



Stories of Science: An Expanding Universe?

The story of how Edwin Hubble corrected Albert Einstein.

Edwin Hubble was born in 1889 in Missouri, USA. He was a talented athlete and captained his University of Chicago Basketball team to a title in 1907. Despite a love of astronomy, he studied law to please his father. He then moved to The Queen's College in Oxford, England, where he studied law, literature and Spanish to gain a master's degree. When his father died in 1913, he returned to America to dutifully help his mother and siblings, however after his father's death he now no longer had the motivation to become a lawyer, so instead taught at a High School. He taught Spanish, physics and maths, as well as being the basketball coach. After a year of teaching he started a doctorate degree (PhD - the highest level of study), which he received in 1917. His dissertation project was titled "Photographic Investigations of Faint Nebulae". He was able to do this because he had access to one of the world's most powerful telescopes at his University (the collecting mirror was 61 cm across).



Edwin Hubble

After finishing his PhD dissertation Edwin joined the United States Army to fight in World War 1. He did not see combat though. After the war he spent a year in Cambridge, England, studying astronomy, before moving to work at the Mount Wilson Observatory in California, so that he could work with the world's largest telescope, the Hooker Telescope, which had a 2.5 m mirror.



Hooker Telescope

Discovery of objects outside of the Milky Way

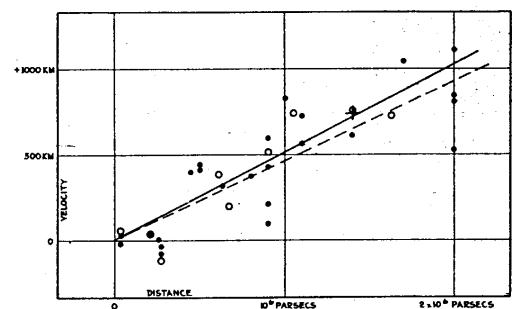
Between 1922 and 1923 Hubble observed lots of stars, including Cepheid variables; a type of pulsating star which get bigger and smaller in size, and therefore brightness. Cepheid variables follow a regular pattern, so by looking at how fast the star changes brightness, you can work out how bright it must be. This means you can tell if a star is a bright star far away, or a dim star that is close.

After further careful observation he concluded that some of the Cepheid variables he found were so far away that they must have been outside of our own Milky Way galaxy.

He published this research in 1924.

Proof of an expanding Universe

Hubble continued to make observations. He spent time looking at red shift. Red shift is an effect where light from an object that is moving away from us looks 'redder' than if the object was stationary. This is a type of Doppler shift, which we hear when a siren goes past us like on an ambulance, or the pitch change of the engine of a Formula One car as it passes. Hubble discovered that the further away a galaxy was, the greater its redshift. This means that galaxies far away are moving away from us at a greater speed. This is called Hubble's law.



Hubble's Graph from 1929

Albert Einstein had thought that the universe was static, but his equations suggested the universe must either be expanding or contracting. He added a number called the 'cosmological constant' to 'correct' his equations to match up to what he believed. After the discovery of Hubble's Law Einstein realised that he was wrong, calling the cosmological constant his "biggest mistake". He travelled to Mount Wilson in 1931 to thank Hubble for providing the evidence to change his thinking.

Shortly before Hubble's death in 1953 he became the first person to use the Hale Telescope, which had a 5.1m mirror. The Hubble Space Telescope, which launched in 1990, is named in his honour.



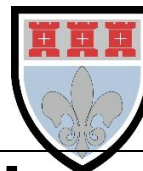
Comprehension and Reflection Questions

1. Hubble faced a difficult choice between studying law and becoming a scientist. What would you do if you were in his shoes?

2. Cepheid variables are sometimes known as 'standard candles' - can you explain why?

3. What pattern do you notice with the size of telescope mirrors during Hubble's lifetime? What do you think caused this? How do you think it helped him?

4. The Hubble Space Telescope has a 2.4 m mirror yet can take much clearer image than the Hooker or Hale telescopes. Why do you think this is?



Extension Activities

Ideas for things to do next:

Research red shift and describe it to someone (you'll probably need a diagram!)

What other things have been named after Hubble? What would you want named after you?

Research Georges Lemaître - why did he struggle with the science he discovered?

Research competing claims to Hubble's Law - should it be named after him?

Further Reading

Ideas for things to read next:

Read some Wikipedia pages:

- Edwin Hubble
- Hubble's Law
- Red Shift
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Read an article by Hubble:

<http://nimble.nimblebrain.net/hubblepaper.html>

Research the value of 'Hubble's constant'. How has our estimation of it changed over time, and what does this show?