Hubble confirms cosmic acceleration with weak lensing (w/ Video)

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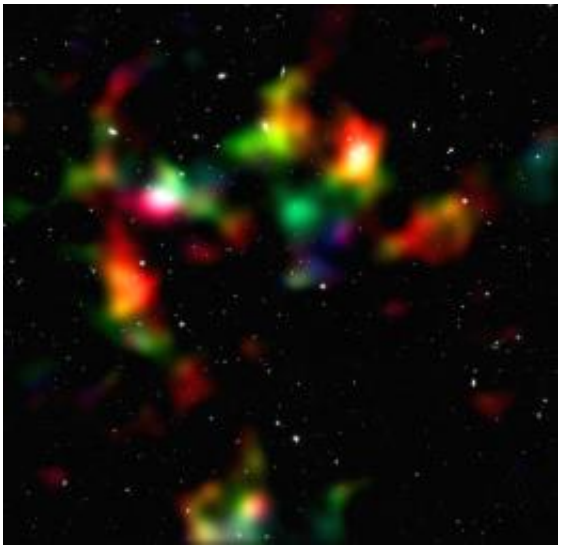


This image shows a smoothed reconstruction of the total (mostly dark) matter distribution in the COSMOS field, created from data taken by the NASA/ESA Hubble Space Telescope and ground-based telescopes. It was inferred from the weak gravitational lensing distortions that are imprinted onto the shapes of background galaxies. The color coding indicates the distance of the foreground mass concentrations as gathered from the weak lensing effect. Structures shown in white, cyan and green are typically closer to us than those indicated in orange and red. To improve the resolution of the map, data from galaxies both with and without redshift information were used. The new study presents the most comprehensive analysis of data from the COSMOS survey. The researchers have, for the first time ever, used Hubble and the natural "weak lenses" in space to characterise the accelerated expansion of the universe. Credit: NASA, ESA, P. Simon (University of Bonn) and T. Schrabback (Leiden Observatory)

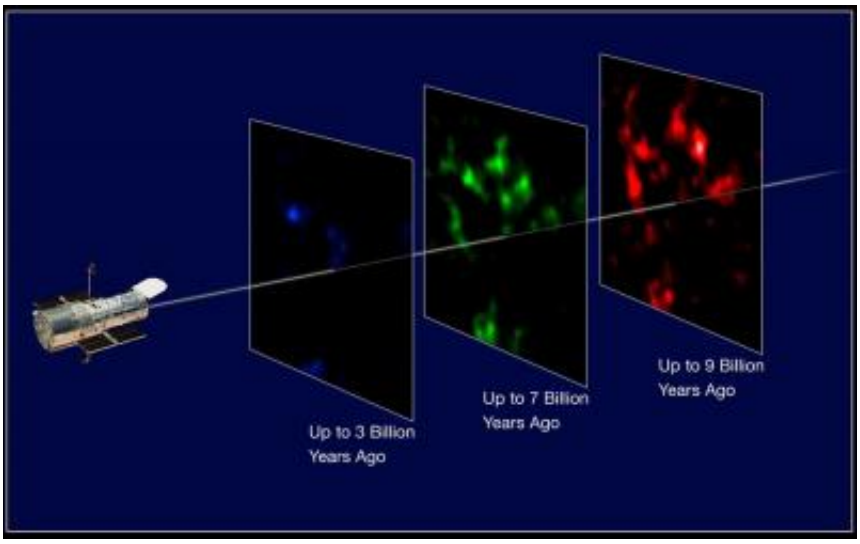
(PhysOrg.com) -- A group of astronomers, led by Tim Schrabback of the Leiden Observatory, conducted an intensive study of over 446 000 galaxies within the COSMOS field, the result of the largest survey ever conducted with Hubble. In making the COSMOS survey, Hubble photographed 575 slightly overlapping views of the same part of the Universe using the Advanced Camera for Surveys (ACS) onboard Hubble. It took nearly 1000 hours of observations.

In addition to the Hubble data, researchers used redshift data from ground-based telescopes to assign distances to 194 000 of the galaxies surveyed (out to a redshift of 5). "The sheer number of galaxies included in this type of analysis is unprecedented, but more important is the wealth of information we could obtain about the invisible structures in the Universe from this exceptional dataset," says co-author Patrick Simon from Edinburgh University.

In particular, the astronomers could "weigh" the large-scale matter distribution in space over large distances. To do this, they made use of the fact that this information is encoded in the distorted shapes of distant galaxies, a phenomenon referred to as weak gravitational lensing. Using complex algorithms, the team led by Schrabback has improved the standard method and obtained galaxy shape measurements to an unprecedented precision. The results of the study will be published in an upcoming issue of Astronomy and Astrophysics.

The meticulousness and scale of this study enables an independent confirmation that the expansion of the Universe is accelerated by an additional, mysterious component named dark energy. A handful of other such independent confirmations exist. Scientists need to know how the formation of clumps of matter evolved in the history of the Universe to determine how the gravitational force, which holds matter together, and dark energy, which pulls it apart by accelerating the expansion of the Universe, have affected them.

"Dark energy affects our measurements for two reasons. First, when it is present, galaxy clusters grow more slowly, and secondly, it changes the way the Universe expands, leading to more distant — and more efficiently lensed — galaxies. Our analysis is sensitive to both effects," says co-author Benjamin Joachimi from the University of Bonn. "Our study also provides an additional confirmation for Einstein's theory of general relativity, which predicts how the lensing signal depends on redshift," adds co-investigator Martin Kilbinger from the Institut d'Astrophysique de Paris and the Excellence Cluster Universe.



In this illustration the NASA/ESA Hubble Space Telescope looks back in time to "map" evolving dark matter. The dataset is created by splitting the background source galaxy population into discrete epochs of time (like cutting through geological strata), looking back into the past. This is calibrated by measuring the cosmological redshift of the lensing galaxies used to map the dark matter distribution, and putting them into different time/distance "slices". Credit: NASA, ESA, P. Simon (University of Bonn) and T. Schrabback (Leiden Observatory)

The large number of galaxies included in this study, along with information on their redshifts is leading to a clearer map of how, exactly, part of the Universe is laid out; it helps us see its galactic inhabitants and how they are distributed. "With more accurate information about the distances to the galaxies, we can measure the distribution of the matter between them and us more accurately," notes co-investigator Jan Hartlap from the University of Bonn. "Before, most of the studies were done in 2D, like taking a chest X-ray. Our study is more like a 3D reconstruction of the skeleton from a CT scan. On top of that, we are able to watch the skeleton of dark matter mature from the Universe's youth to the present," comments William High from Harvard University, another co-author.

The astronomers specifically chose the COSMOS survey because it is thought to be a representative sample of the Universe. With thorough studies such as the one led by Schrabback, astronomers will one day be able to apply their technique to wider areas of the sky, forming a clearer picture of what is truly out there.

More information: Paper: www.spacetelescope.org/news/sc … 005_sciencepaper.pdf

Provided by ESA/Hubble Information Centre

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