Largest 3D Map of Galaxies

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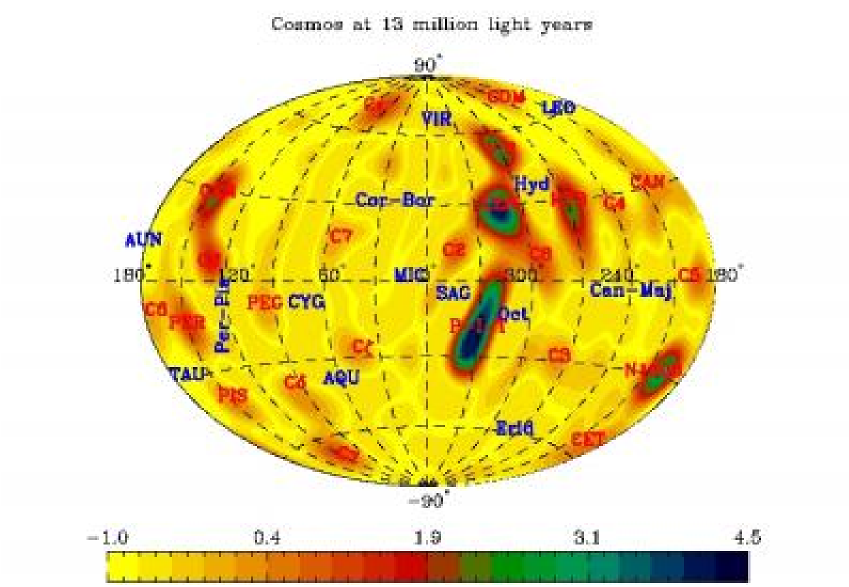


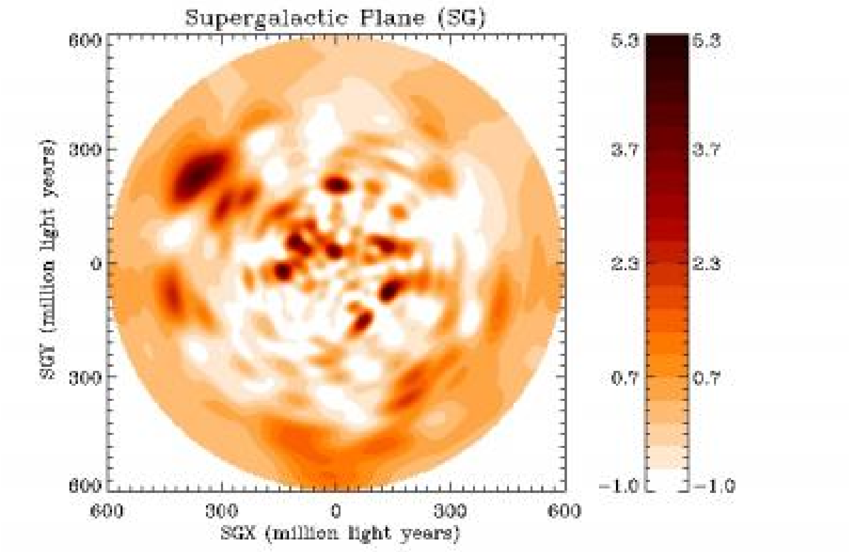
The reconstructed density field, evaluated on a thin shell at 13 million light years. The overdense regions (shown in red) are C6, Perseus (Per), Cd, C?, Ce, C7, C?, Coma (Com), Virgo (Vir), The Great Attractor Clusters [C2, Centaurus (Cen), Pavo-Indus-Telescopium (P-I-T), C8, Hydra (Hyd), C3, C4], Cancer (Can), NGC 1600 (N1600), Cetus (Cet) and C5. The voids (shown in blue) are Aunga (Aun), Taurus (Tau), Perseus-Pisces (Per-Pis), Cygnus (Cyg), Aquarius (Aqu), Corona Borealis (Cor-Bor), Microscopium (Mic), Virgo (Vir), Sagittaurus (Sag), Hydra (Hyd), Octans (Oct), Leo, Eridanus (Erid) and Canis Major (Can - Maj).

A team of American, Australian and British astronomers has released maps from the largest full-sky, three-dimensional survey of galaxies ever conducted.

Their detailed maps show the 'local' cosmos out to a distance of 600 million light years, identifying all the major superclusters of galaxies and voids. They also provide important clues regarding the distribution of the mysterious 'dark matter' and 'dark energy' which are thought to account for up to 96% of the apparent mass of the Universe.

Within this vast volume, the most massive galaxy supercluster is 400 million light years away. It was named after its identifier, the American astronomer Harlow Shapley. The Shapley supercluster is so big that it takes light at least 20 million years to travel from its one end to the other. However, Shapley is not the only massive supercluster in our vicinity.

The Great Attractor supercluster, which is three times closer than Shapley, plays a bigger role in the motion of our Galaxy. According to the team, our Milky Way galaxy, its sister galaxy Andromeda and other neighbouring galaxies are moving towards the Great Attractor at an amazing speed of about a million miles per hour. The researchers also established that the Great Attractor is indeed an isolated supercluster and is not part of Shapley.



The reconstructed density fields in the supergalactic coordinates (SGX, SGY). In this coordinate system, the equator is aligned with the Virgo Cluster, Great Attractor and Perseus-Pisces superclusters. The main overdensities are Hydra-Centaurus (centre-left), Perseus-Pisces (centre-right), Shapley Concentration (upper left), Coma (upper-middle).

The new maps are based on the observation that, as the Universe expands, the colours of galaxies change as their emitted light waves are stretched or “redshifted”. By measuring the extent of this redshift, astronomers are able to calculate approximate distances to galaxies.

The new survey, known as the 2MASS Redshift Survey (2MRS), has combined two dimensional positions and colours from the Two Micron All Sky Survey (2MASS), with redshifts of 25,000 galaxies over most of the sky. These redshifts were either measured specifically for the 2MRS or they were obtained from an even deeper survey of the southern sky, the 6dF Galaxy Redshift Survey (6dFGS).

The great advantage of 2MASS is that it detects light in the near-infrared, at wavelengths slightly longer than the visible light. The near-infrared waves are one of the few types of radiation that can penetrate gases and dust and that can be detected on the Earth's surface. Although the 2MRS does not probe as deeply into space as other recent narrow-angle surveys, it covers the entire sky.

Galaxy redshift surveys are only able to detect luminous matter. This luminous matter accounts for no more than a small fraction of the total matter in the Universe. The remainder is composed of a mysterious substance called 'dark matter' and an even more elusive component named 'dark energy'.

"We need to map the distribution of dark matter rather than luminous matter in order to understand large-scale motions in our Universe," explained Dr. Pirin Erdogdu (Nottingham University), lead author of the paper. "Fortunately, on large scales, dark matter is distributed almost the same way as luminous matter, so we can use one to help unravel the other."

Her collaborator, Dr. Thomas Jarrett from Caltech, added, "The other advantage of observing in the near-infrared wavelength is the fact that it traces directly the luminous matter, and thus the dark matter, as well."

"Our nearly two decade effort has produced the absolute best ever map of the nearby Universe," said Prof. John Huchra of Harvard University. "With this we hope to elucidate the nature and disposition of dark matter and understand much, much more about our cosmological model and about galaxies themselves."

In order to map the dark matter probed by the survey, the team used a novel technique borrowed from image processing. The method was partly developed by Prof. Ofer Lahav, a co-author of the paper and head of the astrophysics group at University College London. The technique utilizes the relationship between galaxy velocities and the total distribution of mass.

“It is like reconstructing the true street map of London just from a satellite image of London taken at night. The street lights, like the luminous galaxies, act as beacons of the underlying roads,” said Prof. Lahav.

"This extraordinarily detailed map of the Milky Way’s cosmic neighbourhood provides a benchmark against which theories for the formation of structure in the Universe can be tested,” commented Prof. Matthew Colless, director of the Anglo-Australian Observatory and leader of the 6dF Galaxy Survey.

“In the near future, the predicted motions derived from this map will be confronted with direct measurements of galaxies’ velocities obtained by the 6dF Galaxy Survey, providing a new and stringent test of cosmological models.”

The findings are presented in a paper entitled “Reconstructed Density and Velocity Fields from the 2MASS Redshift Survey”, which has been accepted for publication by the journal Monthly Notices of the Royal Astronomical Society. This paper is available on the physics preprint server at: arxiv.org/PS_cache/astro-ph/pdf/0610/0610005.pdf

Source: University of Nottingham