How do we measure the size and the age of the universe?

By NASA.gov, adapted by Newsela staff on 11.18.16

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TOP: Barred Spiral Galaxy; NASA Goddard, Flickr. BOTTOM: An image of the globular cluster Messier 69, as viewed through the Hubble Space Telescope, NASA/ESA.

The age of the universe is 13.82 billion years old, according to cosmologists. These are scientists who study the universe. The measurement is based on observations taken by the Planck spacecraft, which was launched in 2009 by the European Space Agency. NASA also participated in the Planck mission.

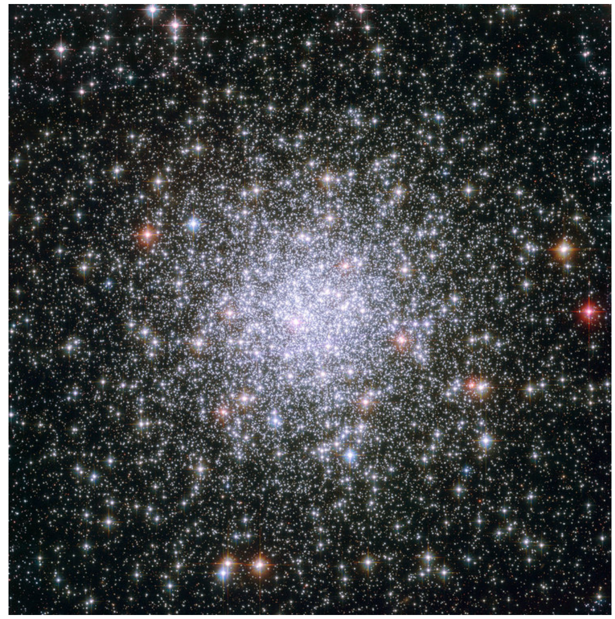
For more than four years, Planck scanned the skies. It took incredibly exact measurements of tiny variations in the universe's oldest light. This ancient light is known as the cosmic microwave background. It is radiation leftover from the Big Bang, the event that formed the universe. The data collected by Planck allowed cosmologists to make the most precise prediction yet of the universe's age.

Not Very Precise

Before Planck and earlier spacecraft gave scientists a closer look at the cosmic microwave background, they had estimated the age of the universe to be somewhere between 10 and 20 billion years old. They made this estimate in two ways: by looking for the oldest stars, and by measuring the rate that the universe is expanding. They used the expansion rate to calculate backward to the Big Bang.

Studying A Star's Life

Astronomers tried to figure out the ages of some of the oldest stars by studying globular clusters. A globular cluster is a group of close to a million stars that all formed around the same time. Near the center of a cluster, the stars are very, very close together.



The life cycle of a star depends upon its mass. High-mass stars are much brighter than low-mass stars, and they burn out more quickly. A star like the sun has enough hydrogen fuel to burn for about 9 billion years. A star that is twice as massive as the sun will burn through its fuel supply in just 800 million years.

A 10 solar mass star is a star that is 10 times more massive than the sun. It burns nearly 1,000 times brighter than the sun, but it has only a 20-million-year fuel supply. On the other hand, a star that is half as massive as the sun burns much more slowly. It has enough fuel to last more than 20 billion years.

The stars in a globular cluster can serve as cosmic clocks. If they are more than 10 million years old, they will be less massive than 10 solar masses. If the stars are more than 2 billion years old, they will be less massive than 2 solar masses. The older the stars, the smaller their solar masses.

The oldest globular clusters contain stars that are less massive than 0.7 solar masses. These low-mass stars are much dimmer than the sun. This suggested to astronomers that the oldest stars were between 11 and 18 billion years old. The uncertainty in this estimate was due to the difficulty in determining the exact distance to a globular cluster.

Since then, more advanced telescopes have allowed scientists to make much more precise estimates. Today, the oldest stars in the universe are believed to be between 13.2 and 13.4 billion years old.

How Fast The Universe Is Expanding

Another way astronomers estimate the age of the universe is based on the "Hubble constant." This is a measure of the current rate at which the universe is expanding. Scientists use this measurement to calculate back to the Big Bang.

This calculation depends upon the current density and composition of the universe. If the universe is flat and composed mostly of matter, then the age of the universe is less than the Hubble constant. If the universe has a very low density of matter, then its age is greater.

Astronomers worked hard for many years to measure the Hubble constant. For a while, their best estimates suggested that the age of the universe was between 10 and 20 billion years.

This estimate posed a problem. If the age of the universe was really as low as 10 billion years, it would suggest that the universe is younger than the age of its oldest stars.

13.7 Billion Years And Counting

NASA soon helped dismiss this apparent contradiction. In 2003, the U.S. space agency published the first batch of data collected by the Wilkinson Microwave Anisotropy Probe (WMAP). This spacecraft was launched in 2001. It was sent up to measure tiny temperature variations in the cosmic microwave background.

WMAP sent back several batches of data during its 12-year mission. Its observations strongly suggested that the expansion age of the universe was, in fact, larger than the age of the universe's oldest globular clusters. WMAP suggested that the age of the universe was approximately 13.7 billion years. The more recent Planck mission improved upon these estimates. According to Planck, the universe is about 100 million years older than WMAP had suggested.

Quiz

1 Read the section "How Fast The Universe Is Expanding."

Select the paragraph that explains WHY astronomers were troubled by early estimates about the age of the universe.

2 Which sentences from the section "13.7 Billion Years And Counting" highlight the idea that advancements in technology have helped to more exactly measure the age of the universe?

(A) NASA soon helped dismiss this apparent contradiction. In 2003, the U.S. space agency published the first batch of data collected by the Wilkinson Microwave Anisotropy Probe (WMAP).

(B) This spacecraft was launched in 2001. It was sent up to measure tiny temperature variations in the cosmic microwave background.

(C) Its observations strongly suggested that the expansion age of the universe was, in fact, larger than the age of the universe's oldest globular clusters.

(D) WMAP suggested that the age of the universe was approximately 13.7 billion years. The more recent Planck mission improved upon these estimates.

3 Read the paragraph from the section "How Fast The Universe Is Expanding."

> *Another way astronomers estimate the age of the universe is based on the "Hubble constant." This a measure of the current rate at which the universe is expanding. Scientists use this measurement to calculate back to the Big Bang.*

What role does this paragraph play in the article?

(A) It explains how scientists are able to understand and use the Hubble constant.

(B) It provides a summary of a scientist's conclusions about the Big Bang theory.

(C) It highlights two competing points of view about the rate at which the universe is expanding.

(D) It gives an example of a way scientists measure the age of the universe.

4 Why does the author include the introduction [paragraphs 1-2]?

(A) to give information about current knowledge of the universe's age

(B) to compare and contrast among ideas of the Big Bang theory

(C) to describe the type of spacecraft used on the Planck mission

(D) to highlight the importance of understanding the age of the universe