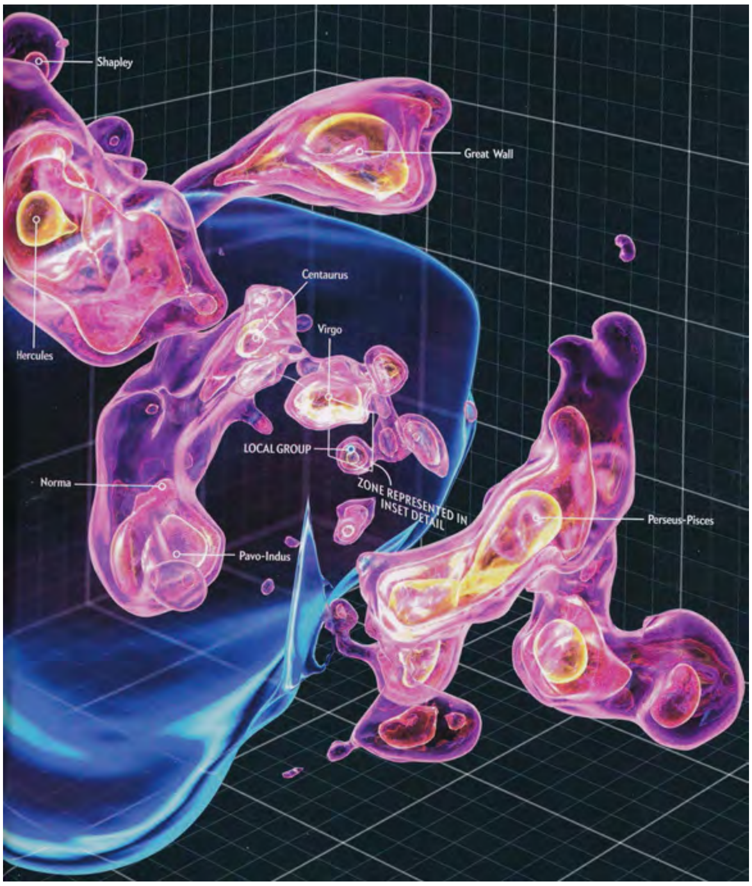
OUR PLACE IN THE COSMOS

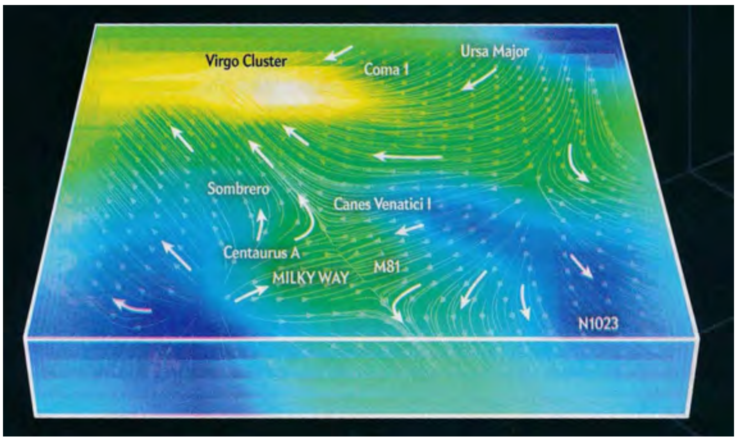
The Milky Way is part of a massive supercluster of galaxies, one of the largest known structures in the universe. This recent discovery is only the beginning of new efforts to map the cosmos.

The local Supercluster, it turns out, is but one lobe of a much larger collection of some 100,000 galaxies stretching across 400 million light years **The team that discovered this gargantuan supercluster named it "Laniakea" – Hawaiian for immeasurable heaven.**



Mapping the Laniakea Supercluster. Here the position of more that 8,000 galaxies are mapped and coloured according to their relative motion. Warmer colours represent galaxy clusters rapidly converging together. The blue outline of Laniakea spans nearly ½ billion lightyears

Mapping galactic flows requires knowing both a galaxy's motion stemming from cosmic expansion and its motion stemming from nearby matter. As a first step, astronomers measure a galaxy's redshift – the stretching out of the galaxy's emitted light as it recedes away from us through the expanding universe. Just as a whistle or siren moving toward us has a higher pitch than if moving away, light waves from a galaxy moving away from us are shifted to lower frequencies and longer, redder wavelengths the faster they are receding, the more redshifted they become**. Thus, a galaxy's redshift gives astronomers a measure of its overall velocity and a rough estimate of its distance**. Astronomers can infer how much of a galaxy's velocity is the result of local gravitational tugging by measuring its distance through other techniques besides redshift. For instance, based on rigorous estimates of the universe's expansion rate,a galaxy measured to be 9.25 million light_years away should have a velocity of about 70 kiiometers per second. If instead the galaxy's redshift yields a velocity of 60 kilometres per second, astronomers could infer that matter concentrations near that galaxy are giving it a peculiar velocity of 10 kilometres per second. The techniques used to provide redshift-independent distance measurements mostly rely on the fact that light's intensity decreases at the inverse square of distance..That is, if you see two identical lighthouses but one appears a quarter as bright, then you know the fainter one is two time farther away. **In astronomy such identical lighthouses are called Standard Candles, objects that shine with the same brightness no matter where they are in the universe. Examples include certain variable, pulsating or exploding stars, even massive galaxies fall into this category.**



Going with the Flow. The arrows show the motion of galaxies, which flow like water towards denser regions (warmer colours). The local cluster, too, is falling along a filament towards the Virgo Cluster.

Just beyond the Local Group, within a volume of about 25 million light-years, three distinctive features appear in our maps. Most of the galaxies here, including our own, live in what has been named the Local Sheet. As "sheet" would imply, it is very thin-most of its galaxies are within three million lightyears of this structure, itself the equatorial plane of what is referred to as the supergalactic coordinate system. Below this plane, after a gap, is a filament of galaxies-the Leo Spur-as well as galaxies in the so-called Antlia and Doradus Clouds. Above the plane there is mostly nothing nearby. This emptiness is the domain of the Local Void. If only the galaxies within the Local Sheet are considered, the situation seems very tranquil. These galaxies are flying apart at the rate of the cosmic expansion, with only small peculiar velocities caused by local interactions. Below the Local Sheet, the galaxies of the

Antlia and Doradus Clouds and the Leo Spur have small peculiar velocities, too. They are, however, approaching the Local Sheet at high speed. The Local Void is the probable culprit. Voids expand like inflating balloons, and matter moves from underdense to overdense regions to pile up at their boundaries. We now appreciate that the Local Sheet is a wall of the Local Void and that this void is expanding to push us down toward Antlia, Doradus and Leo.

Almost 30 years ago a group of astronomers who became identified by the convivial moniker "the Seven Samurai" discovered that it is not just the Milky Way moving hundreds of kilometres per second in the direction of Centaurus but rather the entire Local Supercluster is moving at 600 km per second They called the mysterious mass pulling all these galaxies together the Great Attractor. To some degree, the culprit must be the Great Attractor complex. But we must also consider the gravitational pull of the Shapley Supercluster, which is three times farther away but bears four times the number of rich clusters.

Does it stop there? We do not yet know. Only even bigger surveys mapping even larger swaths of the universe can reveal the ultimate source-and ultimate structure-behind the epic flow of galaxies in our local universe

HOW FAR IS A LIGHT-YEAR?

How can we comprehend the distances to the stars? Stars other than our sun are so far distant that astronomers speak of their distances not in terms of kilometres – but in light-years. Light is the fastest-moving stuff in the universe. If we would simply express light-years as kilometres, we'd end up with impossibly huge numbers. But the 20th century astronomer **Robert Burnham Jr.** – author of Burnham's Celestial Handbook – devised an ingenious way to portray the distance of one light-year and ultimately of expressing the distance scale of the universe, in understandable terms.

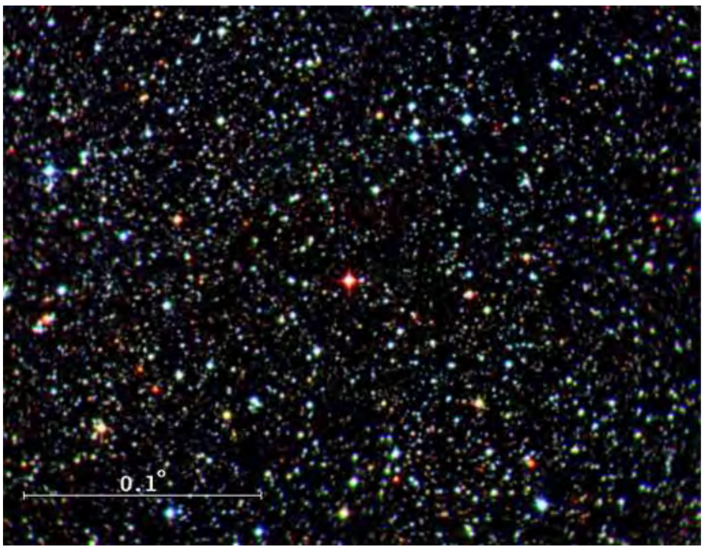
He did this by relating the light-year to the Astronomical Unit – the Earth-Sun distance. One Astronomical Unit, or AU, equals about 150 million km, and light takes just a bit more than 8 minutes to cover the distance.

Robert Burnham noticed that, quite by coincidence, the number of astronomical units in one light-year and the number of inches in one mile are virtually the same: there are 63,000 astronomical units in one light-year, and 63,000 inches in one mile. This wonderful coincidence enables us to bring the light-year down to Earth. If we scale the astronomical unit – the Earth-Sun distance – at one inch, then the light-year on this scale represents one mile.

The closest star to Earth, other than the sun, is Alpha Centauri at some 4.4 light-years away. Scaling the Earth-sun distance at one inch, places this star at 4.4 miles (7 km) distant.

The red star in the centre of this picture is Proxima Centauri, our sun's nearest neighbour among the stars. A beam of light from this star takes about 4 years to travel to Earth.

Scaling the Astronomical Unit at one inch, here are distances to various bright stars, star clusters and galaxies:



Alpha Centauri: 4 miles (6.4 km)
Sirius: 9 miles (14.5 km)
Vega: 25 miles (40 km)
Fomalhaut: 25 miles (40 km)
Arcturus: 37 miles (60 km)
Antares: 600 miles (966 km)
Pleiades open star cluster: 440 miles (708 km)
Hercules cluster (M13): 24,000 miles (38,600 km)
Centre of Milky Way 27,000 miles (43,500 km)
Andromeda galaxy (M31): 2,300,000 miles (3,700,000 km)
Whirlpool galaxy (M51): 37,000,000 miles (60,000,000 km)
Sombrero galaxy (M104): 65,000,000 miles (105,000,000 km)

Light is the fastest-moving stuff in the universe. It travels at an incredible 186,000 miles (300,000 km) per second. If you could travel at the speed of light, you would be able to circle the Earth's equator about 7.5 times in just one second!. A light-year is the distance light travels in one year, about 5.88 trillion miles (9.5 trillion km).

AK, with EarthSky and Scientific American Notes