The "Great Attractor": What is the Milky Way Speeding Towards at 14 Million MPH?

Astronomers have known for years that something seems 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 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 universe as we see it contains only the stable relics and leftovers of the big bang: unstable particles have decayed away with time, and the perfect symmetries have been broken as the universe has cooled, but the structure of space remembers all the particles and forces we can no longer see around us.

Discovering what it is that makes up the heart of the Great Attractor -- will surely rank as one of the greatest discoveries in the history of science.

Recent findings suggest these motions are the result of gravitational forces from not one, but two things: the Great Attractor, and a conglomerate of galaxies far beyond it.

The location of the Great Attractor was finally determined in 1986 and lies at a distance of 250 million light years from the Milky Way, in the direction of the Hydra and Centaurus constellations. That region of space is dominated by the Norma cluster, a massive cluster of galaxies, and contains a preponderance of large, old galaxies, many of which are colliding with their neighbors, and or radiating large amounts of radio waves.

Major concentration of galaxies lies beyond the Great Attractor, near the so-called Shapley Supercluster, 500 million light-years away—the most massive known super-cluster. Mapping X-ray luminous galaxy clusters in the Great Attractor region has shown that the pull our galaxy is experiencing is most likely due to both the nearby Great Attractor and these more distant structures.

In the 1987, a group of astronomers known as the "Seven Samurai," at Cal Tech uncovered this coordinated motion of the Milky Way and our several million nearest galactic neighbors. They found that galaxies are very unevenly distributed in space, with galactic super-clusters separated by incredibly huge voids of visible ordinary matter. The place towards which we all appear headed was originally called the New Supergalactic Center or the Very Massive Object until one of the discoverers, Alan Dressler, decided they needed a more evocative name and came up with "The Great Attractor."

The motion of local galaxies indicated there was something massive out there that are pulling the Milky Way, the Andromeda Galaxy, and other nearby galaxies towards it. For a while, nobody could see what it was, because it lies behind the plane of our Galaxy --- that means the gas and dust in our Galaxy obscures the light from the Great Attractor, and it is outshone by the stars and other objects in our Galaxy.

The Great Attractor is a diffuse concentration of matter some 400 million light-years in size located around 250 million light-years away within the so-called "Centaurus Wall" of galaxies , about seven degrees off the plane of the Milky Way. X-ray observations with the ROSAT satellite then revealed that Abell 3627 is at the center of the Great Attractor. It lies in the so-called Zone of Avoidance, where the dust and stars of the Milky Way's disk obscures as much as a quarter of the Earth's visible sky.

Posted by Casey Kazan. Image credit: Wally Pacholtz

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