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Galaxies consist of stars, planets, and vast clouds of gas and dust, all bound together by gravity. The largest contain trillions of stars and can be more than a million light-years across. The smallest can contain a few thousand stars and span just a few hundred light-years. Most large galaxies have supermassive black holes at their centers, some with billions of times the Sun’s mass. Galaxies come in a variety of shapes, mostly spirals and ellipticals, as well as those with less orderly appearances, usually dubbed irregular. Most galaxies are between 10 billion and 13.6 billion years old. Some are almost as old as the universe itself, which formed around 13.8 billion years ago. Astronomers think the youngest known galaxy formed approximately 500 million years ago. Galaxies can organize into groups of about 100 or fewer members held together by their mutual gravity. Larger structures, called clusters, may contain thousands of galaxies. Groups and clusters can be arranged in superclusters, which are not gravitationally bound. Superclusters, empty voids, “walls” of galaxies, and other large-scale structures make up the cosmic web of matter in the universe. Our home galaxy is called the Milky Way. It’s a spiral galaxy with a disk of stars spanning more than 100,000 light-years. Earth is located along one of the galaxy’s spiral arms, about halfway from the center. Our solar system takes about 240 million years to orbit the Milky Way just once. From our perspective on Earth, the Milky Way looks like a faint, milky band of light arcing across the entire sky, which is how it got its name. This feature marks the central disk of our home galaxy seen edge on. The Milky Way sits in a neighborhood with over 50 other galaxies called the Local Group. Its members range in size from dwarf galaxies (smaller galaxies with up to a few billion stars) to Andromeda, our nearest large galactic neighbor. The Local Group sits just off the edge of the Virgo cluster and is part of the Laniakea supercluster. What is a galaxy? A galaxy is a vast island of gas, dust and stars in an ocean of space. Typically, galaxies are millions of light-years apart. Galaxies are the building blocks of our universe. Their distribution isn’t random, as one might suppose. Instead, galaxies reside along unimaginably long filaments across the universe, forming a cosmic web of star cities. View larger. | Have you ever wondered what a galaxy is or how many galaxies are in the universe? Here’s the Webb telescope’s 1st deep field, released in July 2022. This near-infrared image of the galaxy cluster SMACS 0723 contains thousands of galaxies. High-resolution imaging from Webb – combined with a natural effect known as gravitational lensing – made this finely detailed image possible. Image via NASA/ ESA/ CSA/ STScI. Read more about this image. A galaxy can contain hundreds of billions of stars and be many thousands of light-years across. Our own galaxy, the Milky Way, is around 100,000 light-years in diameter. That’s about 587,900 trillion miles, or nearly a million trillion kilometers. The three types of galaxies are spiral, elliptical or irregular. Galaxy sizes vary widely, ranging from very small to unbelievably enormous. Small dwarf galaxies contain about 100 million stars. Giant galaxies contain more than a trillion stars. Also, there are an estimated two hundred billion galaxies in the universe. Here is a closeup view of 1 small portion of a Webb image that shows more than 45,000 galaxies. Image via NASA/ ESA/ CSA/ Brant Robertson (UC Santa Cruz)/ Ben Johnson (CfA)/ Sandro Tacchella (Cambridge)/ Marcia Rieke (University of Arizona)/ Daniel Eisenstein (CfA)/ Alyssa Pagan (STScI). The discovery of other galaxies The famous astronomer Edwin P. Hubble first classified galaxies based on their visual appearance in the late 1920s and 30s. In fact, Hubble’s classification of galaxies remains in use today. Of course, since Hubble’s time, like any effective classification system, it has evolved from ongoing observations. Hubble identified several basic types of galaxies, each containing subtypes. Spiral galaxies are more mysterious than we thought! @KarenLMasters, @vrooje and hundreds of thousands of volunteers @GalaxyZoo have shown that the ‘Hubble Tuning Fork’ method of categorisation is wrong ?? pic.twitter.com/QFZgrXHjtU — Royal Astronomical Society (@RoyalAstroSoc) June 11, 2019 Before Hubble’s study of galaxies, we believed that our galaxy was the only one in the universe. Astronomers thought that the smudges of light they saw through their telescopes were in fact nebulae within our own galaxy. However, Hubble discovered that these nebulae were galaxies. Additionally, it was Hubble who demonstrated, by measuring their velocities, that they lie at vast distances from us. Galaxies are light-years away These galaxies lie millions of light-years beyond the Milky Way. The distances are so huge these galaxies appear tiny in all but the largest telescopes. Moreover, Hubble demonstrated that, wherever he looked, galaxies were receding from us in all directions. And the farther away they are, the faster they are receding. Thus, Hubble had discovered that the universe is expanding. View at EarthSky Community Photos. | Harshwardhan Pathak of India, using a large remote telescope in Chile, captured the galaxy NGC 1232 in the constellation Eridanus on February 1, 2024. Harshwardhan wrote: “NGC 1232, also known as the Eye of God Galaxy, is an intermediate spiral galaxy about 60 million light-years away. German-British astronomer William Herschel discovered it on October 20, 1784.” Thank you, Harshwardhan! Spiral galaxies The most common type of galaxy is a spiral galaxy. The Milky Way is a spiral galaxy. Spiral galaxies have majestic, sweeping arms, thousands of light-years long. They contain millions upon millions of stars. Their spiral arms stand out because of bright stars, glowing gas and dust. Spiral galaxies are active with star formation. Also, spiral galaxies have a bright center, made up of a dense concentration of stars. There are so many stars that from a distance the galaxy’s center looks like a solid ball. This ball of stars is known as the galactic bulge. Also, there are two types of spiral galaxies. There are regular spirals and barred spirals. If the spiral has bars, they extend off the central bulge. Then, the spiral arms start at the end of the bar. Read more: Wow! See 19 spiral galaxies in stunning Webb images The 3 most common types of galaxies. The top row shows schematic illustrations, and the bottom row shows actual images of galaxies that fit each of the 3 categories. Image via A. Feild/ STScI/ Hubblesite. Elliptical and irregular galaxies Elliptical galaxies are the universe’s largest galaxies. In fact, giant elliptical galaxies can be about 300,000 light-years across. But dwarf elliptical galaxies – the most common elliptical – are only a few thousand light-years across. There are several shapes of elliptical galaxies, ranging from circular to football-shaped. Overall, 1/3 of all galaxies are elliptical galaxies. Elliptical galaxies contain very little gas and dust compared to a spiral or irregular galaxy. They are no longer actively forming stars. The stars in elliptical galaxies are older stars and contain very few heavier elements. Irregular-shaped galaxies have all sorts of different shapes but they don’t look like a spiral or elliptical galaxy. Irregular galaxies can have very little dust or a lot. Plus, they can show active star-forming regions or have little-to-no star formation occurring. They seemed plentiful in the early universe. View larger. | This Hubble Space Telescope mosaic is of a portion of the immense Coma Berenices galaxy cluster. Be sure to use the view larger link and zoom in to see how much larger the football-shaped elliptical galaxies are, in contrast to the spiral galaxies. Image via NASA/ ESA/ J. Mack (STScI)/ J. Madrid (Australian Telescope National Facility). Our Milky Way galaxy The Milky Way, in fact, falls into one of Hubble’s spiral galaxy sub-types. It’s a barred spiral, which means it has a bar of stars protruding out from each side of its center. As the spiral arms sweep out in their graceful and enormous arcs, the ends of the bars are the anchors. This is a recent discovery and it’s unknown how bars form in a galaxy. Our solar system is situated about 2/3 of the way out from the galactic center toward the periphery of the galaxy, embedded in one of these spiral arms. Another recent discovery is that the disk of the Milky Way is warped, like a long-playing vinyl record left too long in the sun. Exactly why is unknown, but it may be the result of a gravitational encounter with another galaxy early in the Milky Way’s history. It also appears that all galaxies rotate. For example, the Milky Way takes 226 million years to spin around once. Since its creation, the Earth has traveled 20 times around the galaxy. Galaxies come in clusters Galaxies group together in clusters. Our own galaxy is part of what is called the Local Group, and it contains roughly 55 galaxies. Ultimately, galaxy clusters themselves group into superclusters. Our Local Group is part of the Virgo Supercluster. The “glue” that binds stars into galaxies, galaxies into clusters, clusters into superclusters and superclusters into filaments is – of course – gravity. In fact, gravity is the universe’s construction worker, which sculpts all the structures we see in the cosmos. The Universe is Infinite. However our existence in our current Galaxy Cluster is Finite. Time is also a factor… Our Galaxy Clusters actually expand into the void of space over time. pic.twitter.com/EAOcisPdZn — Gustavo Suárez (@gsuarez333) February 26, 2023 Galaxies are flying apart Most galaxies are flying apart from each other. But those astronomically close to each other will be gravitationally bound to each other. Caught in an inexorable gravitational dance, eventually they merge, passing through each other over millions of years. They eventually form a single, amorphous elliptical galaxy. Gravity shockwaves compress huge clouds of interstellar gas and dust during such mergers, giving rise to new generations of stars. The Milky Way is caught in such a gravitational embrace with M31, aka the Andromeda galaxy, which is 2 1/2 million light-years distant. Both galaxies are moving toward each other because of gravitational attraction: they will merge in about 6 billion years. However, huge halos of gas surround both galaxies and may extend for millions of light-years. And it was discovered that the halos of the Milky Way and M31 have already started to touch. Galaxy mergers and companion galaxies Galaxy mergers are common. The universe is full of examples of galaxies in various stages of merging together, their structures disrupted and distorted by gravity, forming bizarre and beautiful shapes. Galaxies may take billions of years to fully merge into a single galaxy. As astronomers look outward in space, they can only see glimpses of this long merger process. Located 300 million light-years away in the constellation Coma Berenices, these 2 colliding galaxies have been nicknamed the Mice Galaxies because of the long tails of stars and gas emanating from each galaxy. Otherwise known as NGC 4676, the pair will eventually merge into a single giant galaxy. Image via NASA/ ESA/ Wikimedia Commons (public domain). Then, at the lower end of the galactic size scale, there are so-called dwarf galaxies. They consist of a few hundred to up to several billion stars. Their origin is not clear. Typically, they have no clearly defined structure. Astronomers believe they were born in the same way as larger galaxies like the Milky Way, but for whatever reason they stopped growing. Ensnared by the gravity of a larger galaxy, they orbit its periphery. The Milky Way has around 60 dwarf galaxies orbiting it that we know of, although some models predict there should be many more. Read more: ‘String of pearls’ star clusters form when galaxies collide Our closest neighbors: The Magellanic Clouds The two most famous dwarf galaxies for us earthlings are, of course, the Large and Small Magellanic Clouds, visible to the unaided eye in Earth’s Southern Hemisphere sky. Eventually, these and other dwarf galaxies will rip apart under the titanic pull of the Milky Way’s gravity. This will leave behind a barely noticeable stream of stars across the sky, slowly dissipating over eons. The Large Magellanic Cloud spills across the border of Dorado and Mensa. The Small Magellanic Cloud is at lower left. Image via Yuri Beletsky/ LCO/ ESO. Supermassive black holes lurk in galaxy centers At the center of most galaxies lurks a supermassive black hole, of millions or even billions of solar masses. For example, TON 618, has a mass 66 billion times that of our sun. The one at the center of our own Milky Way galaxy possesses 4.6 million solar masses. The origin and evolution of supermassive black holes remains a mystery. A few years ago, astronomers uncovered a surprising fact: in spiral galaxies, the mass of the supermassive black hole has a direct linear relationship with the mass of the galactic bulge. The more mass the black hole has, the more stars there are in the bulge. No one knows exactly what the significance of this relationship may be. However, its existence seems to indicate that the growth of a galaxy’s stellar population is linked to that of its supermassive black hole. This discovery comes at a time when astronomers are beginning to realize that a supermassive black hole may control the fate of its host galaxy. The copious amount of electromagnetic radiation emitted from the maelstrom of material orbiting the central black hole. This is known as the accretion disk, and the radiation may push away and dissipate the clouds of interstellar hydrogen from which new stars form. This acts as an inhibitor on the galaxy’s ability to give birth to new stars. Ultimately, the activity of supermassive black holes may link to the emergence of life itself. This is an area that is undergoing extensive research. While astronomers still know very little about exactly how galaxies formed in the first place – we see them in their nascent state only a few hundred million years after the Big Bang – the study of galaxies is an endless voyage of discovery. Wow! Thousands of new black holes just found Read more: Oldest-known black hole is eating its galaxy We discovered other galaxies exist about a century ago Around a hundred years ago we realized that other galaxies exist besides our own. Since then, we have learned so much about these grand, majestic star cities. And there is still much to learn. Bottom line: A galaxy is a vast island of gas, dust and stars in an ocean of space. There are three types of galaxies. Learn about these starry islands in space. Read more: New map of Andromeda galaxy and its colossal ecosystem Read more: Milky Way’s farthest stars reach halfway to Andromeda Close your eyes for a moment and picture the night sky. Imagine a sea of stars twinkling in the dark velvet expanse above you. Now, realize this: every point of light you can see with your naked eye is just one tiny fragment of something far bigger and more magnificent. Those stars, and billions upon billions more, are all part of what we call galaxies—vast cosmic cities made of stars, gas, dust, and dark matter, bound together by gravity and stretched across unimaginable distances.But what exactly is a galaxy? Why do they exist? How did they come to be? And what secrets do they hold about the origin and fate of the universe itself? Buckle up, because we’re about to embark on an incredible journey into the grand architecture of the cosmos.At its core, a galaxy is a massive, gravitationally bound system consisting of stars, stellar remnants, interstellar gas, dust, and dark matter. These components are woven together by gravity, forming complex and beautiful structures that can span tens of thousands to hundreds of thousands of light-years across.Galaxies are the building blocks of the universe. In fact, they’re so fundamental that without them, there’d be no stars, no planets, and certainly no life. They act as cosmic cradles where stars are born, live out their lives, and eventually die. Each galaxy can contain anywhere from a few million to a mind-boggling few trillion stars.But galaxies aren’t just collections of stars. They also host nebulae (vast clouds of gas and dust), black holes, star clusters, and countless other celestial objects. Some even harbor the enigmatic supermassive black holes at their cores—monsters millions or billions of times more massive than our Sun.The Earth, the Sun, and every other object in our night sky that you can see with your eyes belongs to the Milky Way Galaxy—a spiral-shaped collection of stars and planets that we call home. And while the Milky Way is immense to us, it’s just one of possibly two trillion galaxies in the observable universe.Let’s rewind the cosmic clock to about 13.8 billion years ago, to the Big Bang—the moment the universe sprang into existence. In the aftermath of the Big Bang, the universe was hot, dense, and filled with a primordial soup of particles. As the universe expanded and cooled, these particles coalesced into atoms—mostly hydrogen, with a little helium and trace amounts of lithium.Over millions of years, slight fluctuations in the density of matter led to gravitational clumping. Imagine the universe as a vast ocean where certain areas are just a tiny bit thicker or denser than others. These denser regions began to pull in more and more material under gravity’s influence, forming massive clouds of gas that became the seeds of the first galaxies.The earliest galaxies, called protogalaxies, were messy, chaotic places. They were small, irregular clumps of stars and gas, prone to violent mergers and collisions. Over time, through processes that are still the subject of intense study, these protogalaxies evolved into the grand spirals, majestic ellipticals, and other galaxy types we see today.Interestingly, some of the galaxies we observe today are ancient, their light having traveled billions of years to reach us. When we observe distant galaxies through powerful telescopes, we’re essentially looking back in time, witnessing galaxies as they were billions of years ago.Galaxies come in a dazzling array of shapes and sizes. In the early 20th century, astronomer Edwin Hubble developed a system to classify galaxies based on their appearance. This system is often called the Hubble Tuning Fork Diagram, and it remains a useful way to categorize galaxies today.Spiral galaxies are perhaps the most visually stunning. They have a flat, rotating disk containing stars, gas, and dust, with a central bulge packed with older stars. Their defining features are the graceful, curving spiral arms that extend outward from the center, often sites of intense star formation.Our Milky Way is a barred spiral galaxy, with a bar-shaped region of stars stretching through its center.Famous spirals include Andromeda (M31) and The Whirlpool Galaxy (M51).Spiral galaxies typically have lots of young, hot stars in their arms, making them appear bright and blue.Elliptical galaxies are more like cosmic footballs or eggs, ranging from nearly spherical to highly elongated shapes. They lack the distinct structure of spirals and contain much less gas and dust, which means they don’t form many new stars.These galaxies are dominated by older, redder stars, giving them a more uniform, reddish appearance.Some ellipticals are enormous, often found at the centers of galaxy clusters.As the name suggests, irregular galaxies don’t fit neatly into the spiral or elliptical categories. They have no distinct shape, often appearing chaotic and clumpy.Irregular galaxies are usually rich in gas and dust, making them fertile grounds for star formation.The Large and Small Magellanic Clouds, companions to our Milky Way, are examples of irregular galaxies.Sitting between spirals and ellipticals are lenticular galaxies. These have a disk like spirals but no prominent arms. They’re often composed of older stars and contain little gas or dust.Galaxies come in an astonishing range of sizes. The smallest known galaxies, called dwarf galaxies, may contain just a few million stars. On the other hand, giant elliptical galaxies can have trillions of stars and span over a million light-years across.For comparison:Our Milky Way is about 100,000 light-years in diameter and contains 200 to 400 billion stars.IC 1101, one of the largest known galaxies, is a giant elliptical that stretches nearly 6 million light-years across and holds an estimated 100 trillion stars.And these are just the parts we can see. Many galaxies are enveloped by massive dark matter halos, invisible scaffolding that extends far beyond their luminous components.Galaxies are not static. They move through space, often influenced by the gravitational pull of their neighbors. Over cosmic timescales, galaxies frequently collide and merge, triggering dramatic transformations.When galaxies collide, stars almost never crash into each other directly—after all, stars are incredibly far apart. However, their gas clouds do interact, often leading to bursts of star formation as shockwaves compress the gas.Collisions can create tidal tails—streamers of stars and gas flung out by gravity.Galaxies can merge into larger ellipticals, or transform into peculiar shapes.In about 4.5 billion years, the Milky Way is expected to collide with the Andromeda Galaxy. The two spirals will merge, potentially forming a massive elliptical galaxy. During this cosmic dance, the Sun (and Earth, if it’s still around) may be flung into a new orbit, but it’s unlikely to be destroyed.One of the biggest mysteries in modern astronomy is dark matter—an invisible substance that makes up most of a galaxy’s mass. We can’t see it directly, but we can detect its influence through gravity.When astronomers measured how fast stars orbit the centers of galaxies, they found something strange: stars far from the center were moving much faster than expected, as if they were being pulled by an invisible force.The conclusion? Galaxies must contain vast amounts of unseen matter—dark matter—forming halos around them. Dark matter doesn’t emit or absorb light, making it virtually impossible to detect except through its gravitational effects.At the center of nearly every large galaxy lies a supermassive black hole, millions or billions of times more massive than the Sun.Our Milky Way’s central black hole, Sagittarius A*, weighs about 4 million solar masses.Some active galaxies, called quasars, have supermassive black holes that gobble up enormous amounts of matter, releasing incredible energy in the process.These black holes can influence galaxy formation, regulating star formation by heating or expelling gas.Galaxies are not just cosmic graveyards—they’re also nurseries, where stars are born.Nebulae, or clouds of gas and dust, collapse under gravity to form new stars.Spiral arms in galaxies are often regions of active star formation.Starbursts can occur after galaxy mergers, lighting up a galaxy with new stars.Galaxies often group together in clusters, bound by gravity.The Local Group, our galactic neighborhood, includes about 54 galaxies, including the Milky Way and Andromeda.Clusters themselves can form superclusters—massive collections of galaxies strung together in filaments and walls across the cosmic web.The largest structures in the universe are these filaments, separated by enormous voids of empty space.The Hubble Space Telescope has provided deep-field images of galaxies billions of light-years away. These ancient galaxies tell the story of how the universe evolved from a hot, dense, formless state into the richly structured cosmos we see today.Future telescopes, like the James Webb Space Telescope, will probe even further, perhaps seeing the very first galaxies that formed after the Big Bang.Galaxies are not just distant points of light. They are the crucibles of creation, forging the heavy elements that make planets, life, and even you and me.Carbon in your body, iron in your blood, and oxygen you breathe were all made in stars within galaxies and scattered through space by supernovae.Without galaxies, there would be no stars, no solar systems, and no life.As the universe expands, galaxies will continue to evolve. Over trillions of years, galaxies may merge, exhaust their star-forming gas, and fade into dark, quiet remnants. Eventually, galaxies themselves may disappear from view as the universe stretches further and further.But for now, galaxies continue their cosmic dance, shaping the universe and offering endless mysteries for us to explore.Galaxies are the grand islands of the universe, each one a vast metropolis of stars, gas, dust, dark matter, and endless possibility. From tiny dwarfs to sprawling giants, galaxies tell the story of the cosmos—its birth, evolution, and perhaps its ultimate fate.As we peer deeper into the cosmos, each new galaxy we discover is a testament to the vastness and beauty of the universe. Our Milky Way is just one of countless galaxies, but it’s home. And within its swirling arms lies the Earth—our small blue planet, a speck in the grand design of the stars.In understanding galaxies, we understand a little more about our place in the universe. And perhaps, we also glimpse the infinite wonders that lie beyond.Love this? Share it and help us spark curiosity about science! Science Astronomy galaxy, any of the systems of stars and interstellar matter that make up the universe. Many such assemblages are so enormous that they contain hundreds of billions of stars.Nature has provided an immensely varied array of galaxies, ranging from faint, diffuse dwarf objects to brilliant spiral-shaped giants. Virtually all galaxies appear to have been formed soon after the universe began, and they pervade space, even into the depths of the farthest reaches penetrated by powerful modern telescopes. Galaxies usually exist in clusters, some of which in turn are grouped into larger clusters that measure hundreds of millions of light-years across. (A light-year is the distance traversed by light in one year, traveling at a velocity of 300,000 km per second [km/sec], or 650,000,000 miles per hour.) These so-called superclusters are separated by nearly empty voids, and this causes the gross structure of the universe to look somewhat like a network of sheets and chains of galaxies.Galaxies differ from one another in shape, with variations resulting from the way in which the systems were formed and subsequently evolved. Galaxies are extremely varied not only in structure but also in the amount of activity observed. Some are the sites of vigorous star formation, with its attendant glowing gas and clouds of dust and molecular complexes. Others, by contrast, are quiescent, having long ago ceased to form new stars. Perhaps the most conspicuous activity in galaxies occurs in their nuclei, where evidence suggests that in many cases supermassive objects—probably black holes—lurk. These central black holes apparently formed several billion years ago; they are now observed forming in galaxies at large distances (and, therefore, because of the time it takes light to travel to Earth, at times in the far distant past) as brilliant objects called quasars.The existence of galaxies was not recognized until the early 20th century. Since then, however, galaxies have become one of the focal points of astronomical investigation. The notable developments and achievements in the study of galaxies are surveyed here. Included in the discussion are the external galaxies (i.e., those lying outside the Milky Way Galaxy, the local galaxy to which the Sun and Earth belong), their distribution in clusters and superclusters, and the evolution of galaxies and quasars. For further details on the Milky Way Galaxy, see Milky Way Galaxy. For specifics about the components of galaxies, see star and nebula. The dispute over the nature of what were once termed spiral nebulae stands as one of the most significant in the development of astronomy. On this dispute hinged the question of the magnitude of the universe: were we confined to a single, limited stellar system that lay embedded alone in empty space, or was our Milky Way Galaxy just one of millions of galaxies that pervaded space, stretching beyond the vast distances probed by our most powerful telescopes? How this question arose, and how it was resolved, is an important element in the development of our prevailing view of the universe. Up until 1925, spiral nebulae and their related forms had uncertain status. Some scientists, notably Heber D. Curtis of the United States and Knut Lundmark of Sweden, argued that they might be remote aggregates of stars similar in size to the Milky Way Galaxy. Centuries earlier the German philosopher Immanuel Kant, among others, had suggested much the same idea, but that was long before the tools were available to actually measure distances and thus prove it. During the early 1920s astronomers were divided. Although some deduced that spiral nebulae were actually extragalactic star systems, there was evidence that convinced many that such nebulae were local clouds of material, possibly new solar systems in the process of forming. Large Magellanic CloudLarge Magellanic Cloud in an optical image taken by the Blanco Telescope at the Cerro Tololo Inter-American Observatory in Chile. The bright nebula at the top of the image is 30 Doradus, also known as the Tarantula Nebula.It is now known that the nearest external galaxies are the Magellanic Clouds, two patchy irregular objects visible in the skies of the Southern Hemisphere. For years, most experts who regarded the Magellanic Clouds as portions of the Milky Way Galaxy system separated from the main stream could not study them because of their position. (Both Magellanic Clouds are too far south to be seen from most northern latitudes.) Moreover, the irregular shapes of the objects and their numerous hot blue stars, star clusters, and gas clouds did indeed make them resemble the southern Milky Way Galaxy. Small Magellanic CloudInfant stars in the Small Magellanic Cloud.The American astronomer Harlow Shapley, noted for his far-reaching work on the size and structure of the Milky Way Galaxy, was one of the first to appreciate the importance of the Magellanic Clouds in terms of the nature of spiral nebulae. To gauge the distance of the Clouds, he made use of the period-luminosity (P-L) relation discovered by Henrietta Leavitt of the Harvard College Observatory. In 1912 Leavitt had found that there was a close correlation between the periods of pulsation (variations in light) and the luminosities (intrinsic, or absolute, brightnesses) of a class of stars called Cepheid variables in the Small Magellanic Cloud. Leavitt’s discovery, however, was of little practical value until Shapley worked out a calibration of the absolute brightnesses of pulsating stars closely analogous to the Cepheids, the so-called RR Lyrae variables. With this quantified form of the P-L relation, he was able to calculate the distances to the Magellanic Clouds, determining that they were about 75,000 light-years from Earth. The significance of the Clouds, however, continued to elude scientists of the time. For them, these objects still seemed to be anomalous, irregular patches of the Milky Way Galaxy, farther away than initially thought but not sufficient to settle the question of the nature of the universe. A galaxy is a massive, gravitationally bound system that consists of stars, stellar objects (such as brown dwarfs and neutron stars), nebulae, an interstellar medium of gas and dust, black holes, and an unknown component of dark matter. Examples of galaxies range from dwarfs with as few as ten million stars to giants with a hundred trillion stars or more, each orbiting through their galaxy. There are probably more than 170 billion galaxies in the observable universe. Astronomers sort galaxies into three main types by their shapes: spirals, ellipticals, and irregulars, and further divide them into subtypes based on their particular characteristics. Find out more about one of the galaxies by selecting it below. A composite image of the Messier 81 (M81) galaxy shows what astronomers call a "grand design" spiral galaxy, where each of its arms curls all the way down into its center. Located about 12 million light-years away in the Ursa Major constellation, M81 is among the brightest of the galaxies visible by telescope from Earth. Photograph courtesy NASA/JPL-Caltech/ESA/Harvard-Smithsonian CfASome galaxies are similar to the Milky Way, but some are quite different.•6 min readGalaxies are sprawling systems of dust, gas, dark matter, and anywhere from a million to a trillion stars that are held together by gravity. Nearly all large galaxies are thought to also contain supermassive black holes at their centers. In our own galaxy, the Milky Way, the sun is just one of about 100 to 400 billion stars that spin around Sagittarius A*, a supermassive black hole that contains as much mass as four million suns.The deeper we look into the cosmos, the more galaxies we see. One 2016 study estimated that the observable universe contains two trillion—or two million million—galaxies. Some of those distant systems are similar to our own Milky Way galaxy, while others are quite different.Types of galaxiesBefore the 20th century, we didn't know that galaxies other than the Milky Way existed; earlier astronomers had classified them as as “nebulae,” since they looked like fuzzy clouds. But in the 1920s, astronomer Edwin Hubble showed that the Andromeda “nebula” was a galaxy in its own right. Since it is so far from us, it takes light from Andromeda more than 2.5 million years to bridge the gap. Despite the immense distance, Andromeda is the closest large galaxy to our Milky Way, and it's bright enough in the night sky that it's visible to the naked eye in the Northern Hemisphere.In 1936, Hubble debuted a way to classify galaxies, grouping them into four main types: spiral galaxies, lenticular galaxies, elliptical galaxies, and irregular galaxies.More than two-thirds of all observed galaxies are spiral galaxies. A spiral galaxy has a flat, spinning disk with a central bulge surrounded by spiral arms. That spinning motion, at speeds of hundreds of kilometers a second, may cause matter in the disk to take on a distinctive spiral shape, like a cosmic pinwheel. Our Milky Way, like other spiral galaxies, has a linear, starry bar at its center.Elliptical galaxies are shaped as their name suggests: They are generally round but can stretch longer along one axis than along the other, so much so that some take on a cigar-like appearance. The universe's largest-known galaxies—giant elliptical galaxies—can contain up to a trillion stars and span two million light-years across. Elliptical galaxies may also be small, in which case they are called dwarf elliptical galaxies.Elliptical galaxies contain many older stars, but little dust and other interstellar matter. Their stars orbit the galactic center, like those in the disks of spiral galaxies, but they do so in more random directions. Few new stars are known to form in elliptical galaxies. They are common in galaxy clusters.Lenticular galaxies, such as the iconic Sombrero Galaxy, sit between elliptical and spiral galaxies. They're called “lenticular” because they resemble lenses: Like spiral galaxies, they have a thin, rotating disk of stars and a central bulge, but they don't have spiral arms. Like elliptical galaxies, they have little dust and interstellar matter, and they seem to form more often in densely populated regions of space.Galaxies that are not spiral, lenticular, or elliptical are called irregular galaxies. Irregular galaxies—such as the Large and Small Magellanic Clouds that flank our Milky Way—appear misshapen and lack a distinct form, often because they are within the gravitational influence of other galaxies close by. They are full of gas and dust, which makes them great nurseries for forming new stars.Galactic clusters and mergersSome galaxies occur alone or in pairs, but they are more often parts of larger associations known as groups, clusters, and superclusters. Our Milky Way, for instance, is in the Local Group, a galaxy group about 10 million light-years across that also includes the Andromeda galaxy and its satellites. The Local Group and its neighbor galaxy cluster, the Virgo Cluster, both lie within the larger Virgo Supercluster, a concentration of galaxies that stretches about 100 million light-years across. The Virgo Supercluster, in turn, is a limb of Laniakea, an even bigger supercluster of 100,000 galaxies that astronomers defined in 2014.Galaxies in clusters often interact and even merge together in a dynamic cosmic dance of interacting gravity. When two galaxies collide and intermingle, gases can flow towards the galactic center, which can trigger phenomena like rapid star formation. Our own Milky Way will merge with the Andromeda galaxy in about 4.5 billion years.Because elliptical galaxies contain older stars and less gas than spiral galaxies, it seems that the galaxy types represent part of a natural evolution: As spiral galaxies age, interact, and merge, they lose their familiar shapes and become elliptical galaxies. But astronomers are still working out the specifics, such as why elliptical galaxies follow certain patterns in brightness, size, and chemical composition.Galaxy originsThe universe's first stars ignited some 180 million years after the big bang, the explosive moment 13.8 billion years ago that marks the origins of the universe as we know it. Gravity had sculpted the first galaxies into shape by the time the universe turned 400 million years old, or less than 3 percent of its current age.Astronomers now think that nearly all galaxies—with possible exceptions—are embedded in huge haloes of dark matter. Theoretical models also suggest that in the early universe, vast tendrils of dark matter provided normal matter the gravitational scaffold it needed to coalesce into the first galaxies.But there are still open questions about how galaxies form. Some believe that galaxies formed from smaller clusters of about one million stars, known as globular clusters, while others hold that galaxies formed first, and later birthed globular clusters. It's also difficult to figure out how many of a given galaxy's stars formed in situ from its own gas, versus forming in another galaxy and joining the party later.By letting astronomers peer into the universe's farthest reaches—and earliest moments—instruments such as NASA's James Webb Space Telescope should help resolve lingering questions. We live on a planet called Earth that is part of our solar system. But where is our solar system? It’s a small part of the Milky Way Galaxy. A galaxy is a huge collection of gas, dust, and billions of stars and their solar systems. A galaxy is held together by gravity. Our galaxy, the Milky Way, also has a supermassive black hole in the middle. When you look up at stars in the night sky, you’re seeing other stars in the Milky Way. If it’s really dark, far away from lights from cities and houses, you can even see the dusty bands of the Milky Way stretch across the sky. The Milky Way galaxy fills the night sky in this photo. Credit: NPS/Dan Duriscoe There are many galaxies besides ours, though. There are so many, we can’t even count them all yet! The Hubble Space Telescope looked at a small patch of space for 12 days and found 10,000 galaxies, of all sizes, shapes, and colors. Some scientists think there could be as many as one hundred billion galaxies in the universe. This is a picture taken by the NASA’s James Webb Space Telescope showing thousands of galaxies. This image covers a patch of sky approximately the size of a grain of sand held at arm’s length by someone on the ground. The universe is a very big place! Credit: NASA, ESA, CSA, and STScI Some galaxies are spiral-shaped like ours. They have curved arms that make it look like a pinwheel. Other galaxies are smooth and oval shaped. They’re called elliptical galaxies. And there are also galaxies that aren’t spirals or ovals. They have irregular shapes and look like blobs. The light that we see from each of these galaxies comes from the stars inside it. Sometimes galaxies get too close and smash into each other. Our Milky Way galaxy will someday bump into Andromeda, our closest galactic neighbor. But don’t worry. It won’t happen for about five billion years. But even if it happened tomorrow, you might not notice. Galaxies are so big and spread out at the ends that even though galaxies bump into each other, the planets and solar systems often don’t get close to colliding. Science & Exploration 39110 views 88 likes This virtual journey, from the centre of the Milky Way to its outskirts, shows the different components that make up our Galaxy, which is home to about a hundred billion stars. With a mass of four million Suns, a supermassive black hole (known as Sagittarius A*) sits at the centre of the Galaxy, its enormous gravity governing the orbits of stars in its vicinity. Stars have been observed orbiting this black hole at distances as close as a few light-days.Moving outwards, we fly through a multitude of stars of the Galactic Bulge. The bulge is located in the central portion of the Milky Way and hosts about ten billion stars, which are mainly old and red. The bulge has an overall elongated shape that resembles that of a peanut-shaped bar, with a half-length of about 10 000 light-years, making the Milky Way a barred spiral galaxy.Beyond the bulge, the journey continues across the Galaxy, flying through the younger population of stars in the stellar disc. Home to most of the Milky Way's stars, the stellar disc is a flattened structure with a radius of about 50 000 light-years and a vertical height of only 1000 light-years. The stellar disc is embedded in a slightly larger structure, the gaseous disc. Stars in the disc are arranged in a spiral arm pattern and orbit the centre of the Galaxy.The discs and bulge are embedded in the stellar halo, a spherical structure which consists of a large number of globular clusters – the oldest population of stars in the Galaxy – as well as many isolated stars. The stellar halo extends out to a radius of about 100 000 light-years.Astronomers believe that, like most galaxies, the Milky Way is embedded in an even larger halo of invisible dark matter. Since it does not emit any light, the presence of the dark matter halo can only be inferred indirectly by its gravitational effect on the motions of stars in the Galaxy.Having seen our Galaxy from afar, we zoom into the disc again and change viewing direction, revealing a face-on view of the spiral arm structure of the Milky Way. The position of the Sun, located at a distance of about 26 000 light-years from the Galactic Centre – roughly half way between the centre and the outskirts of the Milky Way – is shown.Finally, an indication is given of the size of the survey of stellar distances performed by ESA’s Hipparcos mission, which operated between 1989 and 1993. The Hipparcos catalogue, published in 1997, contains the position, proper motion and distance of more than 100 000 stars up to 300 light-years away from the Sun.The survey performed by ESA’s Gaia mission will probe a billion stars, about 1% of the total number of stars in our Galaxy, out to 30 000 light-years away – a hundred times farther than Hipparcos.Credit: ESA Thank you for liking You have already liked this page, you can only like it once!