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Searching for Identity in Our Little Corner of the Universe

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Identity plays an important role in our lives. Race, nationality and religion are just some of the ways in which we identify ourselves. Our passports are usually based on the place we are born or the place where we live. All these expressions of identity, however, are limited to a piece of rock orbiting an average star located in a galaxy of roughly 200 billion stars. What is our identity, no matter how inconsequential, with respect to the vast cosmic ocean?

Our Solar system was born in a spiral galaxy, the Milky Way, roughly 4.6 billion years ago. Milky Way is classified as a spiral galaxy because its brightest and most prominent stars are distributed in a spiral pattern confined to a thin disk; our Sun is part of this disk. From a dark location on a clear summer night, a misty band of light can be seen stretching across the sky. This misty band is the disk of the Milky Way and is the best view of our host galaxy. Galileo, in early 17th century, was the first person to look at the Milky Way with a telescope and saw that it was composed of countless individual stars. Since we are located "in" our galaxy, it is impossible to take a picture of our galaxy from outside and to be able to see its fabulous spiral structure. This is like being in a forest that you cannot leave. You can only see the trees and can only guess the shape of the forest. We have learnt about the shape of Milky Way by carefully studying the motion of stars and gas clouds in our galaxy and by comparing those with other nearby galaxies.

The location of our sun within the Milky Way disk is another lesson in humility for humans, who have always had an inflated sense of self-importance and grandeur. We are

located approximately 28,000 light years from the center of our galaxy. This means that light, traveling at a spectacular speed of 300,000 kilometers in one second, takes 28,000 years to get to us; if a light bulb is switched on near the Galactic center today, we will not detect its light until the year 30,003!

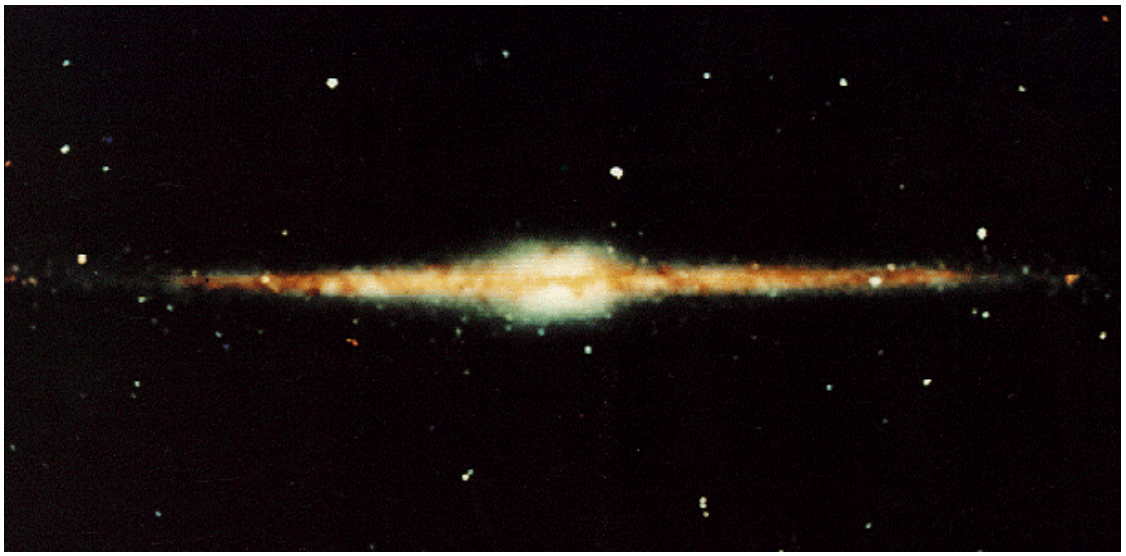

Figure Looking into the centre of the Milky Way. This image was reconstructed from the COBE data. The central bulge and extended disk of stars can be seen clearly. *This image is taken from http://antwrp.gsfc.nasa.gov/apod/ap950908.html.*

Being in the outskirts of our galaxy, the solar commute is long. Even traveling at an enormous speed of 800,000 km/hr (220 km/s), it takes our Sun about 230 million years to complete one orbit around the Galactic center. Early dinosaurs ruled the Earth when we last visited this part of the galaxy. If we consider one orbit as one Galactic year, then our Sun is only 20 Galactic years old since its birth 4.6 billion Earth years ago.

Our Milky Way, however, is not unique. There are more than 100 billion galaxies in our universe. Some are small and some are large. Some exhibit a spiral pattern while others are elliptical or irregular in shape. On a dark, moonless night, one can see through a naked eye a small and faint fuzzy patch in the constellation of Andromeda. This fuzzy patch is our nearest spiral galaxy, Andromeda, also known as M31 (the 31st object in Charles Messier's catalog of 1774 AD).

The Andromeda galaxy contains roughly 400 billion stars and is located 2 million light years away. This is the largest and most distant object that an unaided human eye can see. When you fix a gaze towards the Andromeda galaxy, the light photons hitting your retina at that very moment started their journey when early hominid species were getting

familiar with their first stone tools. With prior knowledge of the size and distance to the Andromeda galaxy, your brain can then potentially convert this photon information from retina into emotional feelings of awe, wonder and humility; what a way for light photons from Andromeda galaxy to end their 2 million year journey!

Not all stars in spiral galaxies are located in the disk. A bulge, composed of relatively old stars, surrounds the central regions of spiral galaxies. The size of bulge is different for different galaxies and may be related to how galaxies form and evolve. The Milky Way and the Andromeda galaxy have a medium sized bulge. The bulge and the disk of spiral galaxies are surrounded by a large spherical halo of very old stars. Some of these halo stars are amongst the oldest objects in the universe. Life forms on a planet around a halo star would have an incredible view of the spiral arms.

The most intriguing area of spiral galaxies is their nuclear region. The density of stars near the nucleus increases dramatically. For a planet orbiting around a star in such a region would never have night-time because of light from the surrounding stars. The center of the Milky Way galaxy is enshrouded in dust and gas clouds, thus obscuring our view in visible light. This veil of dust, however, is lifted in the light of radio waves suddenly exposing a complex and mysterious place. The center of the Milky Way contains a compact object called Sagittarius A* which is the brightest source of radio emission in the galaxy. Studies over the past few decades make a convincing case that Sagittarius A* is a black hole, containing the mass of a million suns. In fact, astronomers now believe that centers of most spiral galaxies contain these giant black holes. The origin of these black holes is still uncertain; either they were formed from the collapse of star clusters in the nuclear regions of these galaxies, or perhaps these black holes are primordial seeds around which these galaxies formed.

Spiral galaxies are usually found in loose collections of several galaxies, called groups. The Milky Way and the Andromeda galaxy are the largest members of the Local Group that has 40 members and roughly spans 100 million light years. There is only one other spiral galaxy in the group, M33, which is located 3 million light years away. Just like the Cold war era when smaller countries were aligned either with the United States or the Soviet Union, the majority of galaxies in Local Group are gravitationally bound to either the Milky Way or the Andromeda galaxy. The Large and Small Magellanic clouds are the two largest satellites of Milky Way and are located 180,000 and 210,000 light years away, respectively.

The large size of our universe would make us believe that galaxies, more or less, live independent lives. However, the serene look of large galaxies contrasts with their cannibalistic tendencies. Galaxies, like the Milky Way, routinely swallow smaller galaxies. The stars of many such cannibalized galaxies are now the inhabitants of the Milky Way. Even today, Milky Way is in the process of ripping apart a small galaxy

called the Sagittarius Dwarf, and will complete its assimilation in the next few million years.

Sometimes, however, even the heavyweights collide. Contrary to our expectations, individual stars do not collide in such an encounter. The distances between stars within a galaxy are so large that stars of each galaxy would pass right by each other, though the gravitational force of passing stars may disturb their orbits. The gas clouds, on the other hand, would bump and crash into each other resulting in a short term burst of intense star formation...genesis at the center of mayhem and chaos. In a merger of two spiral galaxies, the spiral structure is lost and the resulting galaxy may have an irregular or elliptical shape. Whereas, large corporate mergers in the business world may take only a few months or a few years at most, large galaxy mergers usually take a few hundred million to a billion years.

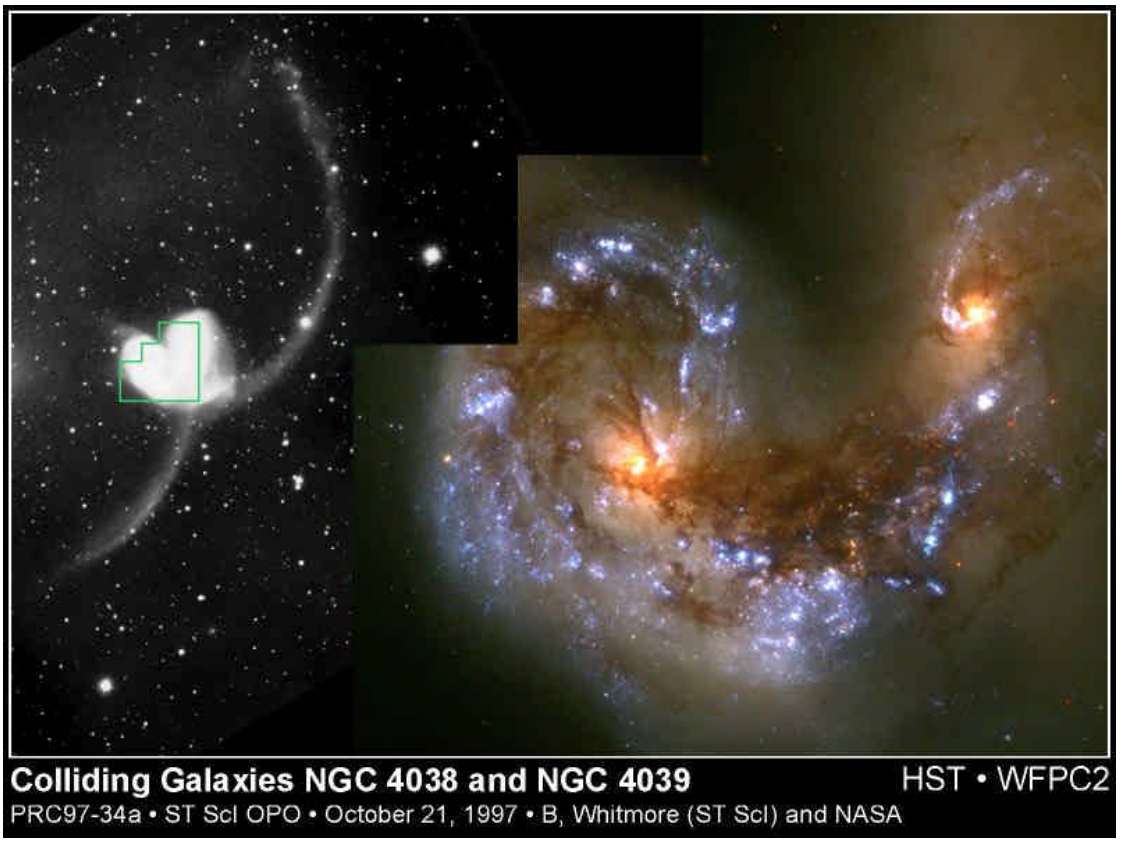

Figure. The collision between our galaxy, the Milky Way, and the Andromeda galaxy may resemble the image of these two colliding galaxies, NGC 4038 and NGC 4039. The image on the left is a ground-based image showing a long tail of stars extending from both galaxies. The Hubble Space Telescope image on the right captures the central region of the merger and shows numerous young blue star clusters coming into view.

Photograph, courtesy Space Telescope Science Institute and NASA.

What is the fate of our own Milky Way? In a suicidal plunge, the Andromeda galaxy and the Milky Way are headed towards each other at a fantastic speed of 500,000 km/hr. At this rate, the Andromeda galaxy will be at our doorsteps in roughly 5 billion years. Our Sun may have burned out by then and Earth left as a lifeless cinder. Humans or some other technological civilization from Earth may have already migrated to planets of other star systems, and may still be around to witness the collision of the two behemoths of our Local Group. Both the Milky Way and the Andromeda galaxy will lose their respective spiral structures and individual identities to form one large elliptical galaxy. During the merger, however, large gas clouds from both galaxies will collide to form copious number of new stars. A number of these new stars will have planets and conditions suitable for the development of intelligent life. For beings from that civilization there would be no band of light across the sky to create related Divine mythologies. I can imagine curious astronomers deducing the elliptical shape of their galaxy by looking at the roughly uniform distribution of stars in the sky. Will they ever know about the existence of an ancient civilization that thrived long before the Great collision, which had developed myths and legends around a misty band of light that crossed their night sky?