# Knock Knock! You have received an invitation from the universe!

By Frank Xie on Arpil 24, 2023

Imagine one night, when you have some free time and lazily lie on the couch...

Suddenly, a bold and intriguing idea pops into your mind: you want to learn about the most grand, romantic, and awe-inspiring things in the world!

You pace around the living room, deep in thought. Eventually, your gaze falls upon the twinkling stars...

Oh, the universe is so ancient, its birth and end are so distant; it holds within it far more vastness than the boundless seas, from galaxies to tiny specks of dust, everything we know is encompassed within it.

You think, maybe there's truly a field of study that can allow you to freely explore the boundless universe...

In that case, cosmology would be your top choice!

So, first of all, what is cosmology?

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Certainly, let's start with the distant year of 1929.

But before we delve into that, please allow me to introduce the esteemed Mr. Hubble:

Edwin Hubble is indeed one of the most renowned astronomers in history. He was a genius at visualizing astronomical data and famously used a single graph to illustrate the concept of cosmic expansion and the Big Bang theory. With his exceptional abilities, he elevated the complexity of the field of astronomy by several notches.

One day, the ever-curious Mr. Hubble had a groundbreaking idea: he wanted to create a graphical representation of the relationship between the distance of stars from us and their recession velocities relative to us.

This plotting endeavor turned out to be far from ordinary, as Hubble discovered that there was, astonishingly, a direct proportionality between these two factors!

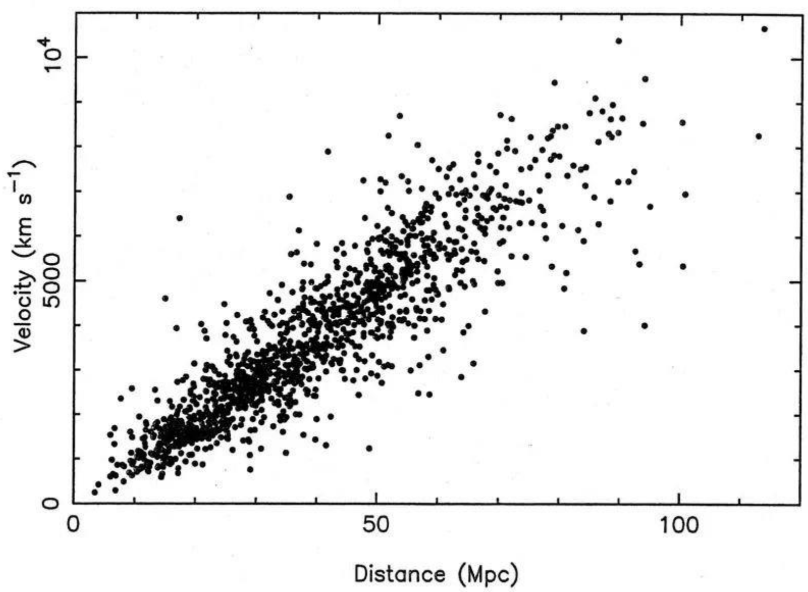


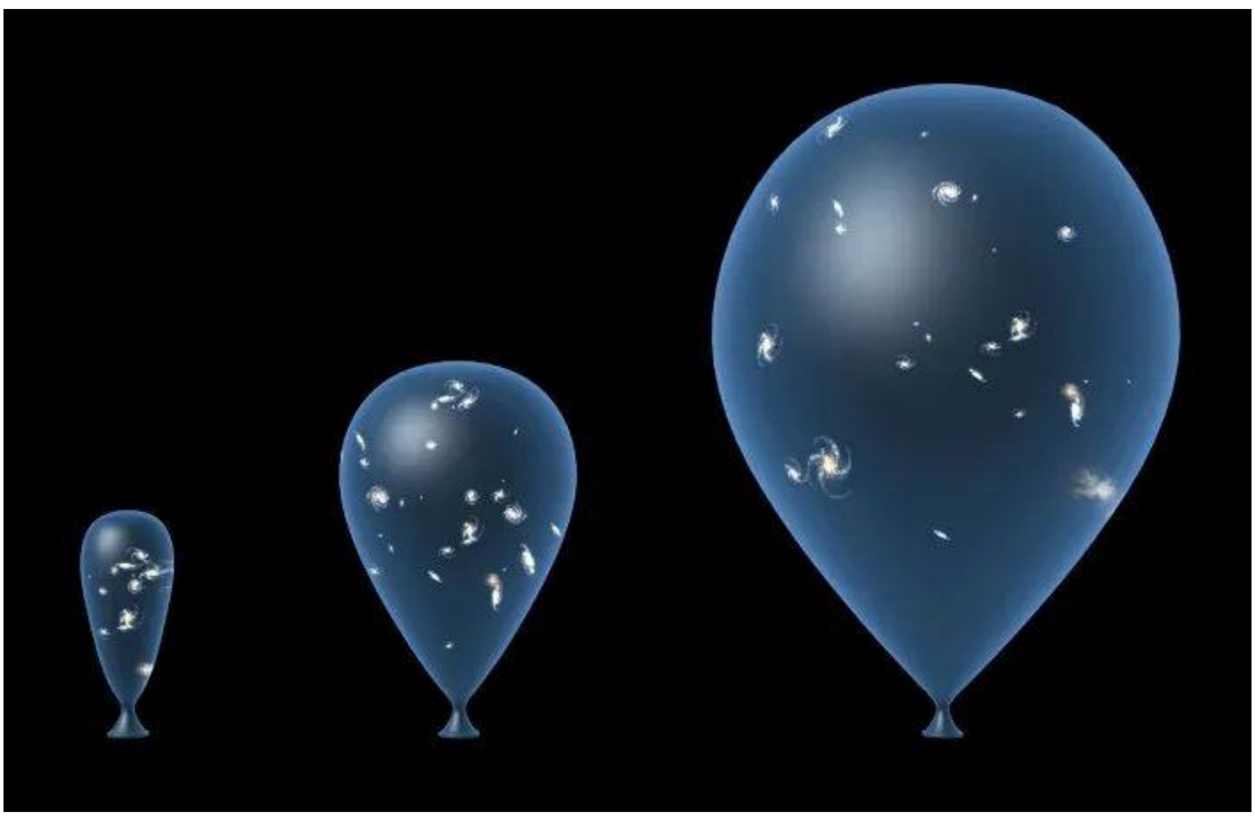

**Figure 2.5** A plot of velocity versus estimated distance for a set of 1355 galaxies. A straight-line relation implies Hubble's law. The considerable scatter is due to observational uncertainties and random galaxy motions, but the best-fit line accurately gives Hubble's law. [The $x$-axis scale assumes a particular value of $H_0$.]

**In simple terms, the farther stars are from us, the faster they move away from us.**

But what does this imply?

This discovery suggests a significant cosmic fact: Earth is not the center of the universe, and there is no real central point in the universe. Instead, celestial objects in the universe are like the various points on the surface of a balloon. As the balloon expands, every point on it is moving away from each other, and the farther apart they are, the faster they are receding relative to one another. In other words, this means that space itself in the universe is expanding, and Earth is not stationary at the center of it.

To give an example, imagine a star representing a point on the surface of the balloon. As the balloon inflates, stars that were originally close together (points) are still relatively close to each other, but those on the opposite side of the balloon have receded quite far. This is the fundamental concept of cosmic expansion, and it provides strong support for the Big Bang theory, which posits that the universe originated from an extremely dense and hot point and has been continuously expanding and evolving since then. This discovery has changed our understanding of the nature of the universe, leading us to realize that the universe is an unbounded space with no true center. **The farther the distance, the faster the recession... doesn't this precisely correspond to the motion of the stars depicted in the graph I created myself?**



In a moment of brilliant insight, Mr. Hubble sensed a whiff of truth and immediately thought: since the pattern of stars' recession resembles the movement of points on the surface of a balloon, could we conclude that the universe itself is expanding, much like a balloon?

So, Hubble boldly hypothesized: the universe is undergoing expansion.

When Edwin Hubble unveiled his research results to the public in 1929, it caused a significant stir in the field of astronomy. While many scholars were still focused on a narrow perspective, Mr. Hubble's vision had already transcended the Earth's atmosphere. What's more, Hubble's research, which approached the universe as a whole, broke away from the traditional approach of astronomy that concentrated on individual celestial objects.

Hubble, along with other pioneering astronomers, made people realize that astronomy could not only focus on specific celestial bodies but could also adopt a broader perspective to observe our world. Thus, the idea of creating a discipline to study the universe from a macroscopic level gained traction.

The proposal of cosmic expansion was one of the key catalysts that opened up this broader view, leading to the emergence of cosmology:

As a branch of astronomy, cosmology studies the universe from a macroscopic perspective, encompassing the overall evolution of the universe, the influence of gravitational fields on large-scale structures, dark matter, dark energy, and more. It emerged as a way for humanity to gain a genuine "God's eye view" and comprehensively study the macroscopic universe.

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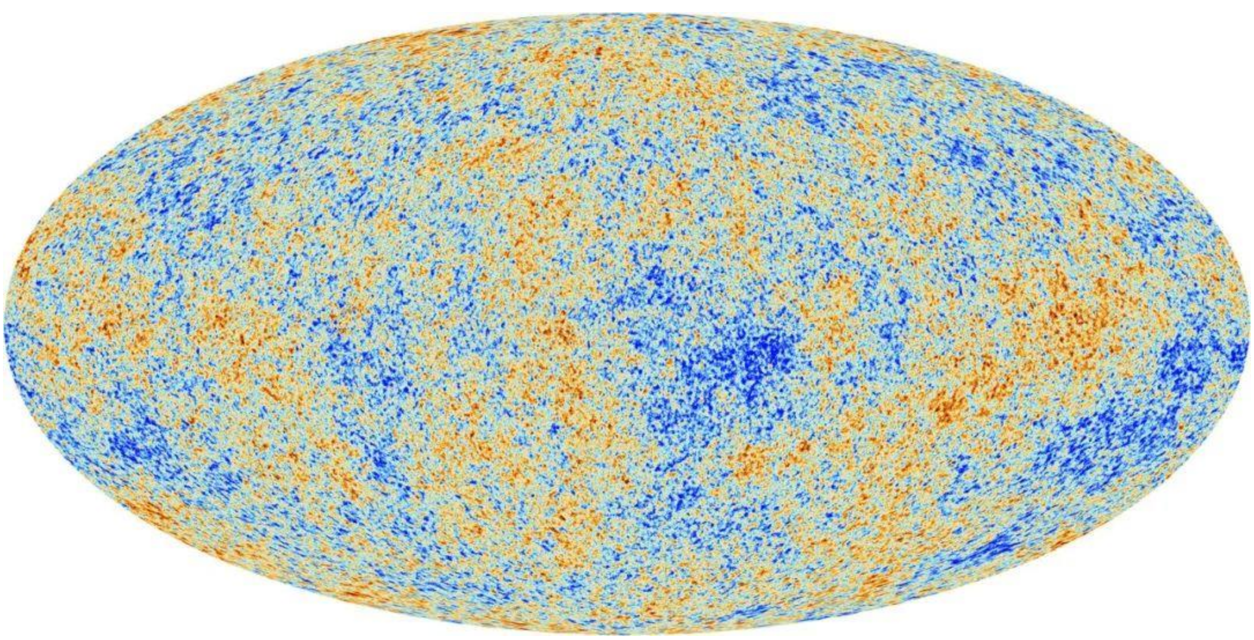
Alright, at this point, you might genuinely wonder:

"I understand the concepts, but what's the practical utility of cosmology?"

Well, I suppose that aside from its use in discovering the origins of the universe, validating theories of physics, expanding our understanding of fundamental physics, unraveling many mysteries of our world, guiding humanity towards a future among the stars, predicting the ultimate destiny of our universe, and researching topics like wormholes and superluminal travel, there doesn't seem to be much else in terms of practical utility (doge).

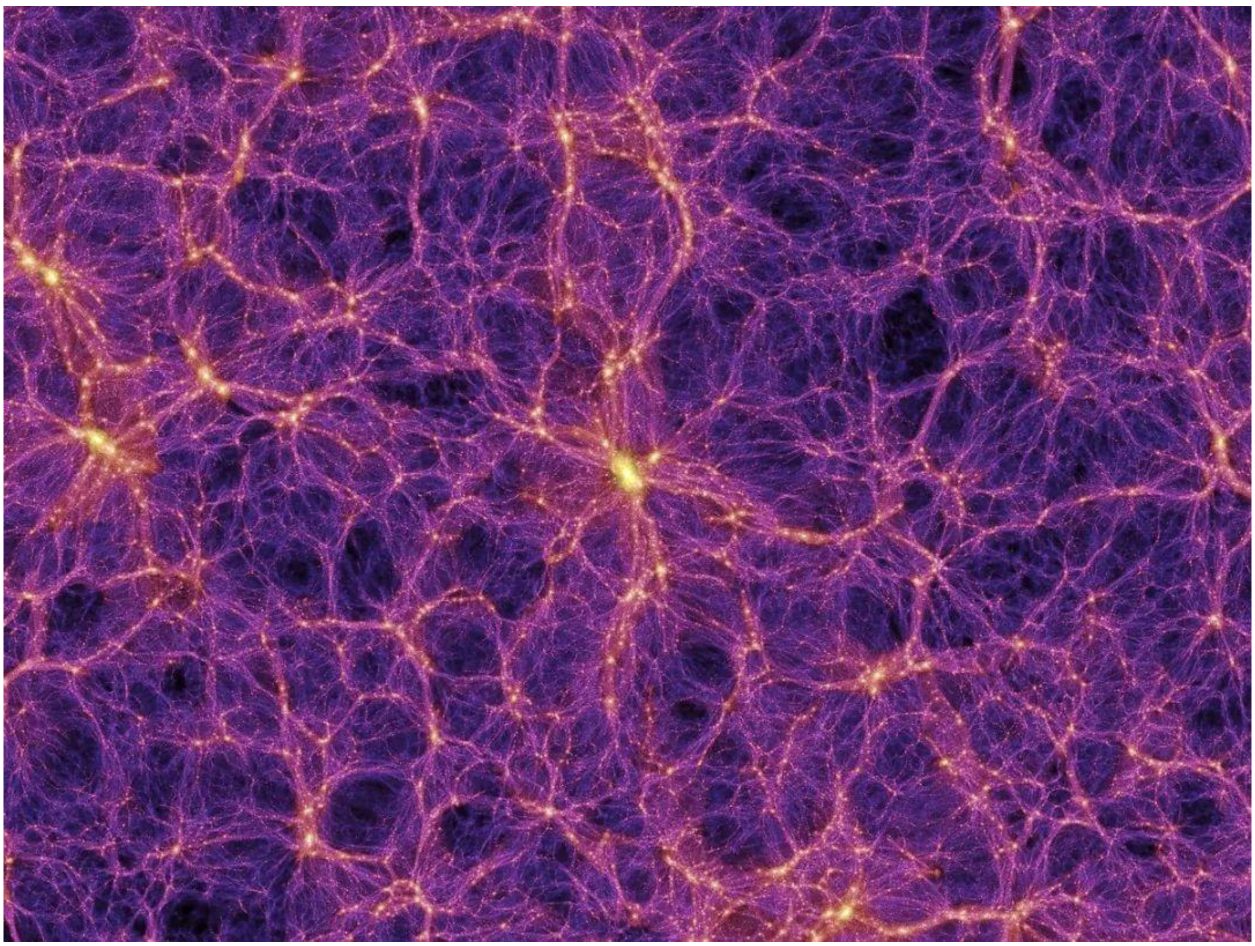
In the course of the development of cosmology:

Cosmologists, by studying the Cosmic Microwave Background Radiation (CMBR), have verified the physics of the Big Bang, providing a clear understanding that our universe evolved from a singularity with infinite density.



Astronomers have confirmed Einstein's General Theory of Relativity by observing gravitational lensing effects and detecting gravitational waves.

Scientists have proposed dark matter and dark energy by observing the activity of galaxies and the expansion patterns of the universe. This development has opened up new frontiers in particle physics and quantum physics.



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Now, you should have some understanding of cosmology, but... theoretical physics? What's that "M" something radiation? Gravitational waves? Dark energy?

Does this bring back memories of a time when physics concepts seemed confusing and hard to distinguish?

The fear of being dominated by physics?

Memories of dozing off in physics class?

Don't worry! In the realm of cosmology, as a purely educational platform, our focus is on humor and simplicity!

We'll start with some fun facts from astronomy:

Where in the solar system can you find a fountain show? ☀️

What kind of ice cream heights can Saturn achieve? □

We'll revisit some anecdotes from the history of astronomy:

How did Neptune witness a quarrel between the British and the French?

Can planets be served on a plate of calamari?

Then, we'll take a look at the prospects of cosmology:

What does the future of the universe look like... a stew? 🌌

How's the appetite of a black hole?

And, of course, there are plenty of fascinating crossovers in astronomy that you may not know about:

Someone composed a symphony for planets? 🎶

If you find this interesting, feel free to continue following us! We'll strive to keep updating.

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