

The Daily Galaxy --Great Discoveries Channel: Sci, Space, Tech



A busy patch of space has been captured in the image below from the NASA/ESA [Hubble Space Telescope](#). Scattered with many nearby stars, the field also has numerous galaxies in the background. Located on the border of Triangulum Australe (The Southern Triangle) and Norma (The Carpenter's Square), this field covers part of the Norma Cluster ([Abell 3627](#)) as well as a dense area of our own galaxy, the Milky Way.

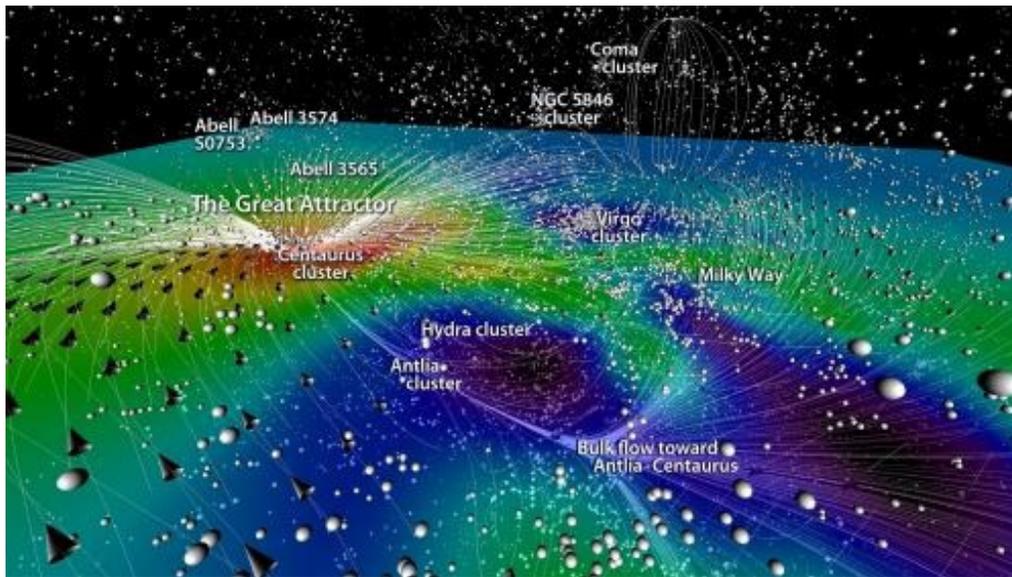
The Norma Cluster is the closest massive galaxy cluster to the Milky Way, and lies about 220 million light-years away. The enormous mass concentrated here, and the consequent gravitational attraction, mean that this region of space is known to astronomers as the [Great Attractor](#), and it dominates our region of the Universe.



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he largest galaxy visible in this image is ESO 137-002, a spiral galaxy seen edge on. In this image from Hubble, we see large regions of dust across the galaxy's bulge. What we do not see here is the tail of glowing X-rays that has been observed extending out of the galaxy — but which is invisible to an optical telescope like Hubble.

Observing the Great Attractor is difficult at optical wavelengths. The plane of the Milky Way — responsible for the numerous bright stars in this image — both outshines (with stars) and obscures (with dust) many of the objects behind it. There are some tricks for seeing through this — infrared or radio observations, for instance — but the region behind the center of the Milky Way, where the dust is thickest, remains an almost complete mystery to astronomers.



Recent evidence from the [European Space Agency's Atacama Desert](#) telescopes in Chile appears to contradict the "great attractor" theory. Astronomers have theorized for years that something unknown appears to be pulling our Milky Way and tens of thousands of other galaxies toward itself at a breakneck 22 million kilometers (14 million miles) per hour. But they couldn't pinpoint exactly what, or where it is.

A huge volume of space that includes the Milky Way and super-clusters of galaxies is flowing towards a mysterious, gigantic unseen mass named mass astronomers have dubbed "The Great Attractor," some 250 million light years from our Solar System.

The Milky Way and Andromeda galaxies are the dominant structures in a galaxy cluster called the [Local Group](#) which is, in turn, an outlying member of the [Virgo supercluster](#). Andromeda--about 2.2 million light-years from the Milky Way--is speeding toward our galaxy at 200,000 miles per hour.

This motion can only be accounted for by gravitational attraction, even though the mass that we can observe is not nearly great enough to exert that kind of pull. The only thing that could explain the movement of Andromeda is the gravitational pull of a lot of unseen mass--perhaps the equivalent of 10 Milky Way-size galaxies--lying between the two galaxies.

Meanwhile, our entire Local Group is hurtling toward the center of the Virgo Cluster (image above) at one million miles per hour.

The Milky Way and its neighboring [Andromeda galaxy](#), along with some 30 smaller ones, form what is known as the Local Group, which lies on the outskirts of a "super cluster"—a grouping of thousands of galaxies—known as Virgo, which is also pulled toward the Great Attractor. Based on the velocities at these scales, the unseen mass inhabiting the voids between the galaxies and clusters of galaxies amounts to perhaps 10 times more than the visible matter.

Even so, adding this invisible material to luminous matter brings the average mass density of the universe still to within only 10-30 percent of the critical density needed to "close" the universe. This phenomena suggests that the universe be "open." Cosmologists continue to debate this question, just as they are also trying to figure out the nature of the missing mass, or "dark matter."

It is believed that this dark matter dictates the structure of the Universe on the grandest of scales. Dark matter gravitationally attracts normal matter, and it is this normal matter that astronomers see forming long thin walls

of super-galactic clusters.

Recent measurements with telescopes and space probes of the distribution of mass in M31 -the largest galaxy in the neighborhood of the Milky Way- and other galaxies led to the recognition that galaxies are filled with dark matter and have shown that a mysterious force—a dark energy—fills the vacuum of empty space, accelerating the universe's expansion.

Astronomers now recognize that the eventual fate of the universe is inextricably tied to the presence of dark energy and dark matter. The current standard model for cosmology describes a universe that is 70 percent dark energy, 25 percent dark matter, and only 5 percent normal matter.

We don't know what dark energy is, or why it exists. On the other hand, particle theory tells us that, at the microscopic level, even a perfect vacuum bubbles with quantum particles that are a natural source of dark energy. But a naïve calculation of the dark energy generated from the vacuum yields a value 10¹²⁰ times larger than the amount we observe. Some unknown physical process is required to eliminate most, but not all, of the vacuum energy, leaving enough left to drive the accelerating expansion of the universe.

A new theory of particle physics is required to explain this physical process. The new "dark attractor" theories skirt the so-called [Copernican principle](#) that posits that there is nothing special about us as observers of the universe suggesting that the universe is not homogeneous. These alternative theories explain the observed accelerated expansion of the universe without invoking dark energy, and instead assume we are near the center of a void, beyond which a denser "dark" attractor pulls outwards.

In a paper appearing in *Physical Review Letters*, Pengjie Zhang at the Shanghai Astronomical Observatory and Albert Stebbins at Fermilab show that a popular void model, and many others aiming to replace dark energy, don't stand up against telescope observation.

Galaxy surveys show the universe is homogeneous, at least on length scales up to a gigaparsec. Zhang and Stebbins argue that if larger scale inhomogeneities exist, they should be detectable as a temperature shift in the cosmic microwave background—relic photons from about 400,000 years after the big bang—that occurs because of electron-photon (inverse Compton) scattering.

Focusing on the "Hubble bubble" void model, they show that in such a scenario, some regions of the universe would expand faster than others, causing this temperature shift to be greater than what is expected. But telescopes that study the microwave background, such as the Atacama telescope in Chile or the South Pole telescope, don't see such a large shift.

Though they can't rule out more subtle violations of the Copernican principle, Zhang and Stebbins' test reinforces Carl Sagan's dictum that "extraordinary claims require extraordinary evidence."

The Daily Galaxy via [PhysRevLett.107.041301](#) and http://www.nasa.gov/mission_pages/hubble/science/great-attractor.html

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