Hubble precisely measures distance to ancient star cluster

An artist's rendering of the galaxy, known by its catalog name z8_GND_5296 | Photo Credit: <u>Reuters/NASA</u>

Scientists using NASA's Hubble Space Telescope have for the first time precisely measured the distance to one of the oldest objects in the universe, a 13.4 billion-year-old cluster of stars born shortly after the Big Bang.

The refined distance yardstick provides an independent estimate for the age of the universe. It will also help astronomers improve models of stellar evolution. Star clusters are the key ingredient in stellar models because the stars in each grouping are at the same distance, have the same age, and have the same chemical composition. They therefore constitute a single stellar population to study.

This stellar assembly, a globular star cluster called NGC 6397, is one of the closest such clusters to Earth. The new measurement sets the cluster's distance at 7,800 light-years away, with just a three per cent margin of error. Until now, astronomers have estimated the distances to our galaxy's globular clusters by comparing the luminosities and colours of stars to theoretical models, and to the luminosities and colours of similar stars in the solar neighbourhood.

However, the accuracy of these estimates varies, with uncertainties hovering between 10 per cent and 20 per cent. The new measurement uses straightforward trigonometry, the same method used by surveyors, and as old as ancient Greek science. Using a novel observational technique to measure extraordinarily tiny angles on the sky, astronomers managed to stretch Hubble's yardstick outside of the disk of our Milky Way galaxy.

The research team calculated NGC 6397's age at 13.4 billion years old. "The globular clusters are so old that if their ages and distances deduced from models are off by a little bit, they seem to be older than the age of the universe," said Tom Brown of the Space Telescope Science Institute (STScI) in the US, leader of the Hubble study. Accurate distances to globular clusters are used as references in stellar models to study the characteristics of young and old stellar populations.

"Any model that agrees with the measurements gives you more faith in applying that model to more distant stars," Brown said. "The nearby star clusters serve as anchors for the stellar models. Until now, we only had accurate distances to the much younger open clusters inside our galaxy because they are closer to Earth."

By contrast, about 150 globular clusters orbit outside of our galaxy's comparatively younger starry disk. These spherical, densely packed swarms of hundreds of thousands of stars are the first homesteaders of the Milky Way. The Hubble astronomers used trigonometric parallax to nail down the cluster's distance. This technique measures the tiny, apparent shift of an object's position due to a change in an observer's point of view.

Hubble measured the apparent tiny wobble of the cluster stars due to Earth's motion around the Sun. With this technique, called "spatial scanning," Hubble's Wide Field Camera 3 gauged the parallax of 40 NGC 6397 cluster stars, making measurements every 6 months for 2 years. The researchers then combined the results to obtain the precise distance measurement.

The researchers said that they could reach an accuracy of one per cent if they combine the

Hubble distance measurement of NGC 6397 with the upcoming results obtained from the European Space Agency's Gaia space observatory, which is measuring the positions and distances of stars with unprecedented precision. The findings appeared in *The Astrophysical Journal Letters*.

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There is no such thing as total failure; ISRO should learn from its satellite launch problem

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