

# The Constantly Changing Hubble Constant

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Find the presentation at

<https://tinyurl.com/bycke8v6>

# Interactive content

You are invited to go to

[www.menti.com](https://www.menti.com)

and enter code

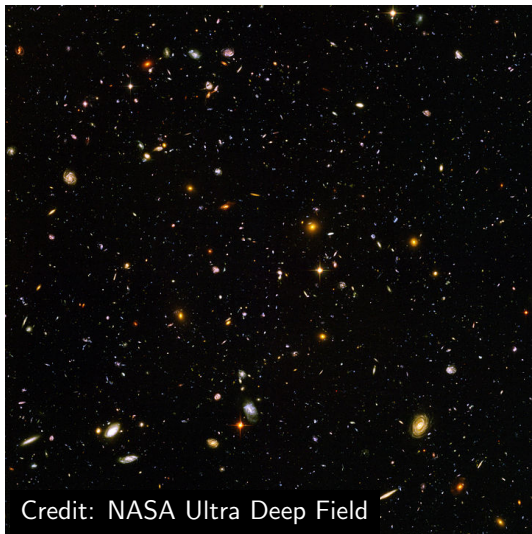
9850 5737

# The Universe is expanding!

- ▶ But what does this actually mean?
- ▶ How do we know it is expanding?
- ▶ Why is it expanding?
- ▶ How fast is it expanding?
- ▶ Are cosmologists completely realistic about the uncertainties in their results?

# How do we know?

- ▶ Everywhere we look, distant galaxies are receding; more distant galaxies are receding faster.
- ▶ So either we are at the centre of a cosmic conspiracy, or all the space between all the galaxies is expanding.



Credit: NASA Ultra Deep Field

# Is the solar system expanding? Are we expanding?

Go to [www.menti.com](http://www.menti.com) (code 9850 5737) and choose one possibility:

1. Yes, a lot
2. Yes, but only a tiny amount
3. No

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# Is the solar system expanding? Are we expanding?

- ▶ Other forces - molecular forces between the molecules in your body, and gravitational forces between the Sun and the planets - are far more than strong enough to overcome the effect of cosmic expansion.
- ▶ Gravity is even strong enough to keep the Andromeda Galaxy from receding from us.
- ▶ It's only the furthest objects - where gravity becomes negligible - that recede.



Credit: David Dayag

## What does *recession velocity* actually mean?

- ▶ We say 'distant galaxies are moving away from us'. This is informal language.
- ▶ They aren't really moving, they just appear to be - because the intervening space is expanding.
- ▶ Sometimes this makes a difference - for example, the recession velocity can exceed the speed of light.



# So how fast is the expansion?

- ▶ For every additional distance of one megaparsec, there's an additional recession velocity of about 70 kilometers per second.
- ▶ So the expansion speed is about 70 kilometers per second per megaparsec.
- ▶ One megaparsec is about three million light years. It's the typical distance between galaxies.
- ▶ 70 kilometers per second is about 150,000 miles per hour.

# So how fast is the expansion?

Start with:

---

# So how fast is the expansion?

Start with:

---

13.5 million years later:

---

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Start with:

---

13.5 million years later:

---

Continental drift is about six times faster...

$H_0$

- ▶ The expansion rate is denoted ' $H_0$ '.

- ▶ The ' $H$ ' commemorates Edwin Hubble (1889-1953), who was one of the first to measure it.



Credit: Johan Hagemeyer

- ▶ The ' $0$ ' refers to today. The expansion rate was different in the distant past.



Credit: Johan Hagemeyer (1884-1962), Public domain, via Wikimedia Common