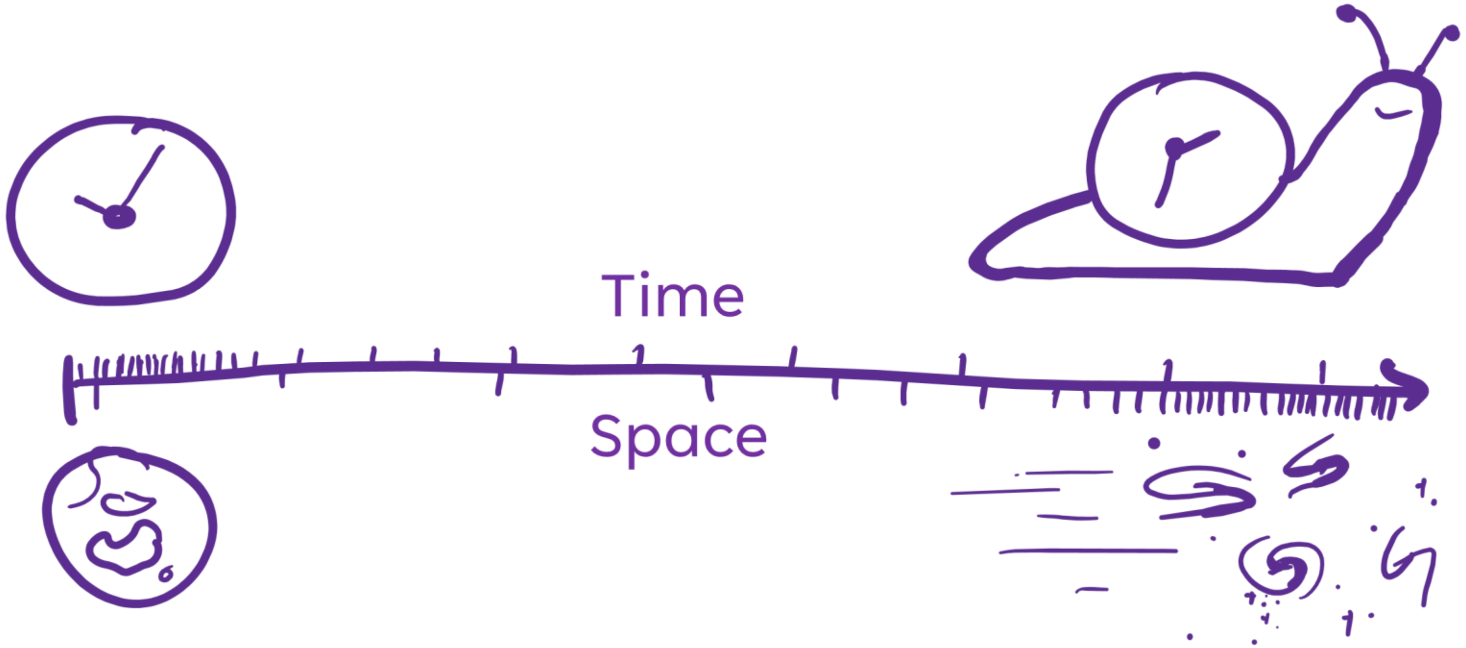
What happens as we look further out?

- When we look reeeeeally far out, things seem to slow down
- This is clear when we look at supernova light curves



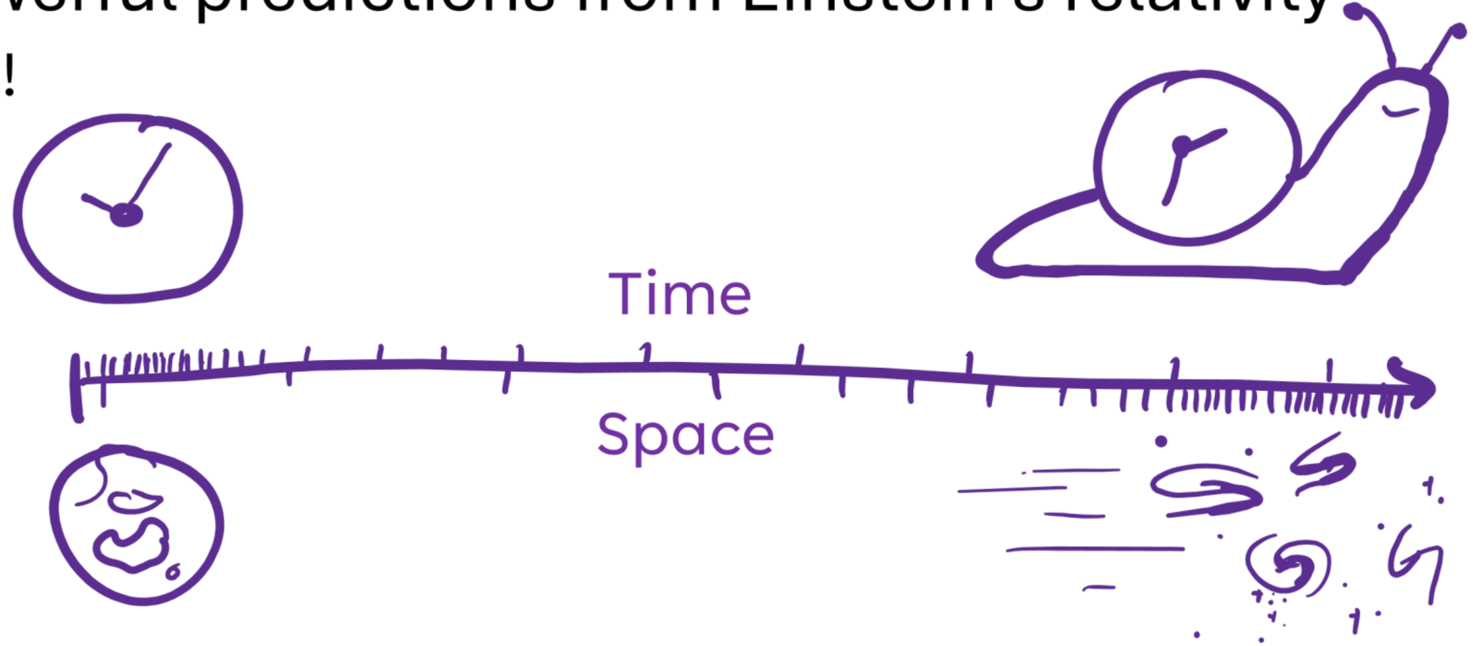
Time dilation?

- Everyone experiences the same speed of light
- From our perspective, people moving faster need to experience time slower for the equation to balance out

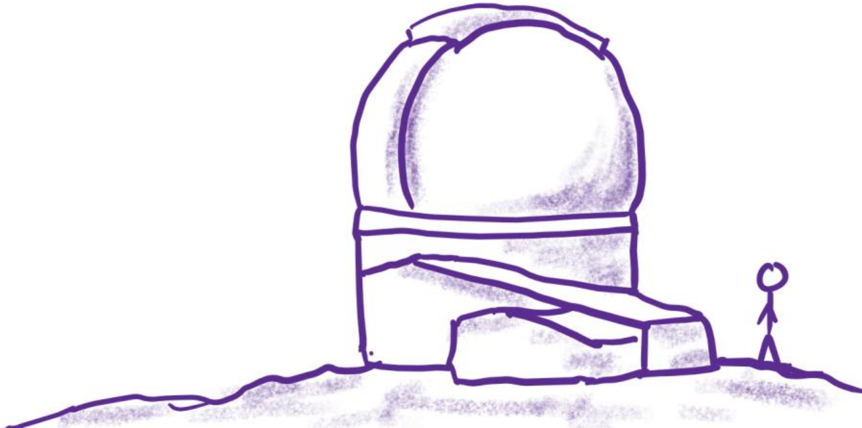


Time dilation?

- Everyone experiences the same speed of light
- From our perspective, people moving faster need to experience time slower for the equation to balance out
- We have powerful predictions from Einstein's relativity
  - Let's test it!

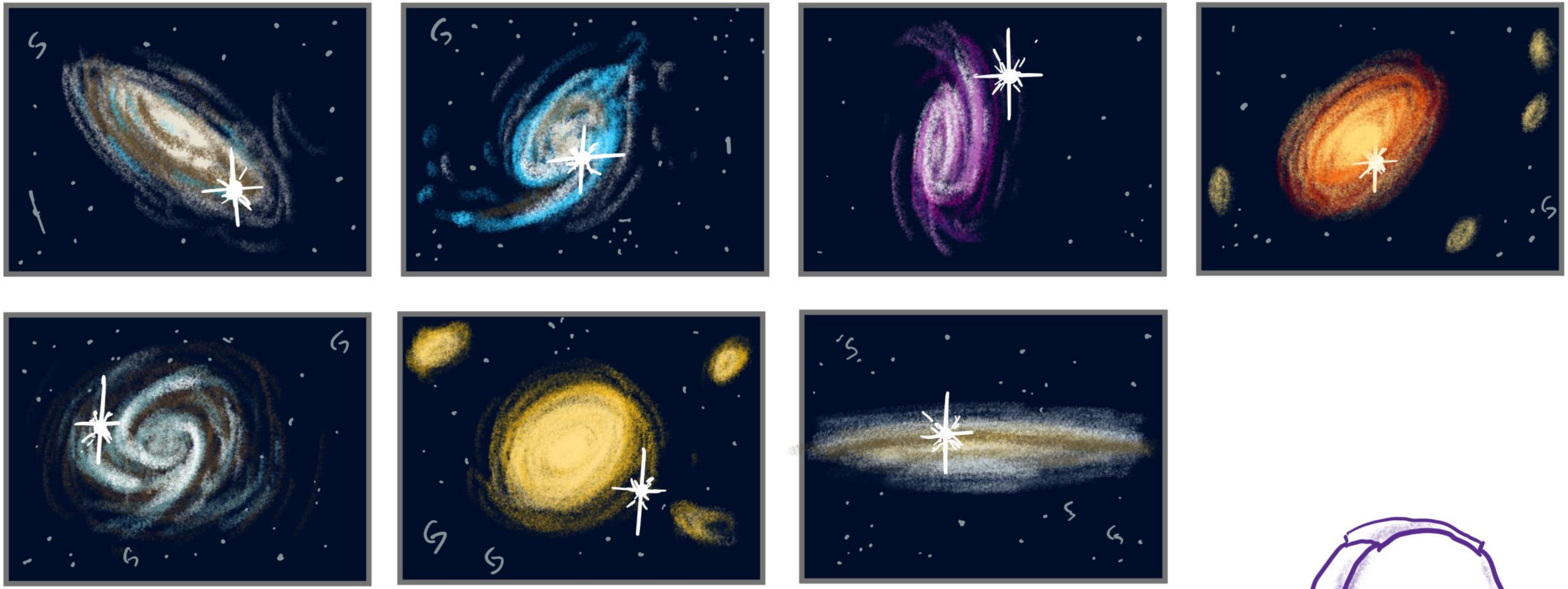


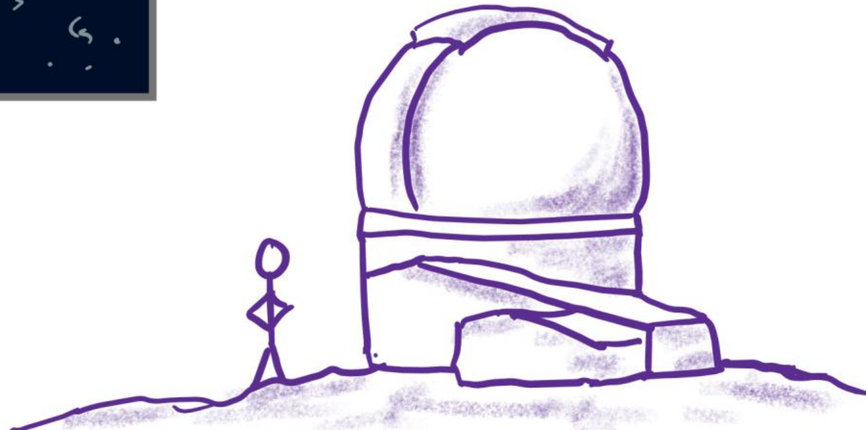
Let’s test time dilation… with 1 supernova?



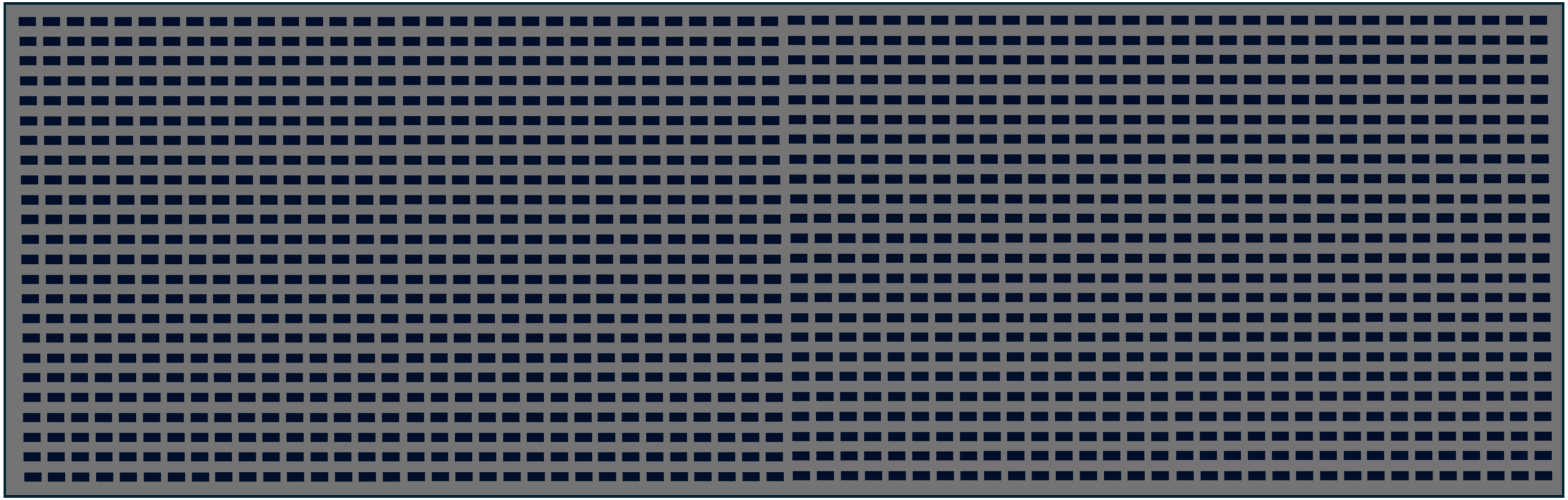
Let’s test time dilation… with 3 supernovae?

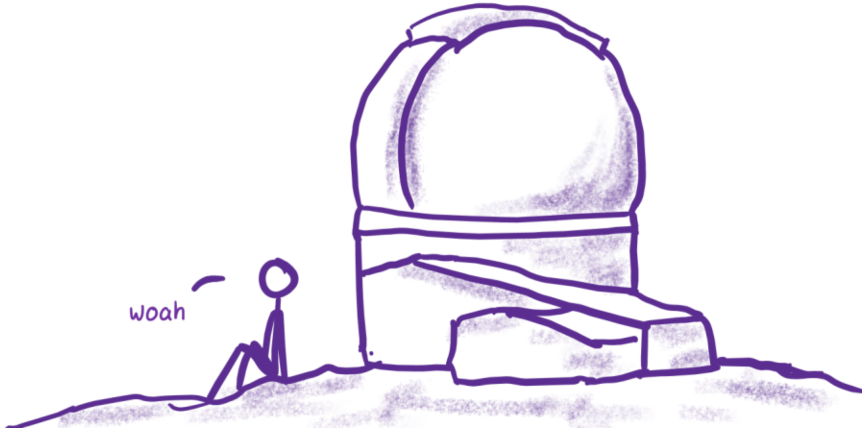
Let’s test time dilation… with 7 supernovae?





Let’s test time dilation... with 1500 supernovae!





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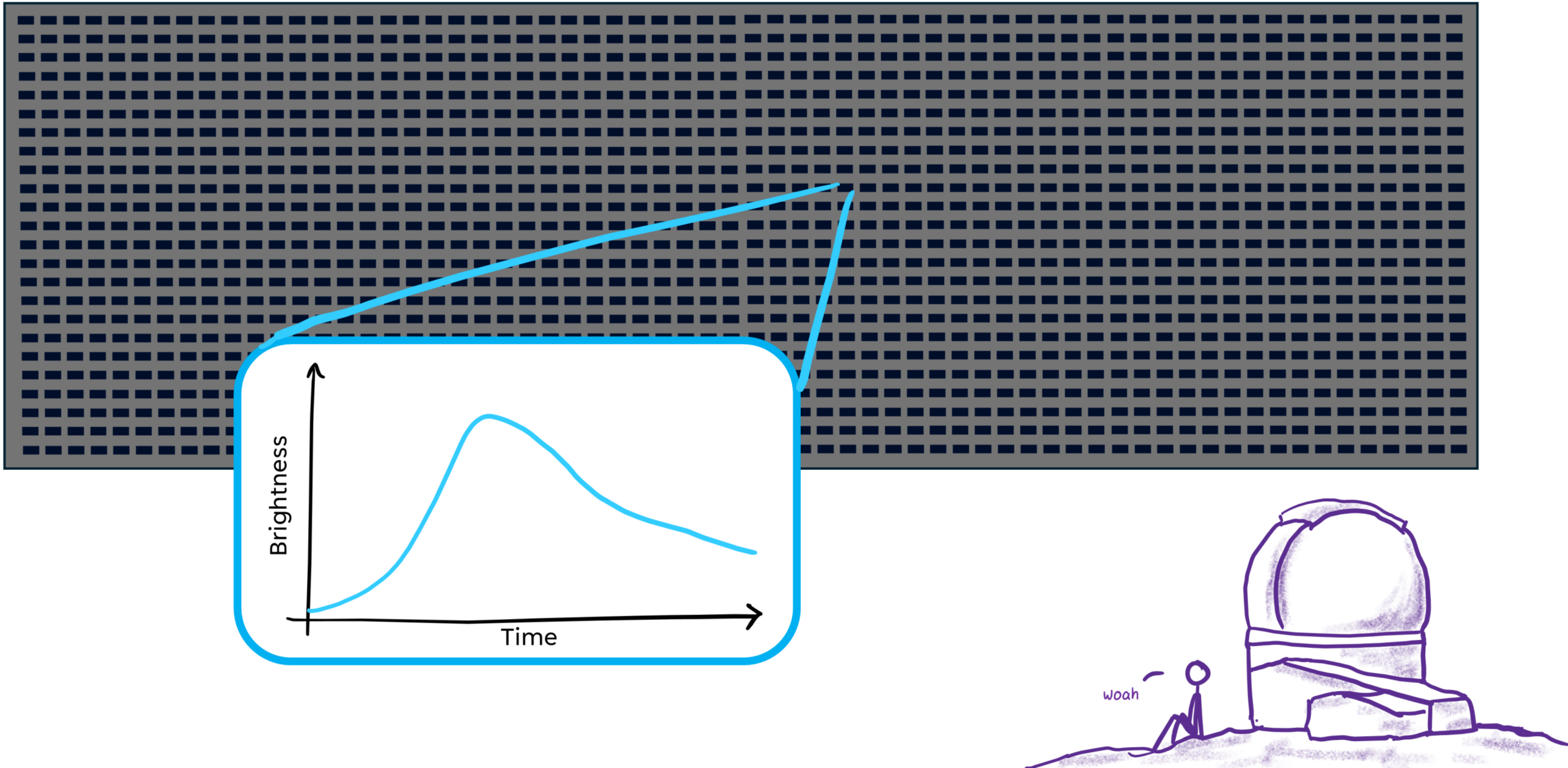

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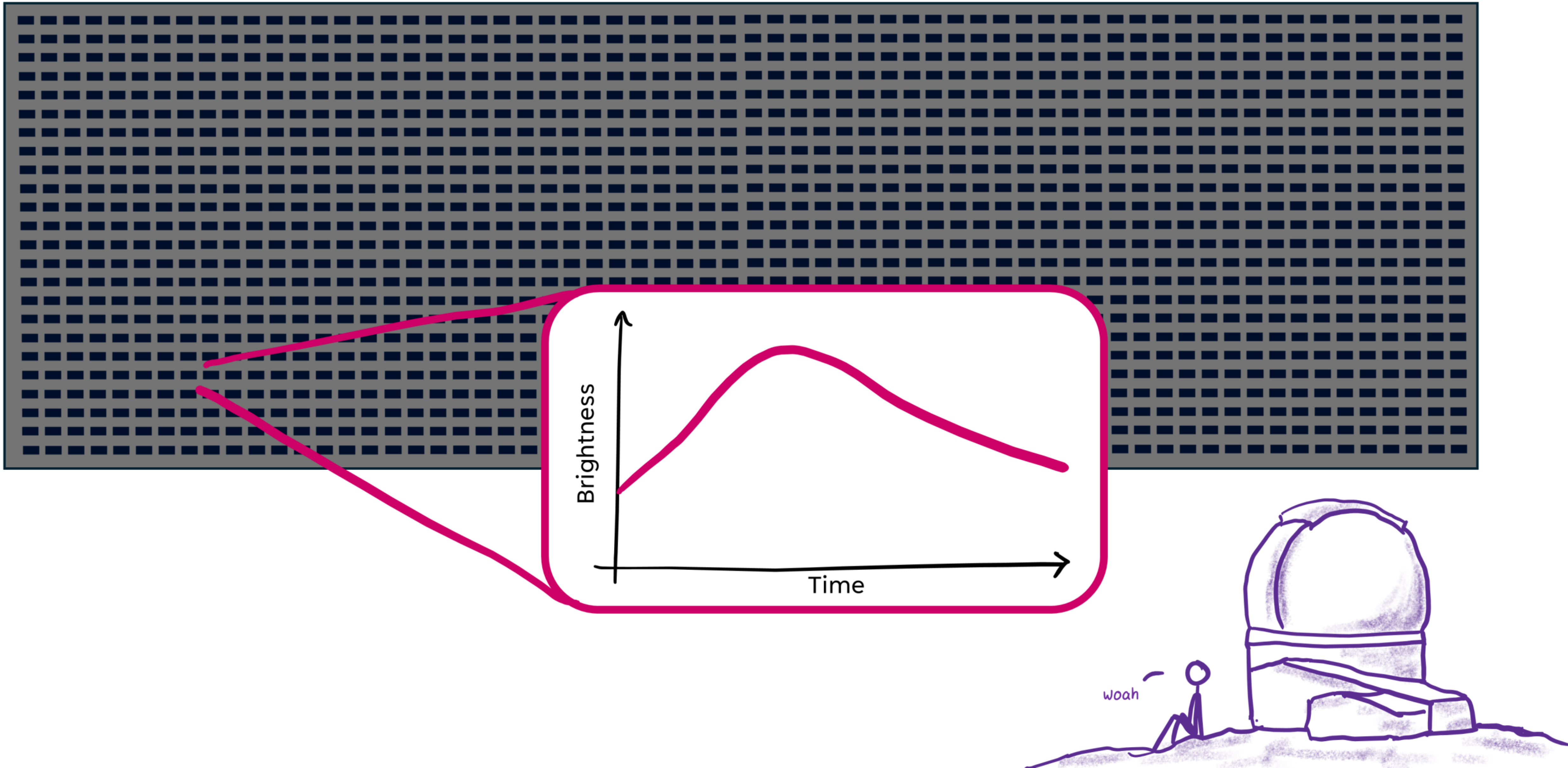
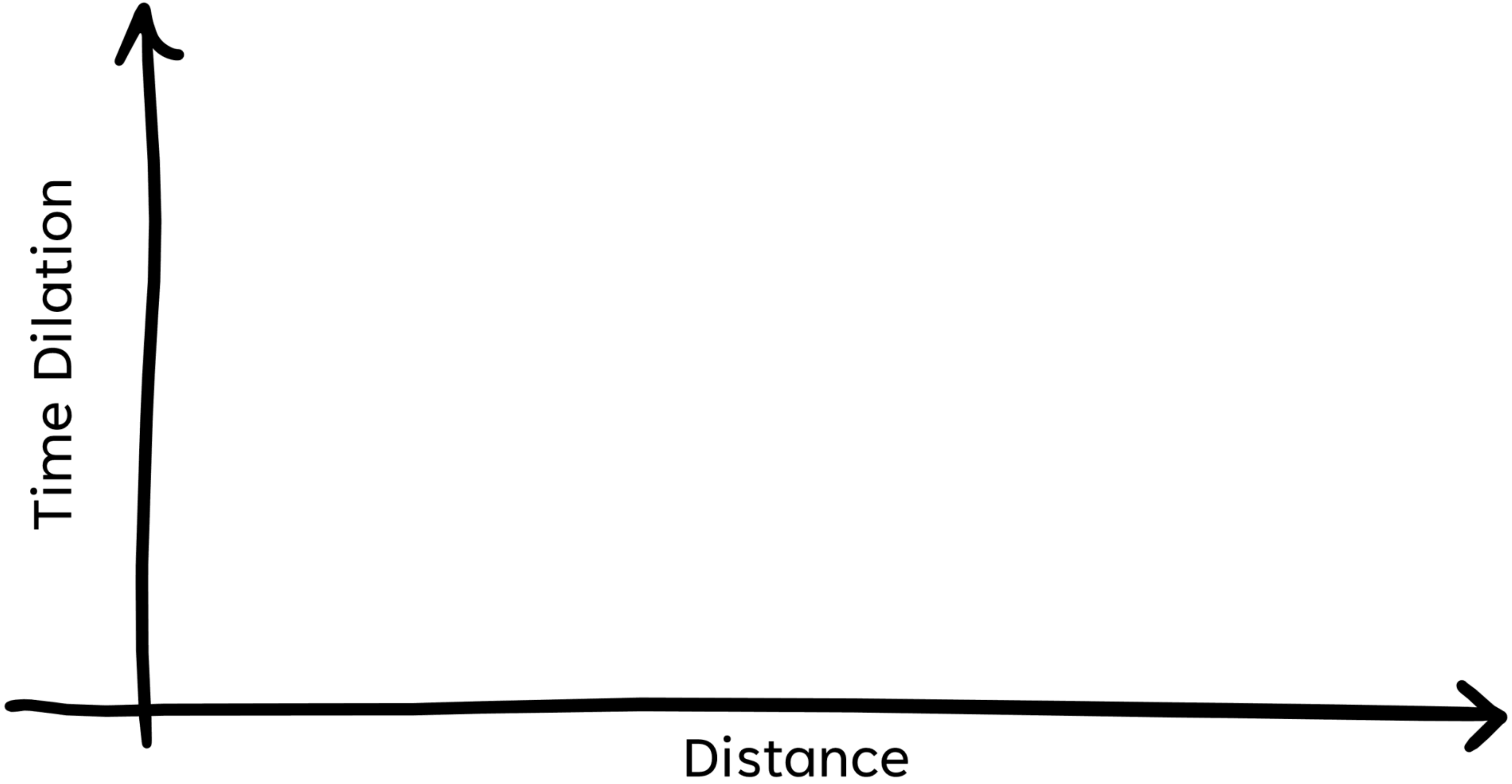


What do we see?



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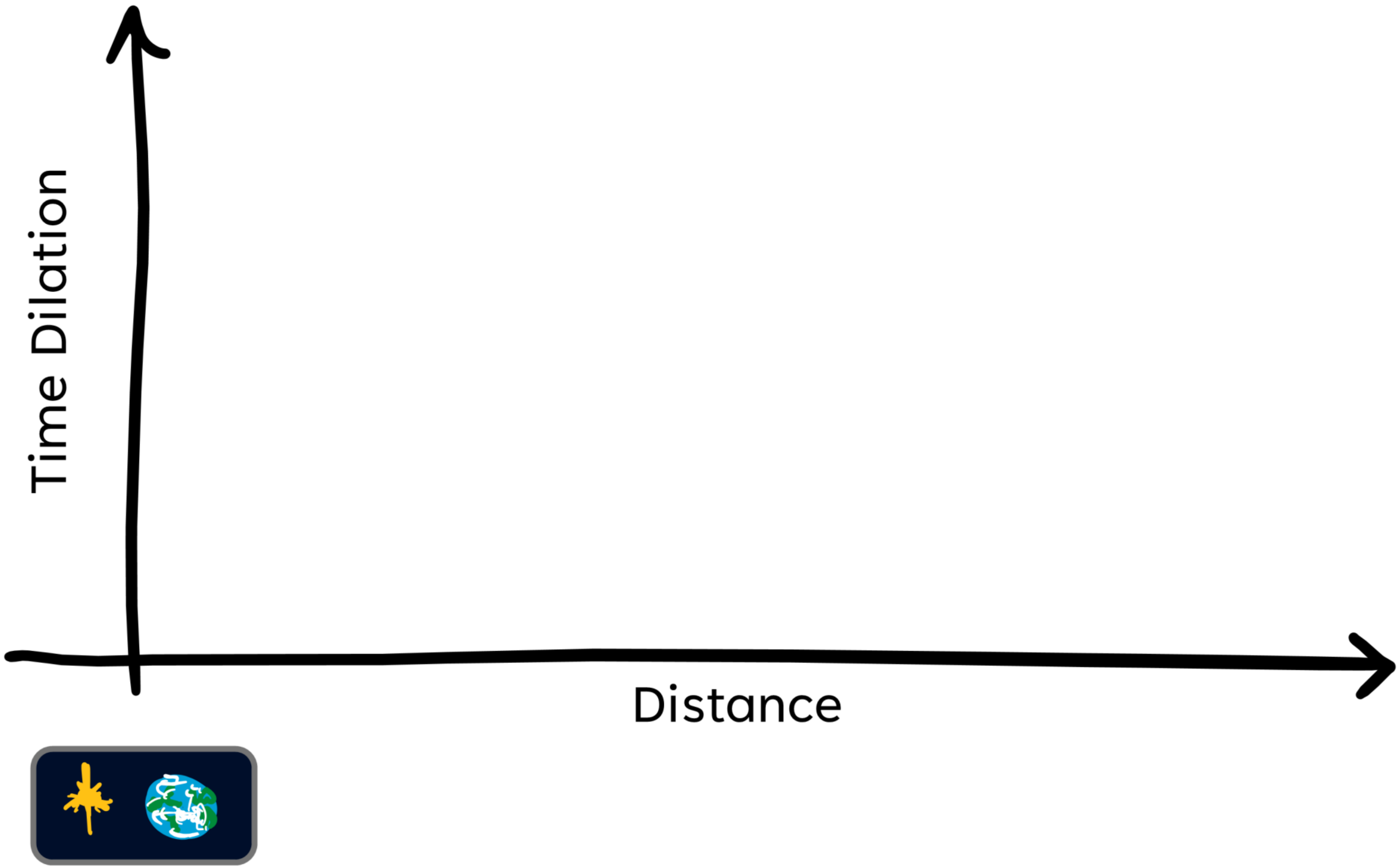

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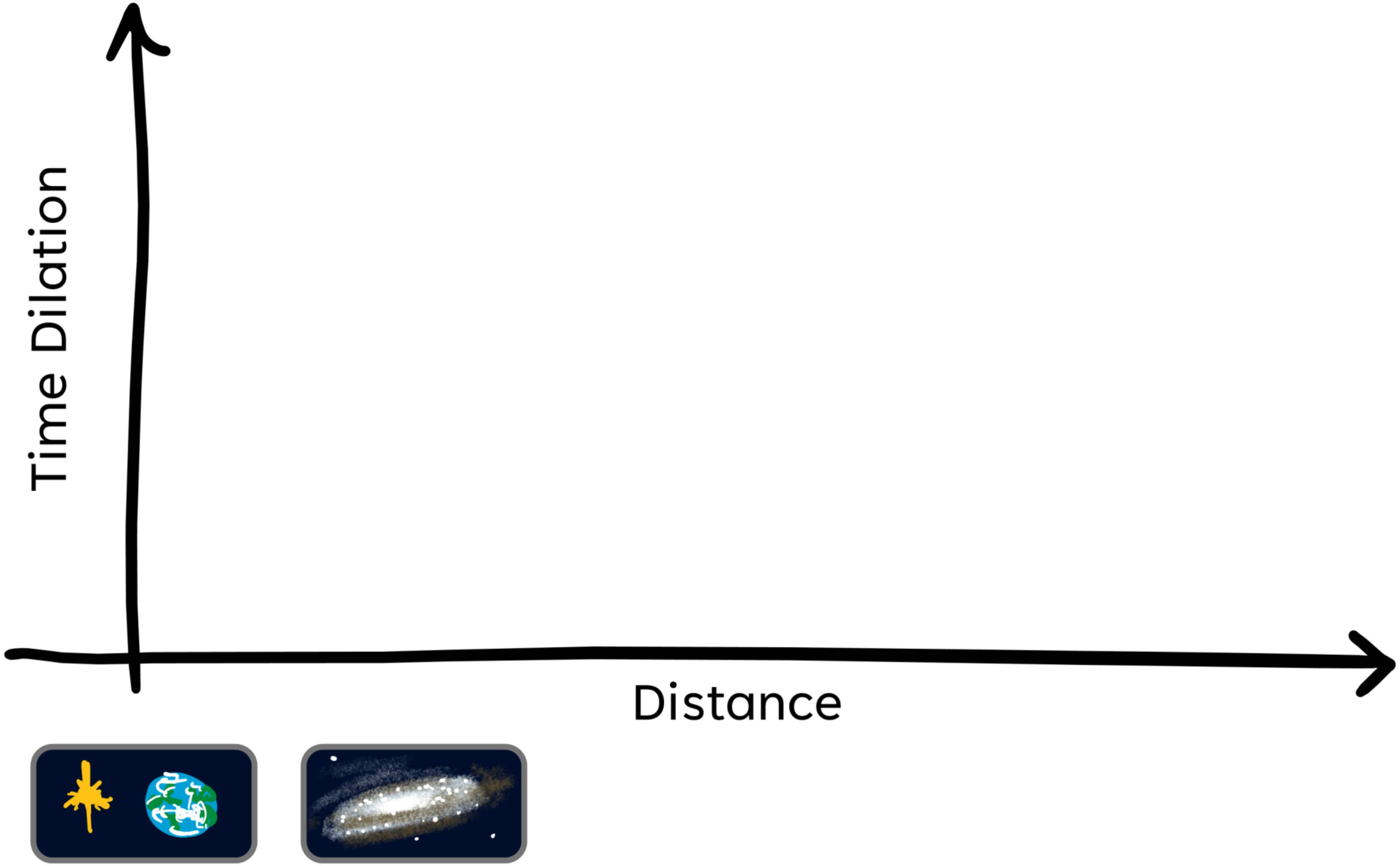

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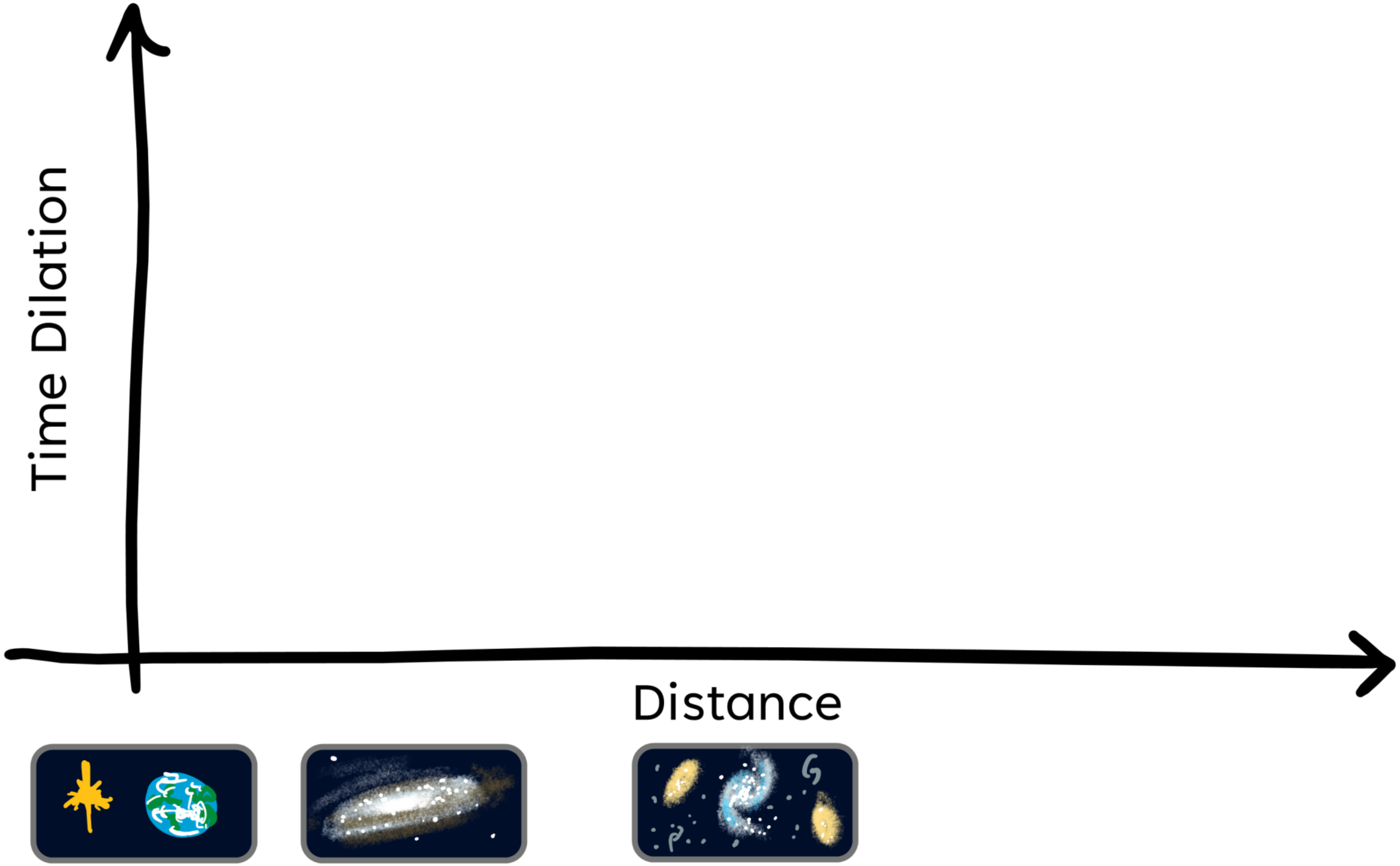

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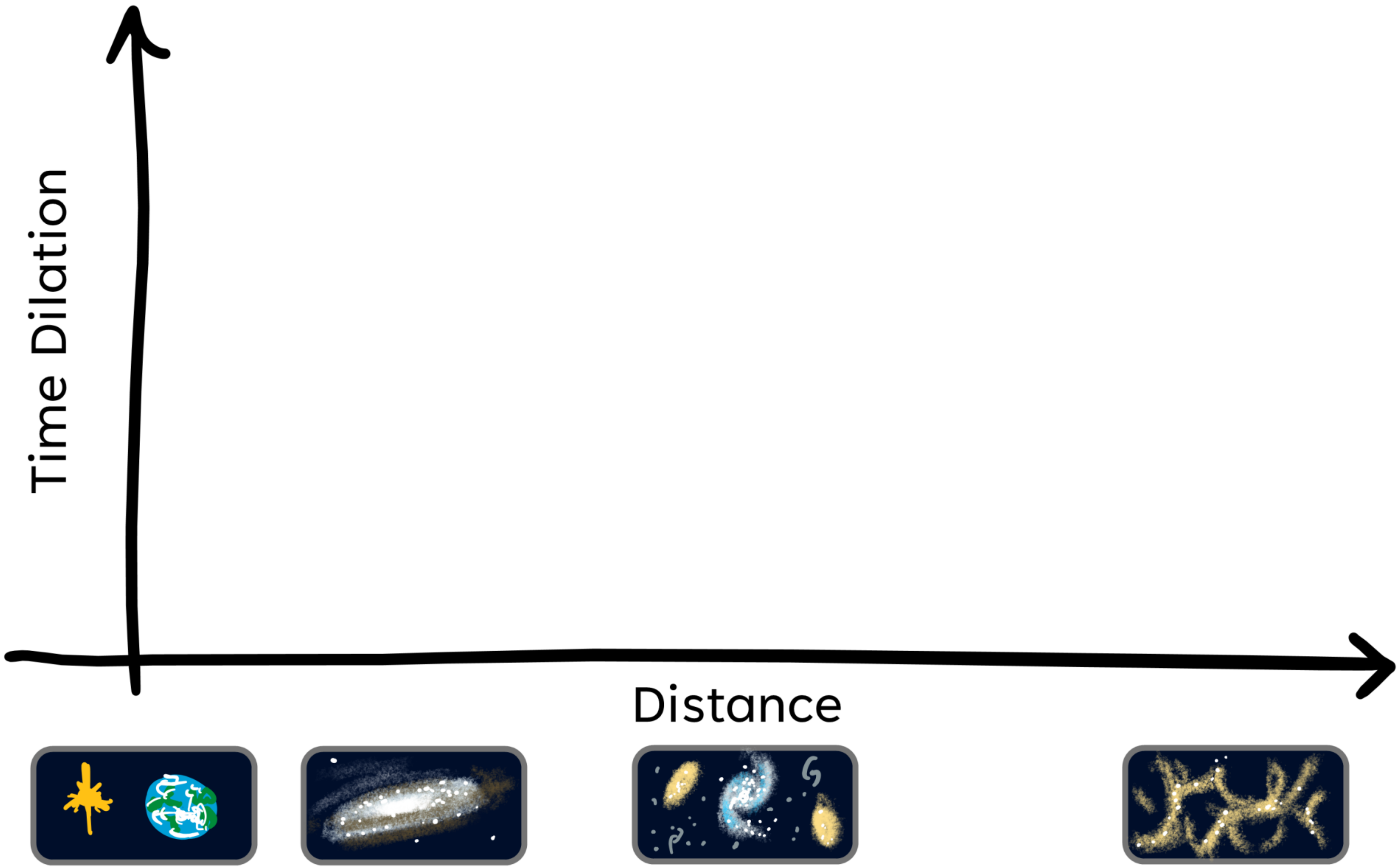

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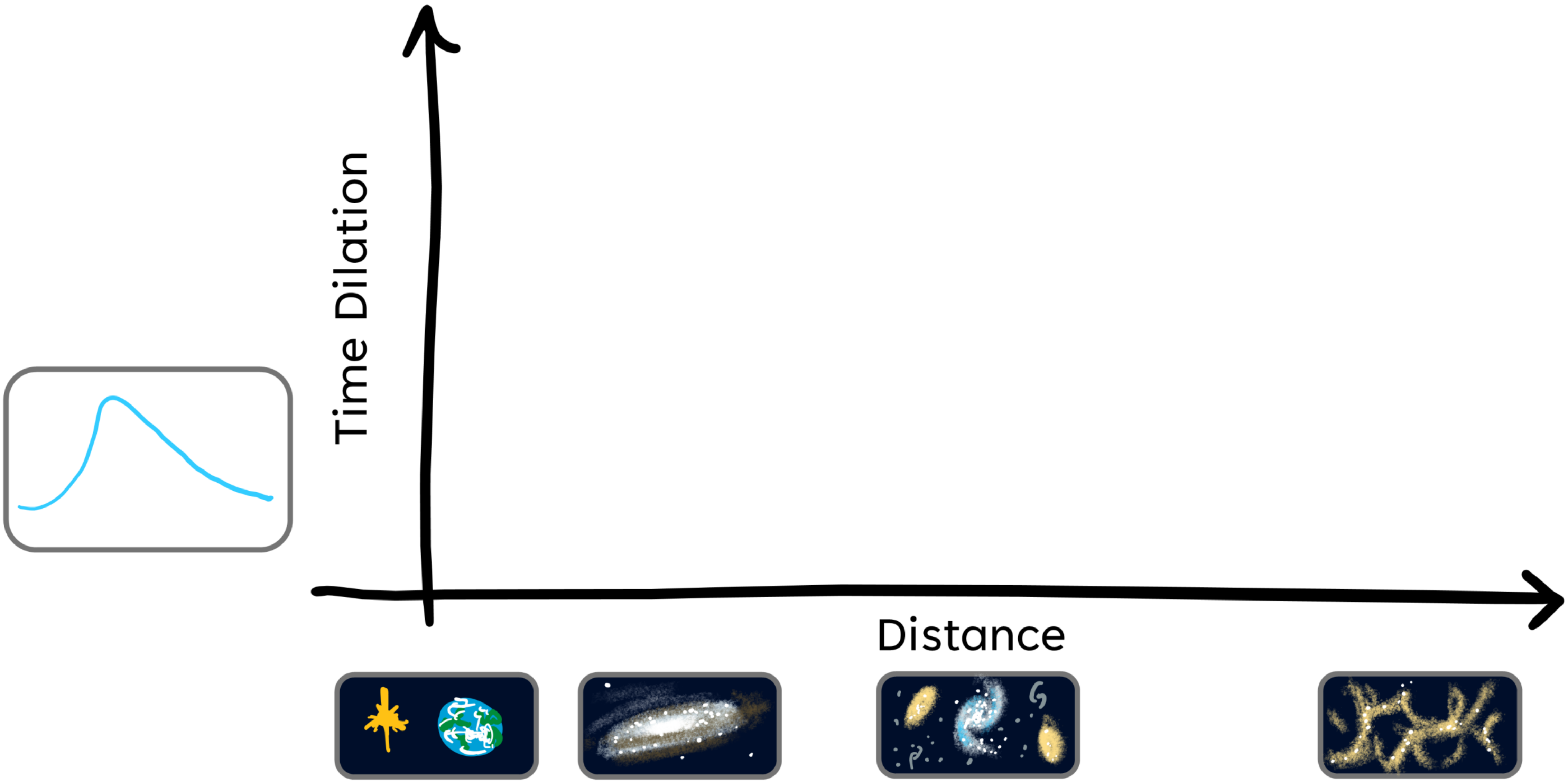

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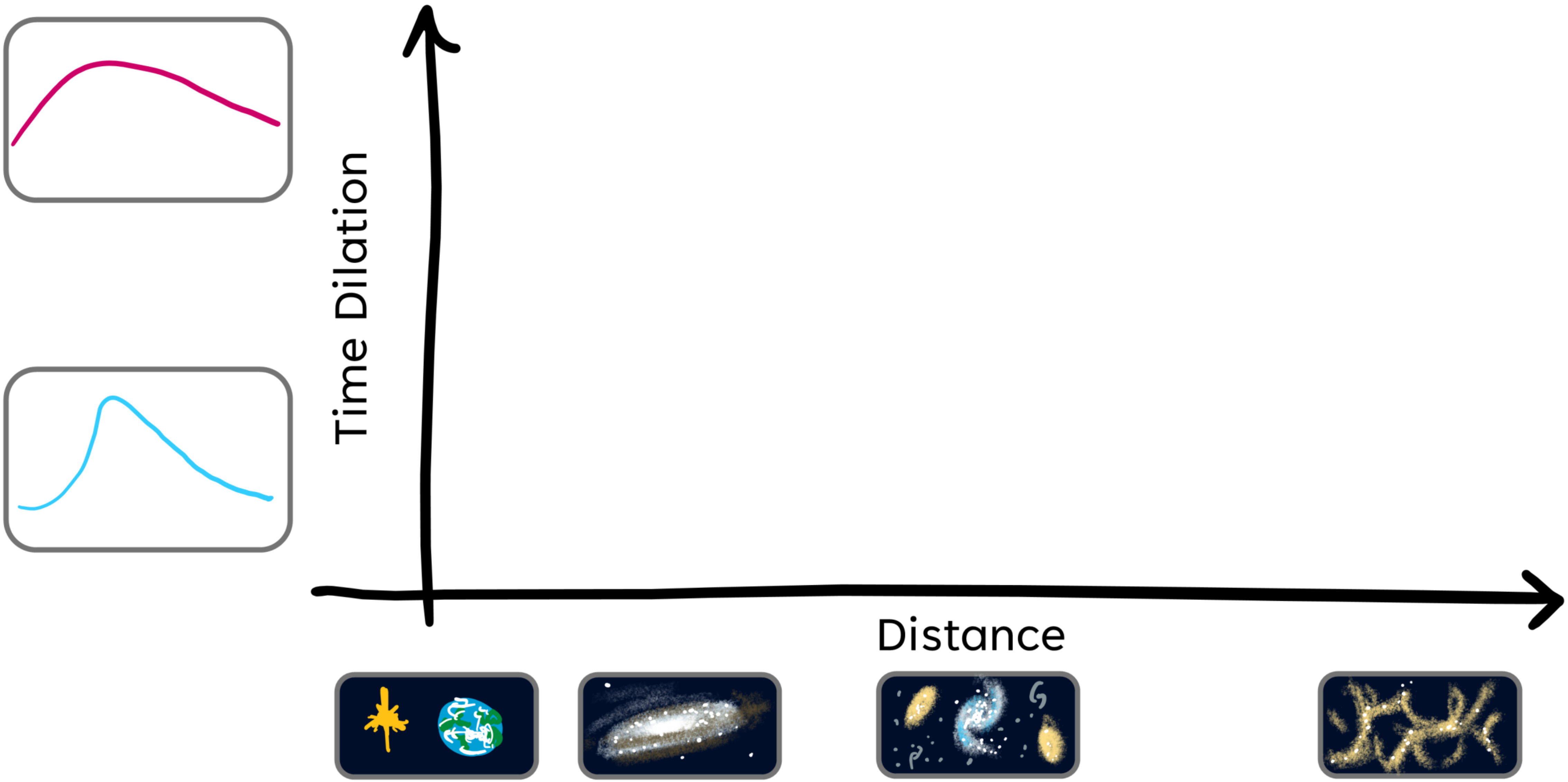

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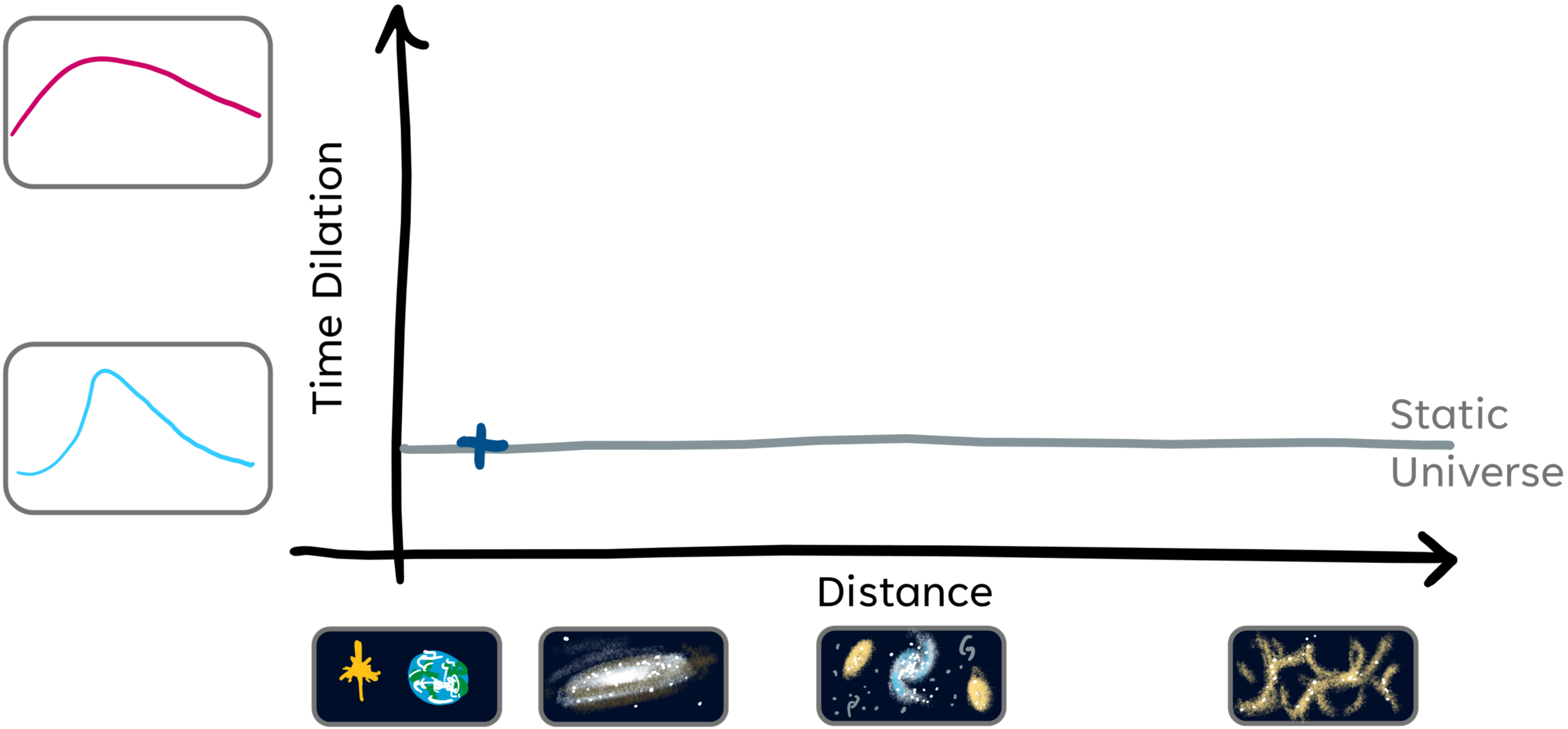

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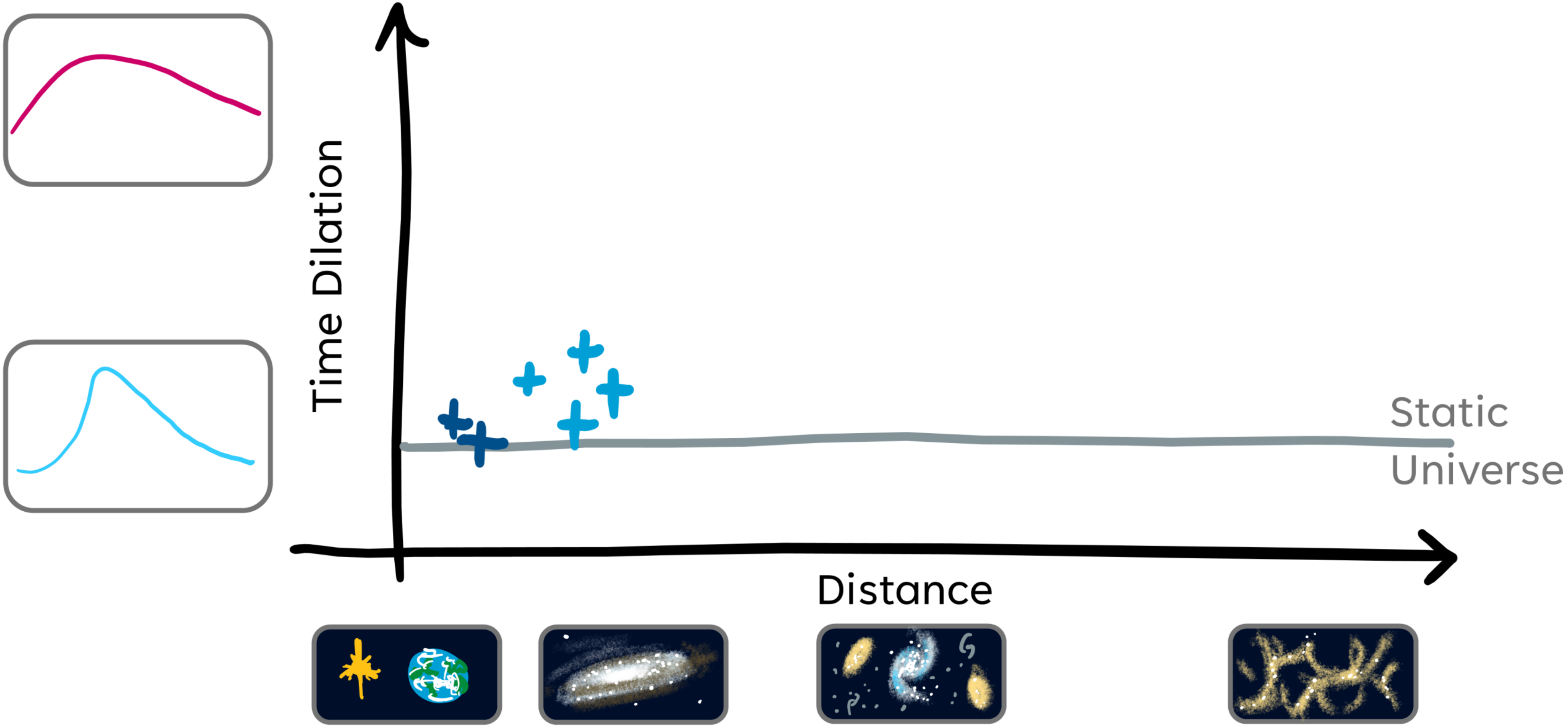

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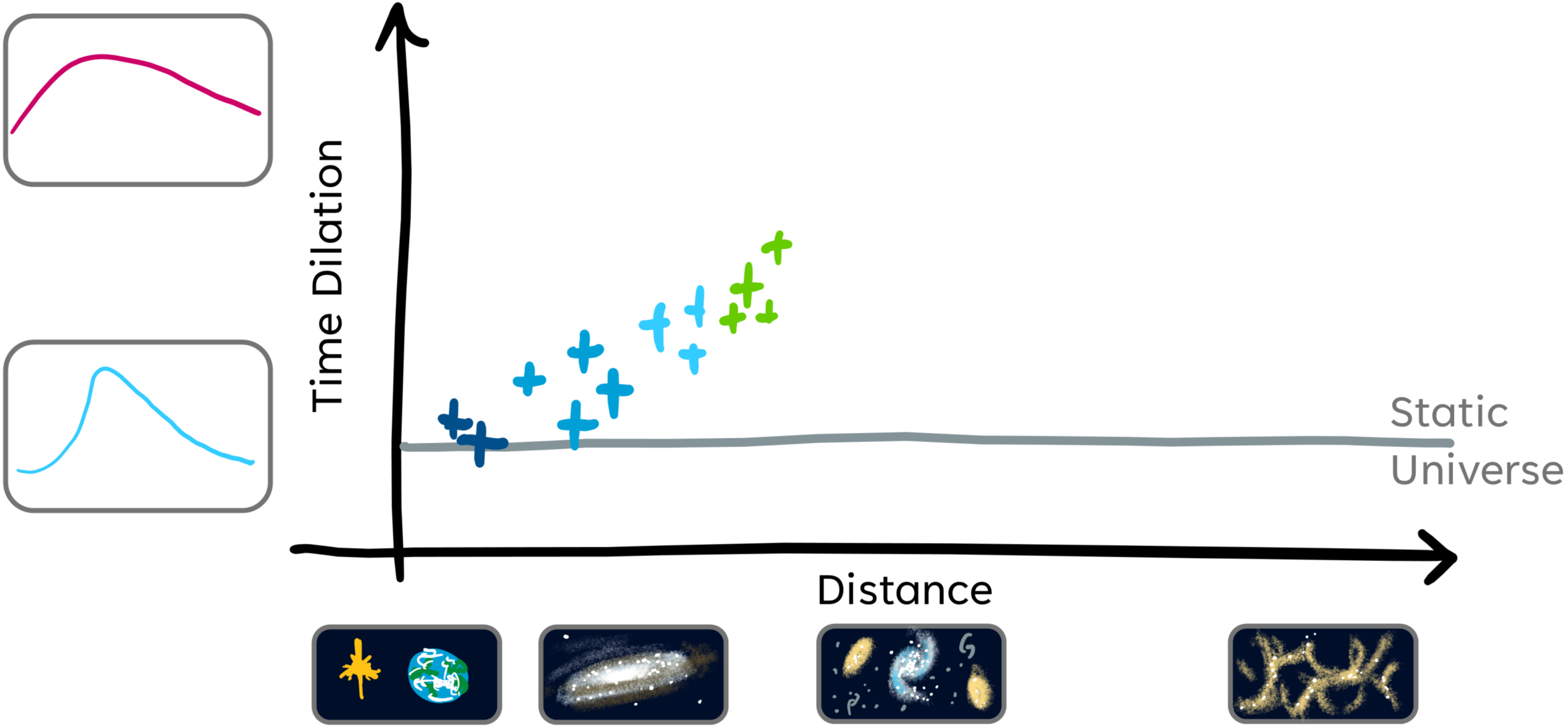

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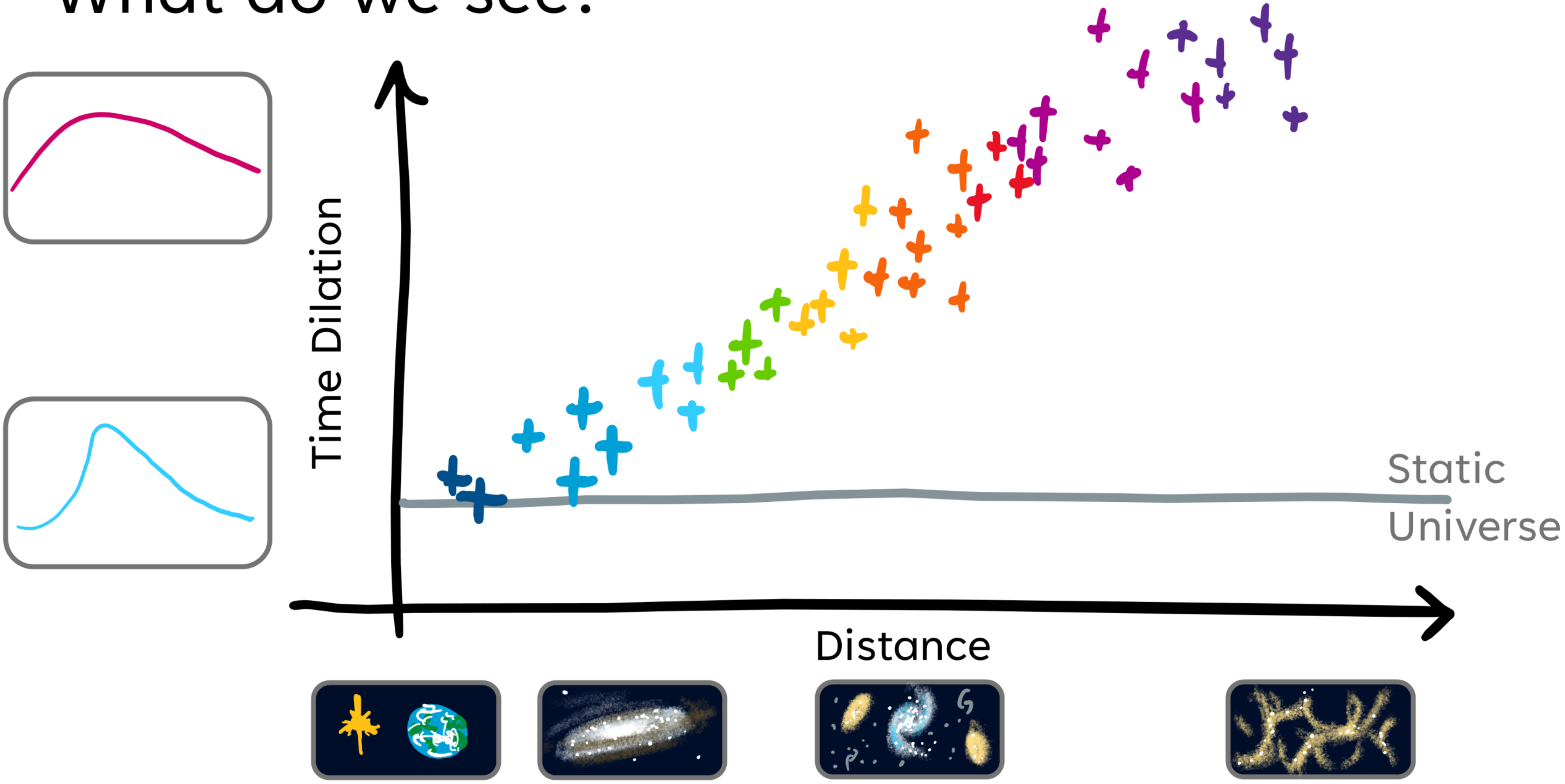

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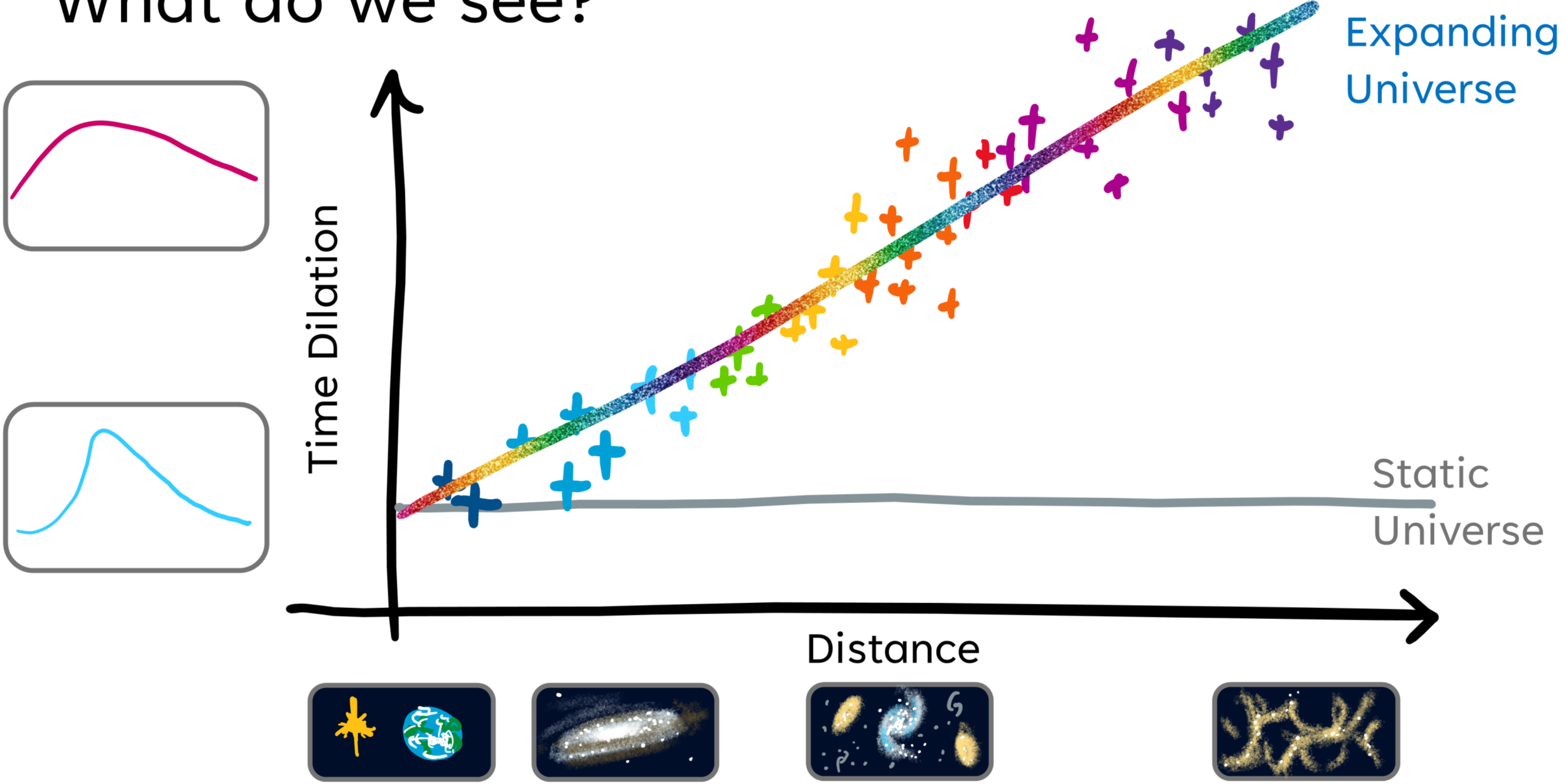
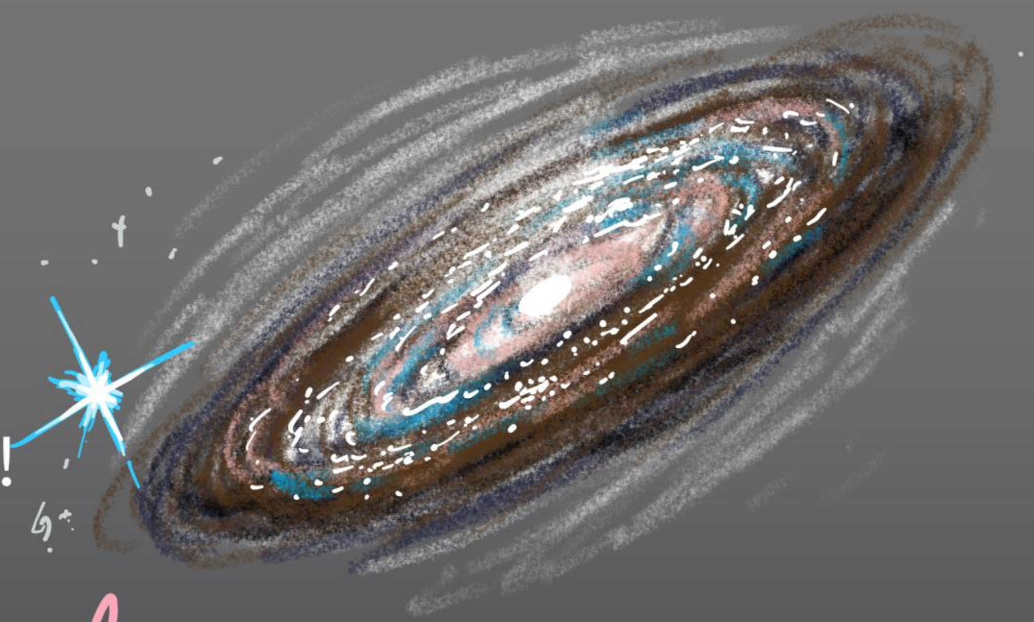


Give it to me straight, doc:

- Time runs slow in the distant Universe
  - This is because the Universe is expanding!
- We used 1500 exploding stars to prove this!



Read more!