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# MEDIA RELEASE

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## **GALAXY SURVEY MAPS WHERE MATTER LURKS**

Australian astronomers have just completed the most detailed survey of galaxies in the nearby Universe, which will reveal not only where the galaxies are but also where they're heading, how fast, and why.

"It's like taking a snapshot of wildebeest on the African plains. We can tell which waterholes they're heading to, and how fast they're travelling," said Dr Heath Jones of the Anglo-Australian Observatory (AAO), lead scientist for the Six-Degree Field Galaxy Survey (6dFGS).

Galaxies are tugged around by each other's gravity. By measuring the galaxies' movements, the researchers can map the gravitational forces at work in the local Universe, and so show how matter, seen and unseen, is distributed.

Giant superclusters of galaxies are huge concentrations of mass, but they can't be weighed accurately by looking at their light alone.

"Light can be obscured, but you can't hide gravity," said Dr Jones.

Results from the survey are being presented today [1 April] at an international meeting in Malaysia by Professor Matthew Colless, Director of the Anglo-Australian Observatory (AAO).

The survey was carried out with the 1.2 m UK Schmidt Telescope, which is operated by the AAO at Siding Spring Observatory in NSW. Broader and shallower than previous comparable surveys — it covered twice as much as sky as the Sloan Digital Sky Survey — it has recorded the positions of more than 110 000 galaxies over more than 80% of the Southern sky, out to about two thousand million light-years from Earth [a redshift of 0.15].

The survey shows strings and clusters of nearby galaxies on large scales in unprecedented detail, and has revealed more than 500 voids—"empty" areas of space with no galaxies.

### ***Disentangling galaxy movements***

The special aspect of this survey is that it will let the researchers disentangle two causes of galaxy movements.

As well as being pulled on by gravity, galaxies also ride along with the overall expansion of the Universe.

For about 10% of their galaxies, the 6dFGS researchers will tease apart these two velocity components—the one associated with the Universe’s expansion, and the one representing a galaxy’s individual, “peculiar”, motion.

“The peculiar velocities collected as part of this survey number more than five times as many as in any previous survey,” said Professor Elaine Sadler of the University of Sydney, a 6dFGS team member.

### ***Benchmark for galaxy properties***

The survey will also act as a benchmark for studying the properties of galaxies that change over time, Professor Sadler said.

Examples of such properties are how rapidly stars are bursting into life, and how busily giant black holes are chewing them up.

Because light takes time to travel from galaxies in the early Universe, as we look out into the distant Universe we are also looking back into the past. We see distant galaxies as they were at an earlier stage in the history of the Universe.

“To understand how galaxies evolve, we need to understand the properties of those in today’s Universe,” Professor Sadler said.

“This survey provides a perfect sample of current galaxies.”

### **More information**

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### **Images**

<http://astronomy.swin.edu.au/~cfluke/6dF/0001.tga.jpg>  
The clustering pattern of about 100,000 nearby galaxies, revealed by the 6dF Galaxy Survey. Each galaxy is shown as a dot. The galaxy we live in is at the centre of the pattern. Credit: Dr Chris Fluke, Centre for Astrophysics and Supercomputing, Swinburne University of Technology.

[http://www.aao.gov.au/press/6dfgs/abell\\_s0740.jpg](http://www.aao.gov.au/press/6dfgs/abell_s0740.jpg)  
A Hubble Space Telescope image of a galaxy cluster (Abell S0740) within the area of sky covered by the 6dF Galaxy Survey. Credit: NASA, ESA and The Hubble Heritage Team (STScI/AURA).

[http://www.aao.gov.au/press/6dfgs/schmidt\\_small.jpg](http://www.aao.gov.au/press/6dfgs/schmidt_small.jpg)  
The UK Schmidt Telescope (jpeg, 172K). Photo: Shaun Amy

[http://www.aao.gov.au/press/6dfgs/schmidt\\_large.jpg](http://www.aao.gov.au/press/6dfgs/schmidt_large.jpg)  
The UK Schmidt Telescope (jpeg, 6MB). Photo: Shaun Amy

### **Publication**

Redshift data from 6dFGS have been released in tranches. The third and final release of redshift data is being made in the paper by Jones et al, "The 6dF Galaxy Survey: Final Data Release (DR3) and Southern Large Scale Structures", which has been submitted to *Monthly Notices of the Royal Astronomical Society* for publication: it is also posted online at <http://www.aao.gov.au/6dFGS/Publications/index.html>.

### **Background**

The Six-Degree-Field Galaxy Survey is a combined redshift and peculiar-velocity survey of more than 110 000 galaxies in the Southern sky.

Redshift is a measure of the difference between the frequencies of particular spectral lines that appear in a star's light, and the "rest" values of those spectral lines (the values that can be measured in a laboratory). It indicates how fast a galaxy is moving away from (or towards) our own.

Because the Universe is expanding, the further away a galaxy is, the faster it is moving away from us. But galaxies are also dragged through space by the gravity of other galaxies or clusters of galaxies, a movement astronomers call the galaxies' "peculiar velocities" (that is, it is "peculiar to" each galaxy). The peculiar velocity adds a component to a galaxy's redshift that is distinct from the overall recession velocity caused by the expansion of the universe.

There have been previous dedicated peculiar-velocity surveys, but 6dFGS will provide more than five times more peculiar velocities than the largest of these surveys.

Calculating peculiar velocities is done by comparing the galaxy's distance predicted by its redshift with its distance measured using the internal properties of the galaxy. The technique depends on measuring the width of spectral lines in a galaxy, and doing this accurately needs a high-resolution spectrograph, such as the one purpose-built for this survey.

From conception to delivery, the 6dFGS has taken almost a decade. It was made possible by a purpose-built spectrograph and robotic fibre-positioner, the Six-Degree Field (6dF) instrument, which allowed 150 spectra to be taken simultaneously. The survey also took advantage of the UK Schmidt Telescope's wide field of view — 5.7 degrees, or 11 times the width of the full Moon — which was key to the survey being able to cover 80% of the Southern sky in a reasonable time.

The sample of galaxies was drawn mainly from the 2MASS Extended Source Catalog: that is, they were selected by their infrared light rather than optically selected. Selecting galaxies by their near-infrared (K band) magnitudes avoids bias against galaxies that are currently forming few stars, and instead selects by total stellar mass.

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