Astronomers improve cosmic distance scale with Hubble

11 April 2007

An international team of astronomers led by Fritz Benedict and Barbara McArthur of The University of Texas at Austin has used Hubble Space Telescope to solve one of the biggest problems in measuring the universe's expansion. Their results are published in the April issue of the *Astronomical Journal*.

The universe's rate of expansion, called "the Hubble constant," has been hotly debated for decades. It plays an important role in calculating the age and fate of the universe, and the understanding of how the universe evolved since the Big Bang.

To calculate the Hubble constant, astronomers must be able to measure precise distances to galaxies billions of light-years away. That capacity, in turn, is built on a series of measurement techniques in the so-called "cosmic distance ladder"—each of which allow astronomers to measure distances a little farther out into the universe.

One rung in the distance ladder is called a "Cepheid variable star." The light from these stars varies in a predictable way, which allows astronomers to know their distance. Benedict's team set out to calibrate these Cepheids, to make them a better distance indicator.

This study, which will be of great use to astronomers in many areas of study, was seen as so essential that it ranked first among more than 1,000 proposals for use of Hubble Space Telescope in 2003, when the project began.

Benedict's team used Hubble to directly measure the distance to 10 Cepheids in our Milky Way galaxy.

"Knowing their distances from an independent method, and then comparing that to the distance derived from the star's light variation, enabled us to calibrate Cepheids into perfect 'standard candles,'" said Tom Barnes of The University of Texas at Austin, the team's Cepheid expert.

The team followed these 10 stars for two years, measuring their apparent motion on the sky, called "parallax." For an easy demonstration of this phenomenon, hold up one finger in front of your face, and close one eye. Then switch eyes. The finger seems to jump, though it hasn't actually moved. That apparent motion is parallax.

First, Benedict's team measured each star's precise position. They did this again six months later, when Earth's (and HST's) vantage point had changed to the opposite side of the Sun. Like the test using your eyes to watch a finger, the stars' positions seemed to jump. But that jump is so small—the size of a quarter seen from 1,500 miles away—that it can only be measured with the Hubble Space Telescope. This level of precision cannot be achieved using a ground-based telescope.

With parallax measurements in hand, the team figured out exactly how the intrinsic light output of each of these stars varies over time. And because Cepheid variable stars all work the same way, they can apply this technique across the universe.

According to Benedict, "With this calibration, astronomers can deduce the distance to any galaxy in which a Cepheid can be detected."

McArthur notes that they tested the result on other galaxies, and it gives distances consistent with other methods.

"Applying this relationship to many and more distant galaxies should improve the accuracy of the Hubble constant," she said.

This science of measuring precise positions of objects on the sky is called "astrometry." The Hubble Space Telescope Astrometry Team was

founded at The University of Texas at Austin long before the telescope launched in 1990, and helped design its Fine Guidance Sensors and ensure they would be useful for this kind of study.

"We've been cranking on this since 1977," Benedict said, "and as we tell our children, 'Practice makes perfect!' This result has excited me more than any in my 35-year career, and we will have more and better over the next five years."

In addition to Benedict, McArthur and Barnes, the international team for this research consisted of Michael E. Feast of The University of Cape Town, Thomas E. Harrison of New Mexico State University, Richard J. Patterson of The University of Virginia, John W. Menzies of the South African Astronomical Observatory, Jacob Bean of The University of Texas at Austin and Wendy L. Freedman of the Observatories of the Carnegie Institution of Washington.

Source: University of Texas at Austin