Universe's 'standard candles' are white dwarf mergers

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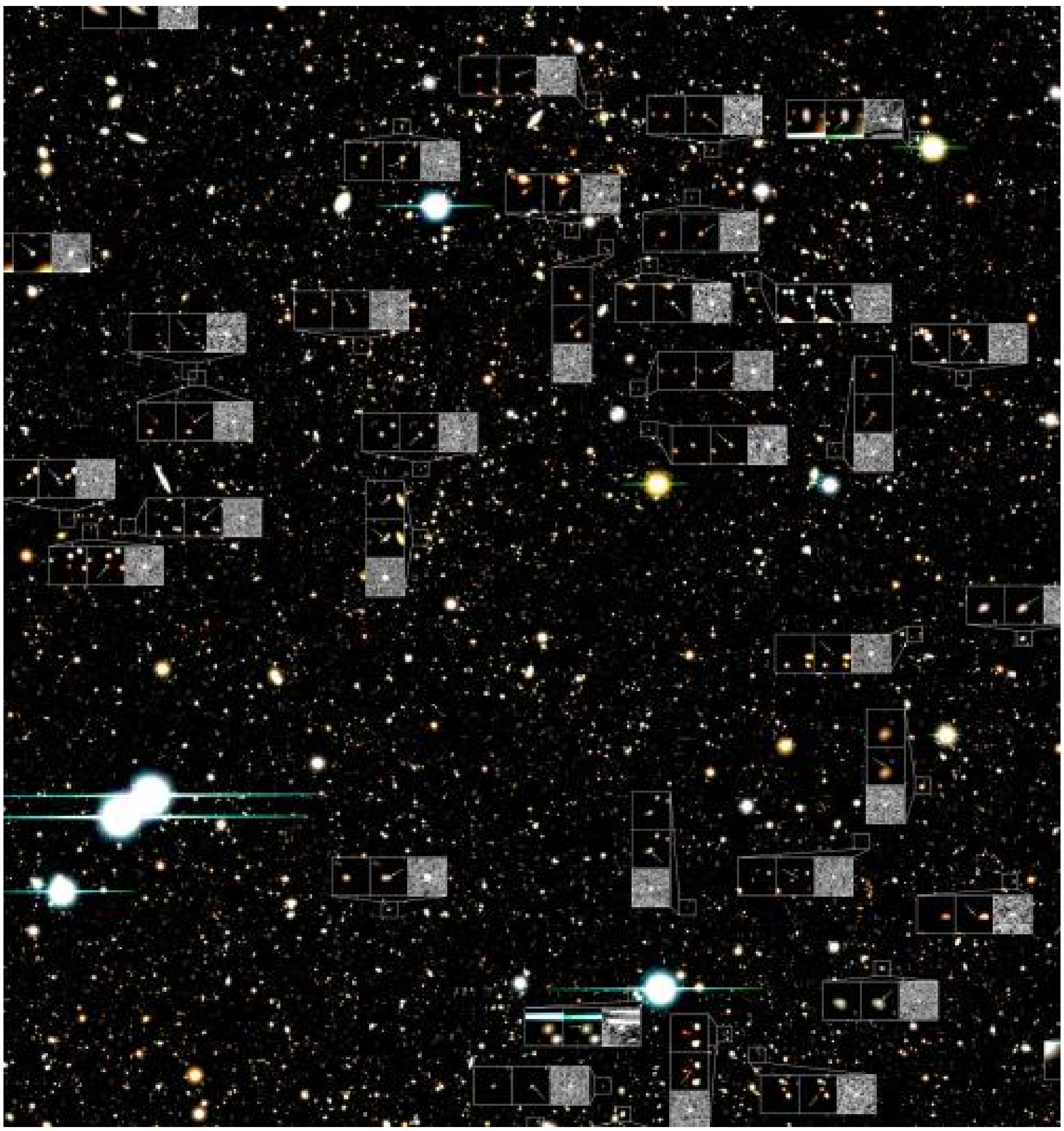

A small section of the Subaru Deep Field image showing some of the galaxies and supernovae used in the study. Credit: NAOJ

(PhysOrg.com) -- The largest survey to date of distant exploding stars is giving astronomers new clues to what's behind the Type Ia supernovae they use to measure distances across the cosmos.

These stellar explosions helped astronomers conclude more than a decade ago that dark energy is accelerating the expansion of the universe. But what caused them was a mystery. Many astronomers thought white dwarf stars were pulling matter from their normal stellar companions and growing so fat they exploded.

But the new study by American, Israeli and Japanese astronomers using Subaru and Keck telescopes in Hawaii instead suggests that many, if not most, of the Type Ia supernovae result when two white dwarf stars merge and annihilate in a thermonuclear explosion.

"The nature of these events themselves is poorly understood, and there is a fierce debate about how these explosions ignite," said Dovi Poznanski, one of the main authors of the paper and a post-doctoral fellow at the University of California, Berkeley, and Lawrence Berkeley National Laboratory.

"The main goal of this survey was to measure the statistics of a large population of supernovae at a very early time, to get a look at the possible star systems," he said. "Two white dwarfs merging can explain well what we are seeing."

Poznanski, Tel-Aviv University graduate student Or Graur and their colleagues will report their findings in the October 2011 issue of the journal *Monthly Notices of the Royal Astronomical Society* (*MNRAS*).

The results do not place in jeopardy the conclusion that the expansion of the universe is accelerating, said coauthor Alex Filippenko, UC Berkeley professor of astronomy.

“As long as Type Ias explode in the same way, no matter what their origin, their intrinsic brightnesses should be the same, and the distance calibrations would remain unchanged,” he said.

Evidence that Type Ia supernovae are caused by the merger of two white dwarfs the so-called double-degenerate theory has been accumulating over the past two years, based on surveys by the Hubble Space Telescope and others.

“The tide is definitely turning, and these are the best data yet to support the double-degenerate theory,” Filippenko said.

White dwarfs are dense, compact stars formed from normal stars like the sun once they exhaust their nuclear fuel and compress under their own weight.

The new, largest-ever survey using the Subaru Telescope in Hawaii accumulated a sample of 150 distant supernovas that exploded between 5 and 10 billion years ago.

The finding, when combined with previous surveys of closer Type Ia supernovae, suggests that astronomers surveying Type Ia supernovae may be seeing a mixture of single- and double-degenerates.

“There are no good answers yet, and it could be that we are seeing a mix of the two types of explosions,” Poznanski said.

Though the two-faced nature of Type Ia supernovae still allows them to be used as calibratable candles to measure cosmic distance, Filippenko said, it might affect attempts to “quantify in detail the history of the expansion rate of the universe. The subtle differences between single- and double-degenerate models could introduce a systematic error that we’ll need to account for.”

The team found that Type Ia supernovae were five times more common 5-10 billion years ago than today, probably because there were more young stars back then rapidly evolving into white dwarfs. Moreover, this study allowed the team to more accurately determine the production of iron over cosmic time, as Type Ia supernovae create iron through nuclear reactions when they explode.

To find their distant sample, the international team of astronomers exploited the enormous light collecting power of the Subaru Telescope's Suprime-Camera on four separate occasions. They pointed the ground-based telescope, located atop Hawaii's Mauna Kea volcano, toward a single field in the sky that was approximately the size of the full moon. Each run yielded about 40 supernovae among 150,000 galaxies.

Then they used the Keck telescopes on Mauna Kea to observe the galaxies where these explosions occurred. These observations were crucial for pinpointing the distance of these events.

Future observations with the Hyper Suprime-Camera, which will be mounted on the Subaru Telescope, will be able to discover even larger and more distant supernova samples to test this conclusion.

More information: Read the paper at: arxiv.org/abs/1102.0005

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