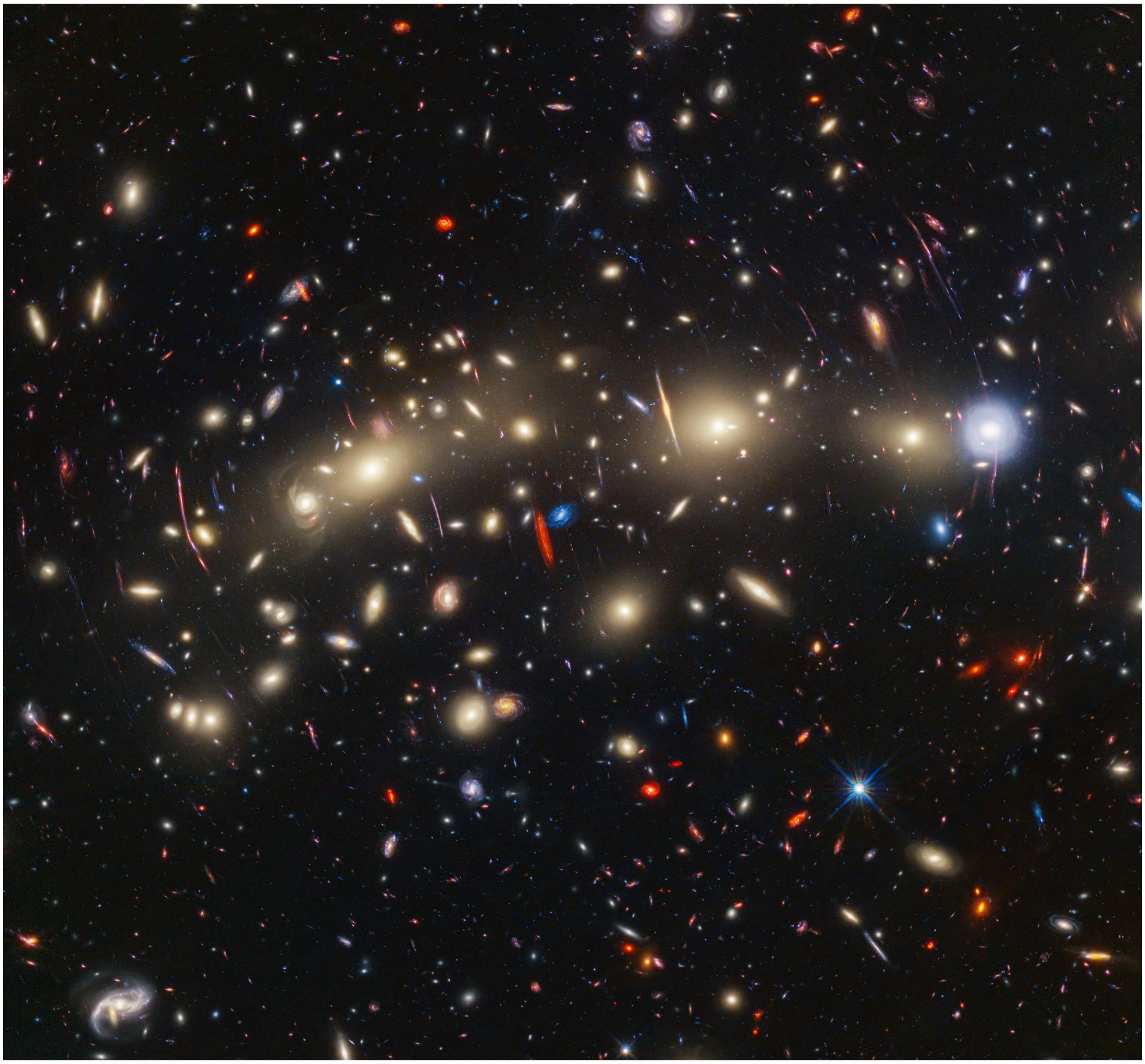
The Great Attractor And The End Of The Universe



In the 1970s, scientists were peering into the night sky when they stumbled upon something bizarre. By then, it was already known that galaxies are travelling entities with no discernible pattern and were part of something called the Hubble Flow, which depicts the movement of galaxies because of the expansion of the Universe. Straightforward stuff, considering the kind of knowledge we already possessed by then about our surrounding galaxies and their movements. However, what was really fascinating was the detection of a common point, like all the galaxies near us were heading towards the same point.

That's right, there's an incredibly large gravitational anomaly that's pulling a gigantic portion of space which currently holds a hundred thousand galaxies all to a single point. Within this gigantic portion of space also includes, our very own Milky Way galaxy, moving rapidly through space at 600 kilometers per second, and we're going towards something we can't see very clearly.

This galactic movement is centered around something that has been dubbed the Great Attractor, which is the result of countless eons of cosmic evolution. Our journey towards this elusive point is, however, bound to fail, for within several billion years, the relentless influence of dark energy will ultimately tear the very fabric of the Universe apart.

But wait… So what exactly is the Great Attractor? And is it really how things are going to end?

An Expanding Universe

Before that, let's talk about a crucial concept we need to clear out. The concept of the expansion of the Universe is fundamental in the field of cosmology. In the 1920s, Edwin Hubble discovered a group of stars called Cepheid variables in spiral-shaped objects in the sky. These stars displayed periodic brightening and dimming, each with a distinct and consistent time frame. We can determine the distance to each star and the galaxy it resides in because of the relationship between their brightness and time period.

The idea of a standard candle has evolved from Cepheids to other galaxy properties and type Ia supernovae, which are the brightest and easiest to see standard candles. Through these methods, we have found a relationship called Hubble's law: the speed at which an object seems to move away from us is equal to the Hubble parameter multiplied by the distance to that object. This is often referred to as the "Hubble constant."

We realized that the Universe's expansion was changing over time and accelerating as we expanded our observations to more distant regions of the

Universe. It is clear from this acceleration that the Universe consists of more than just matter, radiation, and curved space. The present-day Universe is, in fact, dominated by around 70% dark matter, a percentage that only grows more significant with passing time.

When we look back half the age of the Universe, dark energy was not prominently noticeable, as it made up only a small fraction of the total energy density. But as matter and radiation become less dense, dark energy takes over and becomes the main driver of the Universes expansion. This leads to the observed acceleration.

So, any structures that weren't already gravitationally bound, meaning they hadn't reached a sufficient density compared to the average, wouldn't ever come together in this Universe. Instead, they would be pushed apart by the expanding universe.

Gravity has had ample time to shape the Universe even on vast distance scales of millions of light-years. Over the first few billion years since the Big Bang, trillions of star clusters and hundreds of billions of galaxies came into existence, which made up the rich and complicated structure of the Universe. The most densely populated regions evolved into galaxies and groups and clusters of many galaxies, bound together in huge cosmic conglomerations.

The gravitational impact of these local imperfections is highly significant. For example, when we look at a galaxy like Andromeda, which is our closest neighbor at a distance of about 2.5 million light years, we might think that it is going away because the Universe is expanding. But if these galaxies have enough mass, the gravitational interaction between the Milky Way and Andromeda can stop this expansion.

If the gravitational force between them is strong enough and happens early enough in their history, they will become bonded to each other. Even though dark energy pushes distant galaxies away, over time, these galaxies will get closer and eventually merge into a single big cosmic structure.

Which brings us to the elephant in the room. There is a formidable entity somewhere deep in the vast expanse of the cosmos, far removed from the familiar borders of our home galaxy. It operates with a methodical and inevitable pull, gradually drawing us and everything around us into its cosmic grasp. Over the course of billions of years, this force has been acting relentlessly, and it can only be explained by gravity. Whatever the cause may be, this phenomenon is massive and unyielding.

This cosmic entity is called the Great Attractor, a name that has kept its true nature a mystery. Although its character remains puzzling, recent discoveries have illuminated certain aspects of its character, although the full extent of its secrets is yet to be unraveled.

The first sign of the Great Attractor was discovered in the 1970s, when astronomers meticulously mapped the Cosmic Microwave Background, which is the relic of the primordial light of the universe. They observed a slight, yet significant temperature variation, which is equivalent to less than one one-hundredth of a degree Fahrenheit, between the Milky Way's two sides. Our galaxy is moving through space at a great speed, about 370 miles per second, or 600 km/s, according to this temperature difference.

Even though they could measure this quick motion, astronomers couldn't figure out where it came from, which made the Great Attractor even more mysterious. The mystery of the Great Attractor comes from a set of interesting circumstances. Astronomers excel in their space observations, given their primary vocation.

It is possible that someone would have pointed a telescope in the direction of our motion and unraveled this cosmic enigma by now. However, there is a significant obstacle that exists. The Great Attractor is in the direction of the Centaurus constellation, but our Milky Way galaxy blocks our view in that direction. Within our galaxy, an assortment of cosmic clutter, including stars, gases, dust, and more, prevents light from passing from the distant universe.

The Zone Of Avoidance

Astronomers have done an impressive job of mapping the vast structures of the universe, but they have a hard time looking through our own galaxy. Astronomers have called this area the *"Zone of Avoidance."* It's tough to describe the Great Attractor because it's deep within this tough zone. Still, there is reason for optimism, as X-ray and radio astronomers have begun to probe the murky depths of the Milky Way, beginning a tentative exploration of this previously uncharted cosmic realm.

To understand the dynamics of the Great Attractor, we must broaden our perspective to the greatest scale possible. I'm talking about the biggest view possible. Our closest substantial cosmic neighbor, the Andromeda Galaxy, is located just beyond our Milky Way galaxy, at a distance of just over 2.5 million light-years, which is a relatively short cosmic distance in this case.

The Milky Way, Andromeda, the Triangulum Galaxy, and a handful of associated companions collectively form what is known as the Local Group. This is a gravitationally bound assembly that spans approximately 10 million light-years.

Continuing on this cosmic journey, we come across the Virgo Cluster, which is often called the cosmological downtown of our local cosmic neighborhood. More than 1,300 galaxies are packed into a compact region that is only 65 million light-years away. Like the Local Group, the Virgo Clusters galaxies are interconnected by their shared gravitational influence, which causes them to cluster together.

The perspective we expand beyond this point becomes a bit nebulous when characterizing structures beyond our own galaxy. We have discovered immense clusters of galaxies, commonly referred to as "superclusters," which were for a considerable period of time, formally referred to as "larger than a cluster, but smaller than a universe."

They were typically given endearing names, sometimes based on the constellation used for mapping their structure, or even after notable astronomers. Several examples of such clusters include the Virgo Supercluster, the Hydra-Centaurus Supercluster, and the Shapley Supercluster. This informal classification served its purpose until the need for more precise definitions and research was required, such as unraveling the mysteries of the Great Attractor.

Our universe has a hierarchy that has evolved over the course of more than 13 billion years. Matter has gradually coalesced into small clumps, which in turn have merged into more substantial sizes. But around 5 billion years ago, the universe changed a lot because dark energy became more powerful.

In the present era, our universe has already given birth to galaxies, groups, and clusters. Within our Local Group, a convergence is underway, with the Milky Way and Andromeda galaxies on a collision course that will occur in roughly 5 billion years. In addition to our local group, several other groups and smaller clusters are advancing along the cosmic gravitational pathways leading to the central hub, the Virgo Cluster, situated at the center of the aptly named Virgo Supercluster.

All nearby cosmic entities, including the Milky Way, Andromeda, the Virgo Cluster, and their vicinity, are moving toward the gravitational attraction of the Great Attractor. Recent advances in cosmic exploration, including more sophisticated surveys done in the Zone of Avoidance, and a more in-depth understanding of the concept of "superclusters," have started the process of figuring out the mystery of the Great Attractor.

The idea that a "supercluster" is just a "large cluster of galaxies" has changed. Studies of the speeds of galaxies in our immediate cosmic neighborhood have helped to define a "supercluster". It's now thought of as a volume of space where all the galaxies in that space are gravitating toward a common central point. This reinterpretation has majorly altered our perception of the local universe, revealing that the Virgo Supercluster is not an isolated entity but rather an extensive part, an enormously large one at that, of a much more grand structure, the Laniakea Supercluster.

When we examine the super-galactic structures in terms of the flow of matter, the nature of the Great Attractor becomes more apparent. We operate in a hierarchical fashion, with small-scale structures akin to galactic building blocks blending into larger ones. The Milky Way and Andromeda galaxies are gravitating towards the center of the Local Group as it undergoes condensation as part of this process. Simultaneously, all the components within the Virgo Supercluster are converging towards its central core, represented by the Virgo Cluster.

Continuing this concept, everything within the Laniakea Supercluster is gravitating towards its center, which is currently occupied by the Norma Cluster. The Norma Cluster is a group of gas and galaxies that have already arrived there.

The Great Attractor, rather than being an isolated entity, ought to be perceived as a location, a focal point within our cosmic domain. It is the result of a process initiated over 13 billion years ago, and it emerges as a natural consequence of the flows and accumulation of matter in the universe. The precise origins of this process are a topic worthy of its own dedicated discussion.

A point to remember is that the Great Attractor's "greatness" is not a permanent state. In fact, we'll never actually reach it. Until such a meeting can occur, the expansive force of dark energy will pull the Norma Cluster away from us. While clusters may continue to exist, superclusters may never fully embody their grandiose titles. This insight provides reassurance that there is no imminent threat from the Great Attractor.

An Ongoing Debate

Several astronomers questioned whether this was a genuine astronomical effect or a consequence of the Malmquist bias, which stems from the easier observability of bright galaxies compared to their dimmer counterparts. Some believe that a thorough examination of the nearby cosmos, considering the numerous smaller and fainter galaxies, could negate the apparent extra motion, restoring a sense of normalcy to our knowledge.

The crucial change came with more thorough examinations of the cosmic microwave background or CMB. The CMB represents the residual light from when the universe transitioned from a plasma state to the formation of neutral atoms, a mere 380,000 years after the universe's birth. This is a relative infant compared to its current age. The CMB covers the entire celestial sphere, containing nearly all cosmic photons, about 99.99 percent, radiating from every direction.

The CMB's uniform field of photons covering each degree with an astonishingly uniform temperature of roughly 2.75 Kelvin might not immediately strike you as remarkable if I were to present a map of it across the sky – essentially a uniform field of photons covering each degree, but it's still pretty amazing. Yet, with enough sensitivity, we can see a small temperature change, one part in a thousand. The CMB has a slight excess of warmth in one direction and a slight cooling in the opposite direction.

This phenomenon is known as the CMB dipole, which is a consequence of Earths motion through the cosmos. Photons coming from the direction we're going toward experience a blue shift, meaning they're slightly more energetic, while photons coming from behind us experience a red shift, which means they're less energetic. The extent of this spectral shift can be used to determine our current velocity, which amounts to roughly 600 kilometers per second, and our trajectory, which leads us in the general direction of the Centaurus constellation.

Our motion is influenced by a portion of known variables. For example, the Sun is in orbit around the center of the Milky Way galaxy, and the Milky Way is in a collision with the Andromeda Galaxy, our closest cosmic neighbor. These motions comprise a small part of the 600 km/s, but not all of it. What's really interesting to us is that we, like most galaxies in our area, seem to be hurtling towards a point in the universe. This point seems to be driven by a giant source of gravitation.

The mystery surrounding the Great Attractor would be considerably less perplexing were it not for an incredibly unfortunate turn of events. In the late 1970s, astronomers had honed their skills in making large surveys of the distant cosmos. They had mapped out the positions and distances of thousands of galaxies spread across hundreds of millions of light-years. The dazzling and intricate web of galaxies revealed by these investigations was awe-inspiring.

These surveys continued to get bigger and more detailed, with one big exception: an area of the sky called the Zone of Avoidance. The predicament arises from the fact that we are situated within our own galaxy, the Milky Way, which is a galaxy brimming with diverse forms of dust. Massive dust clouds forming stars, smaller dust masses surrounding dead stars, and even solitary dust particles drifting aimlessly without contributing to star formation are some examples. This abundance of cosmic dust causes what astronomers call 'extinction,' a phenomenon where visible light scatters and undergoes reddening.

The Enigma Of The Great Attractor

Since most of these early surveys, and most modern ones as well, work in the visible wavelength spectrum, the Milky Way is full of dust and blocks our view of galaxies beyond the plane. This region remains obscured, resulting in an uncharted territory amid our otherwise comprehensive explorations.

Indeed, the Great Attractor finds itself ensconced within the Zone of Avoidance. For decades, our knowledge of the Universe's structure in that direction was severely limited, leaving us in the dark regarding the identity and constituents of the Great Attractor, despite our certainty about its existence based on our galactic motion.

Astronomers were faced with two choices. They could opt for patience and wait for the natural orbit of the Solar System around the Milky Way's center to position us for a better view. But this approach would take around 100 million years, which is even longer than the typical grant-funding cycles, making it an unpractical solution.

The second way was to use creativity. Throughout their quest for celestial understanding, astronomers turned to alternative wavelengths of light to peer through the Milky Way's dusty veil and explore the depths of the Universe. The X-ray spectrum is capable of piercing through cosmic dust, but its primary purpose is to reveal the brightest galaxies actively engaged in star formation and the massive yet rare galaxy clusters. Infrared light turned out to be a more versatile tool that could look into deep cosmic distances, as the James Webb Space Telescope showed.

In the 1990s, astronomers began to do X-ray and infrared surveys in the Zone of Avoidance. This endeavor required significant telescope time to collect the necessary light for distance estimation, and it was only possible to capture a limited number of galaxies or clusters at any one time. While these maps are still a work in progress, they have begun to provide us with our initial comprehensive depiction of the region of the Universe centered around the Great Attractor.

Our home in the universe is the Milky Way galaxy, which covers an area of approximately 100,000 light-years and hosts hundreds of billions of stars. Our closest neighbor, Andromeda, is larger than our galaxy and resides at a considerable distance of 2.5 million light-years from us. Along with the Triangulum galaxy, which deserves more recognition, and many dwarf galaxies, we make up the Local Group.

Strong connections with all the members of the Local Group are prudent because we are interconnected by our shared gravitational bonds, and in a few billion years, we will amalgamate into a single colossal galaxy.

The Local Group works as a whole, and it is headed towards the Virgo cluster, which is the nearest metropolis in our cosmic vicinity. The Virgo cluster, which is located at an approximate distance of 50 million light-years from our location, is home to a remarkable array of over 1,000 distinct galaxies, all densely packed within a relatively compact sphere measuring about 5 million light-years in diameter. In terms of mass, the Virgo cluster is the dominant colossus in our cosmic neighborhood.

Combined with its stars, gas, and mysterious dark matter, the cluster's total mass exceeds a staggering billion trillion times that of our Sun. The Virgo cluster is surrounded by smaller galactic groups that are drawn to it by its strong gravitational pull.

We refer to the Virgo Cluster and its adjacent groups as the Virgo supercluster. It is an unfortunate example of duplicate naming, which, despite its confusion, stands as a fact. Superclusters do not experience gravitational binding and have not yet undergone complete collapse, unlike clusters and groups. Initially, astronomers believed that the Virgo supercluster was the most substantial structure in our neighboring universe.

The Zone of Avoidance has seen more comprehensive surveys conducted that have revealed a more expansive cosmic landscape. The Virgo supercluster is merely a segment of a much larger supercluster, which is thankfully devoid of the designation of “hypercluster”. This supercluster is commonly referred to as Laniakea, a Hawaiian term that roughly translates to “immeasurable heaven.”

Understanding The Laniakea Supercluster

Laniakea encompasses four supercluster branches, encompassing more than 500 groups and clusters, each of which comprises over 100,000 individual galaxies. The complex is over half a billion light-years in length and intricately designed. The Great Attractor is at the heart of this gigantic structure. We have to rewind a bit to understand what the Great Attractor is and why it is at the center of the Laniakea supercluster. 13 billion years to be exact.

The cosmos is expanding, with the average distance between galaxies at large scales increasing with time. However, at smaller scales, and in cosmology, anything less than a hundred million light-years is considered small. Accordingly, our present-day Universe is the outcome of a multi-billion-year construction effort.

In the early Universe, everything was mostly even and there were no big differences in density from place to place. However, at cosmological scales, the only force at play was weak, feeble, but persistent gravity, which gripped the small density differences that did exist. Through hundreds of millions and then billions of years, gravity focused on those tiny initial density variations. The first evidence of that work can be seen in the CMB. The dipole has temperature differences of one part in a million, which shows the first changes in density that would affect the entire universe.

Despite the unrelenting efforts of gravity, the rich get richer and the poor get poorer. Regions with a stronger gravitational pull can collect more material. With a stronger pull, they can collect more mass. Over time, the disparities in density within our Universe increase, with the low-density regions evaporating to become cosmic voids, while the high-density regions expand to become stars, galaxies, groups, clusters, and ultimately superclusters.

At the cosmic scale, the monumental construction project is still in progress. Although galaxies and clusters may have collapsed and achieved stability billions of years ago, gravity remains an unceasing architect. This patient force continues to shape superclusters, including the immense Laniakea, leveraging their individual components in an ongoing endeavor to create cohesive, self-contained entities governed by their internal gravitational forces.

In this context, it's more fitting to think of the Great Attractor as a place, a focal point of attraction. It serves as the lowest point in our local gravitational landscape, the point at which all the surrounding phenomena converge, akin to the bustling downtown of urban centers. It is the best place to see things and be seen in.

The Great Attractor is the result of billions of years of hard work by gravity. It's inevitable because of this huge construction project. Our present trajectory is not solely our intended destination, but rather a future that encompasses our destiny from the outset. Despite our never-ending trek towards it, we might never arrive at its actual spot.

The Final Address

Cosmologists are occupied in ongoing debates about the exact composition and location of the Great Attractor. The mass and position of the object are inferred from limited surveys conducted within the Zone of Avoidance and reconstructions of galactic motions. It is challenging to observe these movements in real time due to the enormous scales involved.

The alleged location of the Great Attractor already contains a substantial concentration of mass, represented by the Norma Cluster, which is located over 200 million light-years away. Our very own Virgo cluster and all the surrounding galaxies are currently in motion, gravitating towards Norma, which serves as the central point of the galactic flow within Laniakea.

Recent investigations have revealed a level of complexity. It appears that Norma itself is moving towards another supercluster, the Shapley Supercluster, which might surpass our own Laniakea in size. Norma is located at the celestial point of our local gravitational well, but a deeper one exists nearby. Reconstructions of our local universe further suggest the existence of a third supercluster, named the Vela, that is unrelated to the Great Attractor and is believed to be responsible for some of our cosmic motion.

All of these celestial processes are temporary. Over five billion years ago, the remarkable machines of creation, powered by the force of gravity, stopped functioning. The cosmic web, as defined by its extensive and interconnected strands of clusters and superclusters, will forever remain incomplete.

Dark energy is the elusive culprit in this scenario. Although the precise nature of dark energy is unknown to astronomers, its effects are well understood. Whatever its essence, dark energy is driving the universe's expansion to accelerate. With the passage of time, galaxies not already gravitationally bound to each other will increasingly drift apart at swifter rates.

Dark energy has perpetually lingered in the cosmic backdrop. During the initial stages of the universe, the collective gravitational influence exerted by all the matter within it prevailed over the accelerating impact of dark energy. This equilibrium allowed gravity to construct substantial cosmic structures. However, approximately 5 billion years ago, the cosmic matter became too diluted, giving dark energy the upper hand.

While our Local Group will be able to deal with the impending separation, Laniakea won’t be as lucky. We won't even approach the Virgo cluster, let alone the location of the Great Attractor. Over the next several billion years, our journey toward the Great Attractor will slow down, come to a halt, and then reverse.

They will find themselves pushed away from what they will undoubtedly call the Great Repeller, with the amalgamated mega-galaxy, formerly the Local Group, serving as their sole sanctuary in an increasingly desolate, frigid, and isolated universe. The cosmic web with its many superclusters will slowly break up, leaving each group and cluster to fend for itself in the dark future.

In this universe, nothing lasts forever, not even the strongest gravitational forces within our cosmic proximity. It appears that some components were never intended, and some endeavors are bound to fail.

So, in reality, will the “Great Attractor” ever be of any issue? Before we end this video, we wanted to ask a couple of solid questions that’ll help us store those apocalyptic thoughts in our minds, for another time.

Is it truly as extraordinary as it appears?

Researchers at the Parkes observatory have found new information about whole galaxies, galaxy clusters, and even new parts of the cosmic web. Instead of providing further answers, observations have only deepened the perplexity surrounding this particular enigma. The over-density exists on the far side of the Milky Way's disk, which causes the dilemma. A chaotic mix of gases and interstellar dust are interspersed with the stars and star clusters.

All these elements obscure the light that would typically emanate from that direction, making it virtually impossible for us to observe and scrutinize it. It is thought that the Great Attractor is right in the middle of it. There are sometimes fragmentary insights that emerge. Radio and X-ray astronomers have recently begun peering into the mysteries on the other side. Yet, the current picture is still in its infancy and surrounded by uncertainty.

Does it truly mean the beginning of our end?

Astronomers have confirmed that our galaxy, along with all the others in our supercluster, is presently on a trajectory towards the Great Attractor. But it's not clear whether this motion is a threat or not. Astronomers suggest that it will be several years before we gain further insight into this enigma. Astronomers have differing opinions, with some dismissing it as a menace while others theorize that galaxies and clusters are aggregating into ever-larger superclusters, potentially leading to the universe's end.

On a more positive note, despite the absence of any imminent danger from the Great Attractor, there are other pressing concerns to address, including climate change, the potential collision of a massive asteroid with Earth, or the eruption of a supervolcano triggering a volcanic winter, all of which have the potential to jeopardize humanity. If any or all of these scenarios were to occur, humanity would face the eventual demise of our sun within 7-8 billion years, the collapse of the Higgs boson field, or the ultimate heat death of the universe. The Great Attractor is, however, one of the most mysterious apocalyptic scenarios ever imagined.

So what do you think? Will the Great Attractor bring an end to the universe as we know it? Or will something greater put an end to things? Let us know in the comments below. If you liked this video, make sure to subscribe to the channel, and leave a like on this video. As always, thanks for watching.

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The Great Attractor: What Is It? How Will It Destroy Us?

Explainer: What is the Great Attractor and its pull on the Milky Way?

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