

Galactic Tails of Plasma

Astronomical objects make jets, are made by jets, or are jets.

Jets are the diaries of astronomical objects.

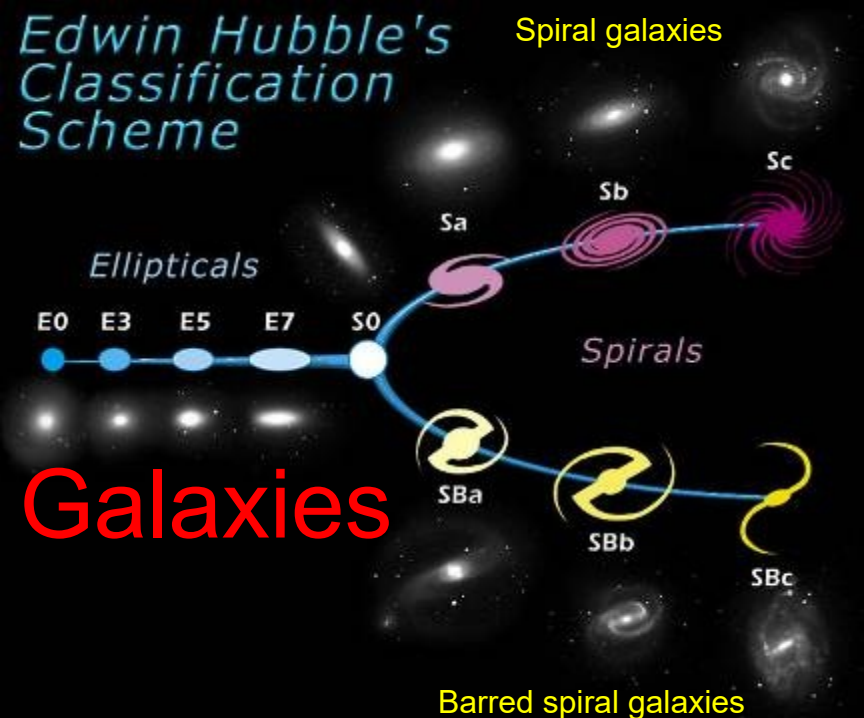
The brightest extragalactic radio object, called Cygnus A, is only 730 million light years away and if it was not obscured by our galactic dust this galaxy would equal a full Moon. Called 3C405 in the quasar catalog it is a massive, powerful, and dangerous giant elliptical (cD) galaxy. Our galaxy is occasionally bathed in such aimed gamma-ray bursts (GRBs). Each jet shown is 300,000 ly long.



Part 3 of Tails of Plasma By Michael Marron

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PASAZ.org



Edwin Hubble discovered galaxies in the 1930's and arranged them by appearance from elliptical to spiral galaxies. Because the bright galaxies are expanding away from each other he incorrectly assumed a single Big Bang created everything. Today we can examine much more of the properties of galaxies. That gives us new and better clues as to their origins and evolution. His still used classification of galaxies is based on his wildly wrong assumptions about galactic evolution.

M87 a giant elliptical (cD) galaxy with a 6.6 billion solar mass (Sol) central black hole. M87 is thousands of times more massive than any other of the surrounding spiral galaxies.

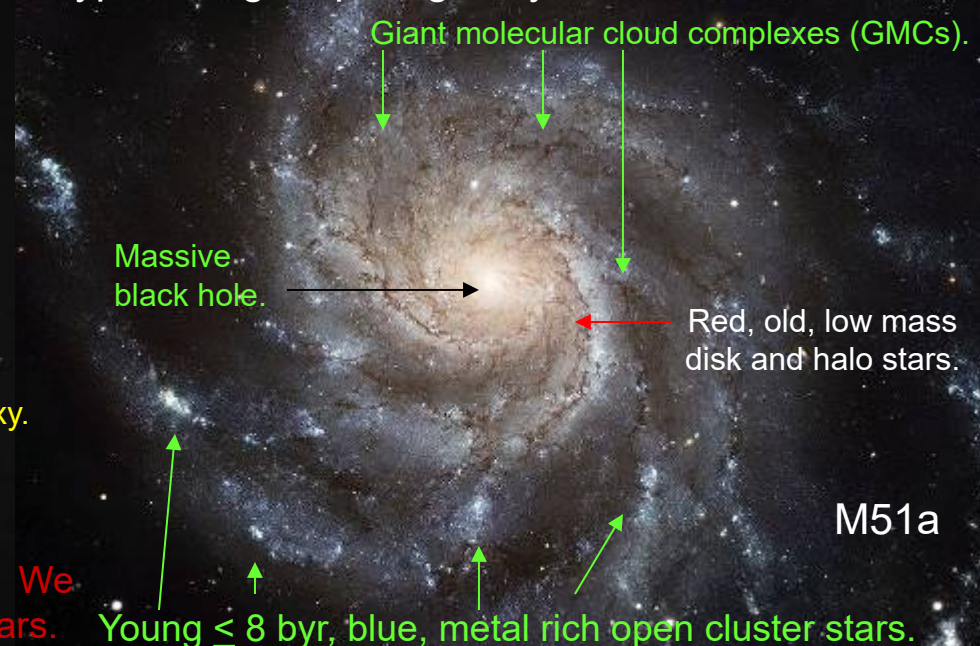
Only ~10 – 14 byr old red stars, little gas and dust. →

Supermassive black hole. → Typical massive jet from a massive cD giant elliptical galaxy.

M87 center of the Virgo Cluster.

More than 12,000 old globular clusters surround M87. We have less than 160 and each has ~100,000 low mass stars.

35% of the Milky Way's mass, the Whirlpool Galaxy is a typical bright spiral galaxy with 160 billion stars.



Young stars < 8 byr

POPULATION I

Older tidally torn
Open Clusters

Andromeda, a Spiral Galaxy

Old stars ~10 to 14
byr

POPULATION II

Central bulge and disk

Massive black hole

Metals and dirt

DUST CLOUDS

Cold gasses

NEUTRAL HYDROGEN

Hot giant molecular
cloud complexes

OPTICAL GAS CLOUDS

Population I

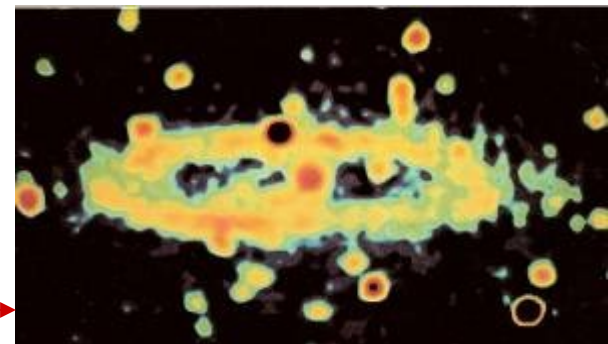
OPEN CLUSTERS

Newest stars ≤ 8 byr

The **Andromeda Galaxy** (M31) is a spiral galaxy approximately 2.5 million light-years (2.4×10^{19} km) from Earth in the Andromeda constellation. The Andromeda Galaxy is the nearest spiral galaxy to our Milky Way galaxy, but not the closest galaxy overall. The Andromeda Galaxy is the largest galaxy of the Local Group, which also contains the Milky Way, the Triangulum Galaxy, and about 30 other smaller galaxies. Although the largest, the Andromeda Galaxy may not be the most massive, as recent findings suggest that the Milky Way contains more dark matter and could be the most massive in the grouping. The 2006 observations by the Spitzer Space Telescope revealed that M31 contains one trillion stars: at least twice the number of stars in our own galaxy, which is estimated to be 200–400 billion. The Andromeda Galaxy is estimated to be 7.1×10^{11} solar masses. In comparison a 2009 study estimated that the Milky Way and M31 are about equal in mass, while a 2006 study put the mass of the Milky Way at ~80% of the mass of the Andromeda Galaxy. The two galaxies are expected to collide in 3.75 billion years.

The bands of blue-white making up the galaxy's striking rings are neighborhoods that harbor hot, young, massive stars. Dark blue-grey lanes of cooler dust show up starkly against these bright rings, tracing the regions where star formation is currently taking place in dense cloudy cocoons. When observed in visible light, Andromeda's rings look more like spiral arms. The ultraviolet view shows that these arms more closely resemble the ring-like structure previously observed in infrared wavelengths with NASA's Spitzer Space Telescope. Astronomers using Spitzer interpreted these rings as evidence that the galaxy was involved in a direct collision with its neighbor, M32, more than 200 million years ago.

Andromeda, a typical spiral galaxy.



The black hole at the center of Andromeda makes spiraling equatorial jets that impact the surrounding dust and gas rings which makes new stars.

Black hole
Hot GMCs
New open clusters



M31 Andromeda

The Milky Way a Barred Spiral Galaxy

Galactic disk

Giant molecular cloud (GMC)

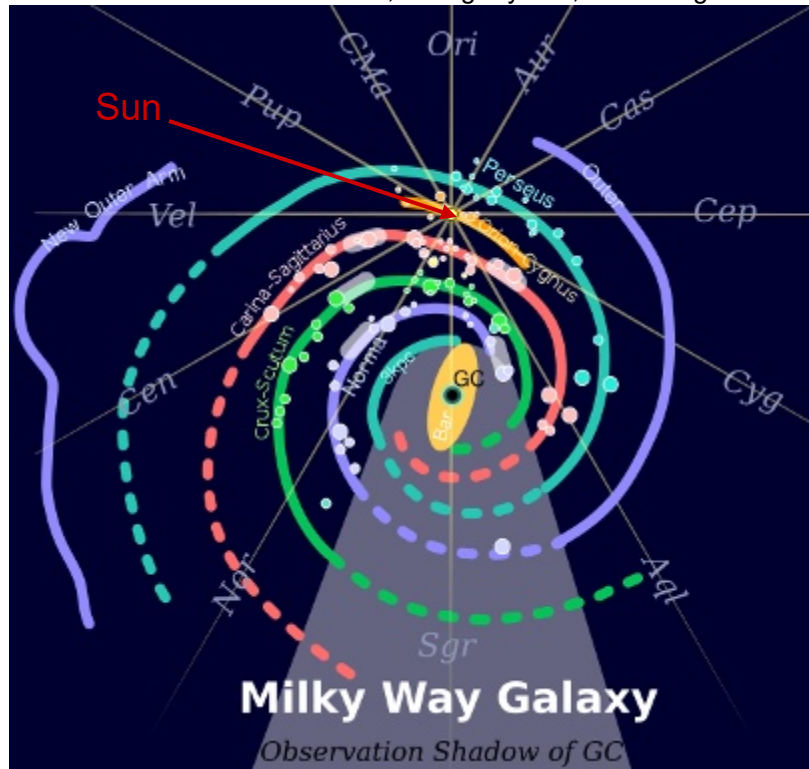
Young open clusters

The black hole at the center
Sagittarius A (Sgr A)

Galactic central bulge of old red stars.

The Milky Way is a large galaxy comprising an estimated 200 billion stars (some estimates range as high as 400 billion) arrayed in the form of a disk, with a central elliptical bulge (some 12,000 light-years in diameter) of closely packed stars lying in the direction of Sagittarius. It is surrounded by a flat disk marked by six spiral arms—four major and two minor—which wind out from the nucleus like a giant pinwheel. Because of these arms, the Milky Way was classified as a spiral galaxy. However, increasing evidence indicates that the Milky Way probably has a bar or bar like structure of new, bright stars in its central region. This would modify its classification to a barred spiral or an intermediate type between barred and “normal” spiral. Our sun is situated in one of the smaller arms, called the Local or Orion Arm, that connect the more substantial next inner arm and the next outer arm. The sun lies roughly two thirds of the way from the center of the disk, which is some 28,000 light-years distant, and in the galactic plane. When we look in the plane of the disk we see the combined light of its stars as the Milky Way. The diameter of the disk is c.100,000 light-years; its average thickness is 10,000 light-years, increasing to 30,000 light-years at the nucleus.

The equatorial GMC jets from the center of our galaxy has made at least six distinct arms. Each spiral arm details the series of feeding events at the center. Where a spiral arm has a GMC with new open clusters the opposing arm will show a gap in gas and new stars (use a ruler). Galactic arms are both negative and mirror images of each other, clues to how they are made.



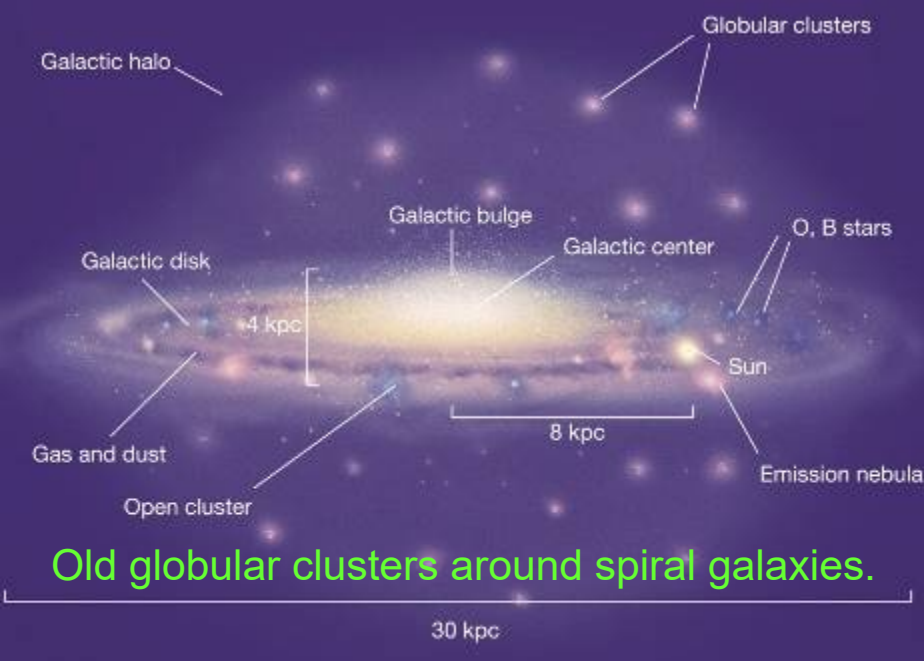
Young stars in loose associations within the galactic disk are open clusters.



Pop I Stars

New population I stars, often blue, are born in open clusters from the irregular gas and dust of the galactic disk. Born ≤ 8 byr in irregular stellar associations but later dispersed in the disk. These metal enriched bright young stars define the spiral arms of galaxies. The solar system was born 4.6 bya but our sibling open cluster stars are now mixed into the Milky Way's disk. The Pleiades is an open cluster that can be easily seen with naked eyes in dark areas.

In astronomy metals means any element heavier than helium.



Red dwarf stars ~10 –14 byr fill globular clusters and galactic disks.

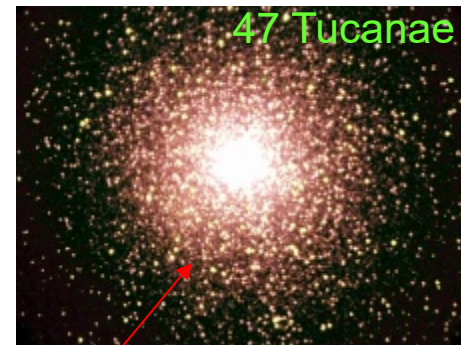
The Milky Way galaxy has at least 157 Pop II globular clusters each with ~100,000 stars.

Their galactic orbits can be over 100 myr along elongated elliptical paths.

Pop II Stars



The lowest mass Pop II stars can quietly burn for trillions of years as deep red ember stars.



47 Tucanae is ~13.5 byr old and ~100 light years across.

M55 is a large and lovely globular cluster of around 100,000 stars. Only 20,000 light-years away in the constellation Sagittarius, M55 appears to earth-bound observers to be nearly 2/3 the size of the full moon. Globular star clusters like M55 roam the halo of our Milky Way Galaxy as gravitationally bound populations of stars known to be much older than stellar groups found in the galactic disk.

Djorgovski 1's stars contain hydrogen and helium, but not much else. In astronomical terms, they are described as "metal-poor". Globular clusters are the almost metal free collections of the oldest Pop II stars of spiral galaxies. The first stars are thought to have only H & a tiny bit of He as population III stars (not found in nearby galaxies). The mostly red dwarf Pop II stars of the disk of our galaxy are 10 – 14 byr. There is about a two billion year gap between the youngest Pop II stars and the oldest Pop I stars (8 byr) in our Milky Way galaxy. More clues to follow.

Recent H-R diagrams are force fit to a 13.8 byr old universe to match age of 2.7° radiation.

Globular clusters were 1st thought to be ~14 - 18 byr.

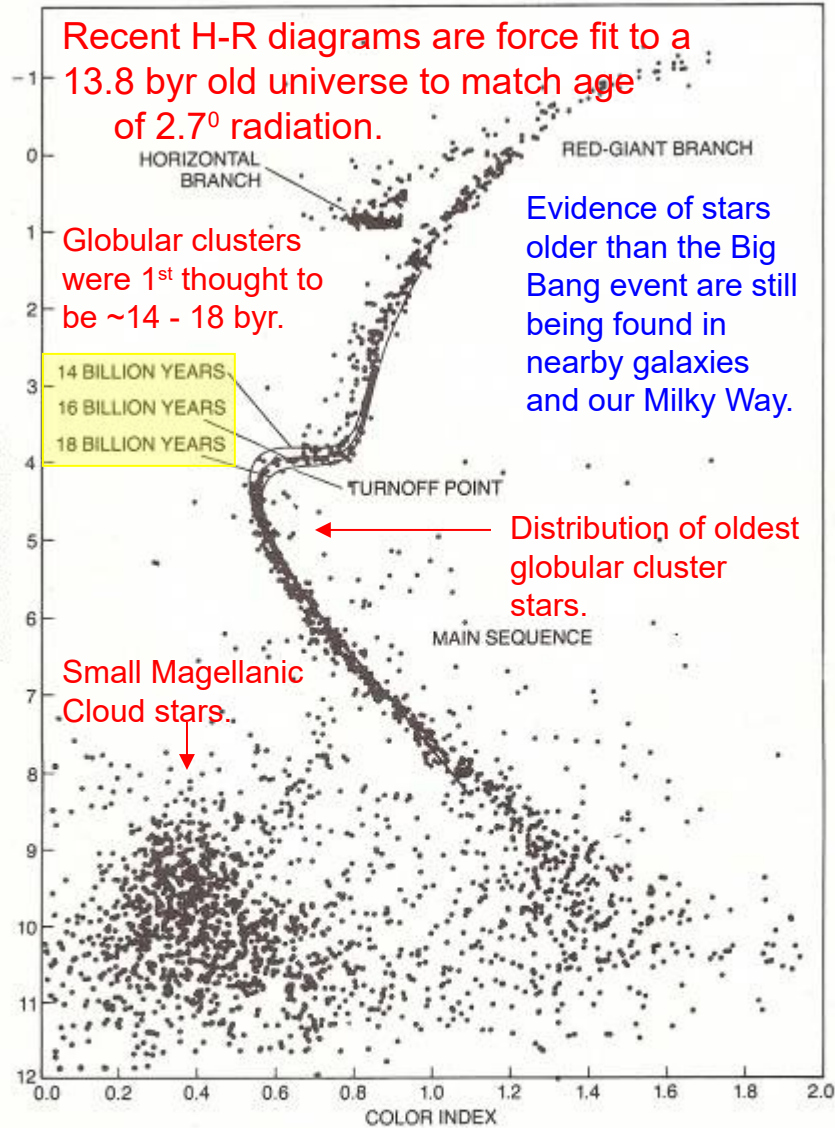
14 BILLION YEARS
16 BILLION YEARS
18 BILLION YEARS

Evidence of stars older than the Big Bang event are still being found in nearby galaxies and our Milky Way.

Distribution of oldest globular cluster stars.

Small Magellanic Cloud stars.

ABSOLUTE MAGNITUDE



AGE OF A GLOBULAR CLUSTER can be estimated by comparing a theoretical model of the evolution of stars in the cluster with their observed distribution on an H-R diagram. The distribution calculated from an evolutionary model, particularly at the turnoff point, depends sensitively on the cluster age assumed in the calculations. The H-R diagram shown here is for the giant globular cluster 47 Tucanae. Most of the data were obtained by James E. Hesser of the Dominion Astrophysical Observatory and William E. Harris of McMaster University with the four-meter telescope at the Cerro Tololo Inter-American Observatory in Chile. The theoretical models (black lines) were computed by Don A. Vandenberg of the University of Victoria. The "best fit" at the turnoff point is offered by the model corresponding to a cluster age of 16 billion years. Most of the stars in the lower left corner of the diagram actually belong to the Small Magellanic Cloud, a galaxy that lies behind 47 Tucanae.

Stellar Ages in the Milky Way

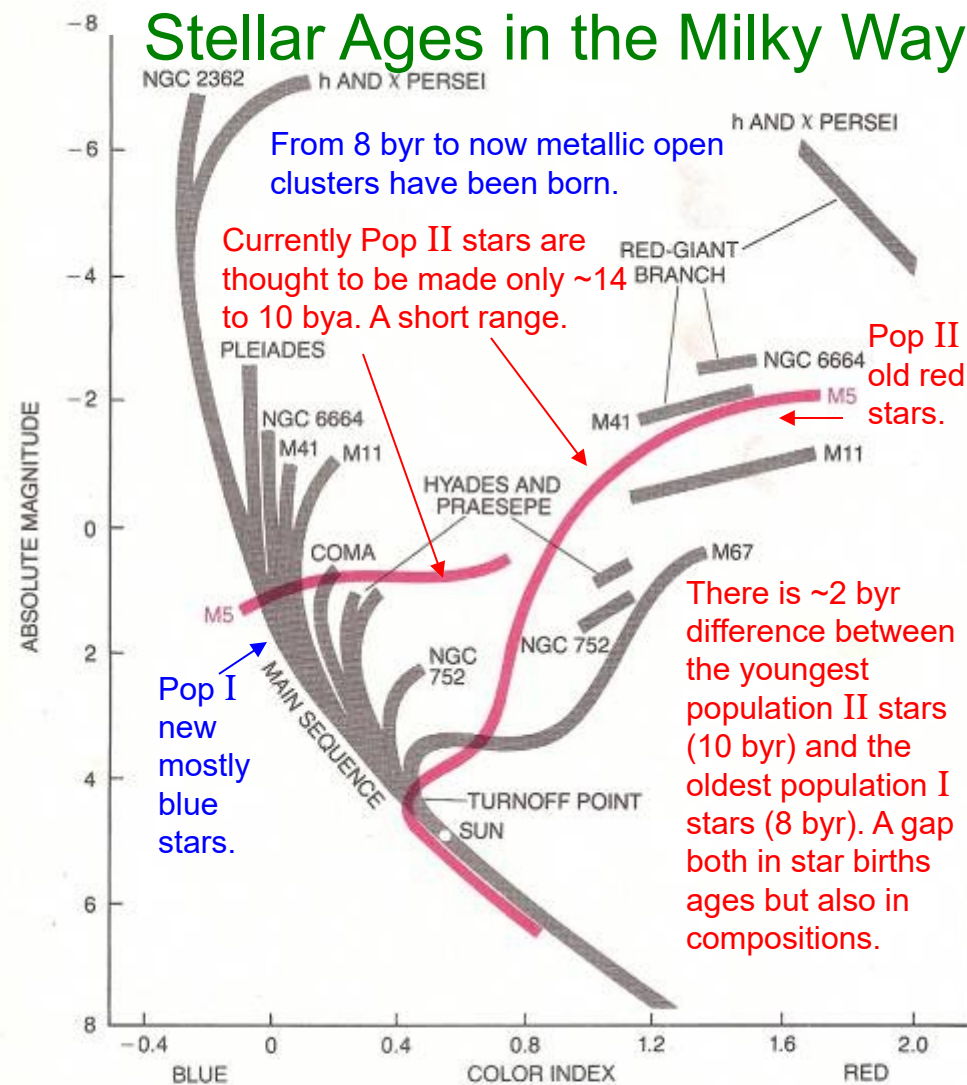
From 8 byr to now metallic open clusters have been born.

Currently Pop II stars are thought to be made only ~14 to 10 bya. A short range.

Pop II old red stars.

Pop I new mostly blue stars.

There is ~2 byr difference between the youngest population II stars (10 byr) and the oldest population I stars (8 byr). A gap both in star births ages but also in compositions.



HERTZSPRUNG-RUSSELL DIAGRAMS show the distribution of stars in a cluster according to color and magnitude; they provided the first evidence for the existence of two different stellar populations. This schematic composite illustration contrasts the H-R diagrams of open clusters (gray) in the galactic disk with the diagram of the globular cluster M5 (color), which belongs to the halo. In an individual cluster all the stars are the same age, and so the H-R diagram reflects the path of stellar evolution. Massive, bright stars (those with negative magnitudes) evolve the fastest; they are the first to exhaust the hydrogen in their core, turn off the main sequence and become red giants. As the cluster ages, the turnoff point moves down the magnitude scale. Open clusters (Population I) vary in age. One of the youngest, NGC 2362, was formed roughly a million years ago. Globular clusters (Population II), including M5, are all thought to have been formed at least 13 billion years ago.

Center of the Milky Way

Stars, dust and gas of disk.

Sagittarius A (Sgr A), the black hole at the center of our galaxy.

This composite color infrared image of the centre of our Milky Way galaxy reveals a new population of massive stars and new details in complex structures in the hot ionized gas swirling around the central 300 light-years. This sweeping panorama is the sharpest infrared picture ever made of the Galactic core and offers a laboratory for how massive stars form and influence their environment in the often violent nuclear regions of other galaxies. This view combines the sharp imaging of the Hubble Space Telescope's Near Infrared Camera and Multi-Object Spectrometer (NICMOS) with color imagery from a previous Spitzer Space Telescope survey done with its Infrared Astronomy Camera (IRAC). The Galactic core is obscured in visible light by intervening dust clouds, but infrared light penetrates the dust. NICMOS shows a large number of these massive stars distributed throughout the region. A new finding is that astronomers now see that the massive stars are not confined to one of the three known clusters of massive stars in the Galactic Centre, known as the Central cluster, the Arches cluster, and the Quintuplet cluster. These three clusters are easily seen as tight concentrations of bright, massive stars in the NICMOS image. The distributed stars may have formed in isolation, or they may have originated in clusters that have been disrupted by strong gravitational tidal forces. The winds and radiation from these stars form the complex structures seen in the core, and in some cases, they may be triggering new generations of stars.

Extreme close up of the central black hole surrounded by orbitally captured stars.

Hot stars blowing away their gas.

Invisible black hole Sgr A.

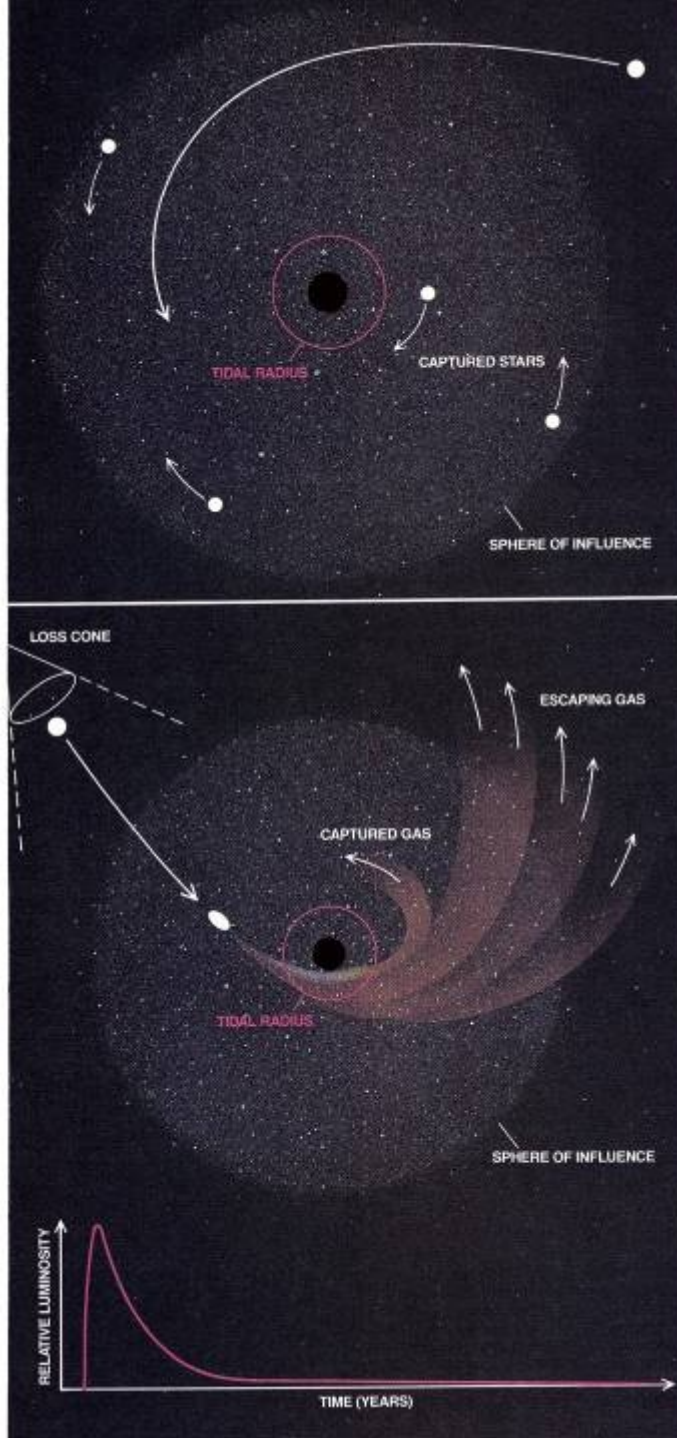
New giant molecular cloud jets spiral out of the center. These become new spiral arms as they collide with disk material.

Closing in on the center of our galaxy shows our central black hole axis was recently tilted in respect to the galactic disk plane and is making a bar of stars where the two planes now intersect.

Black Holes and Accretion Disks Destroy Stars

BLACK HOLE CAPTURES all stars within a critical radius with its gravitational pull, producing a distinctive cluster of fast-moving stars (*top*). Stars that approach the hole at small angles enter the tidal radius, within which the hole's gravity tears the star apart.

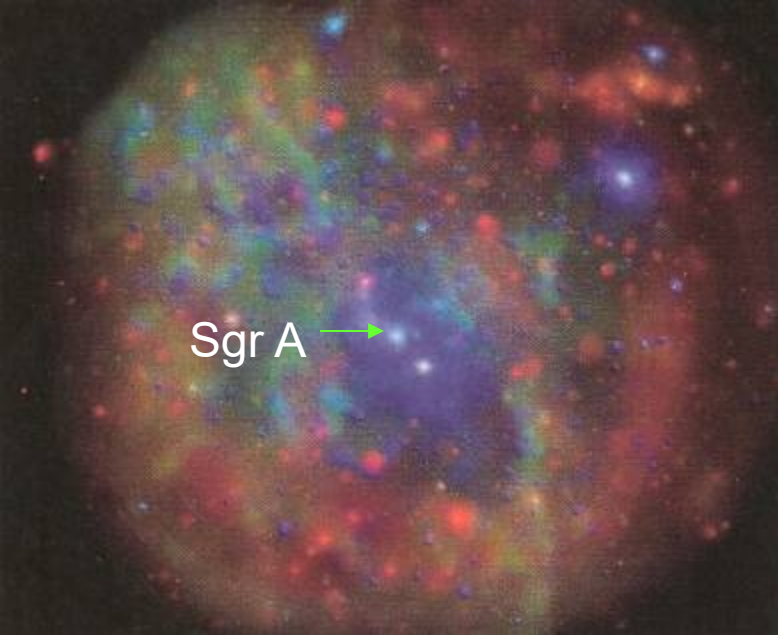
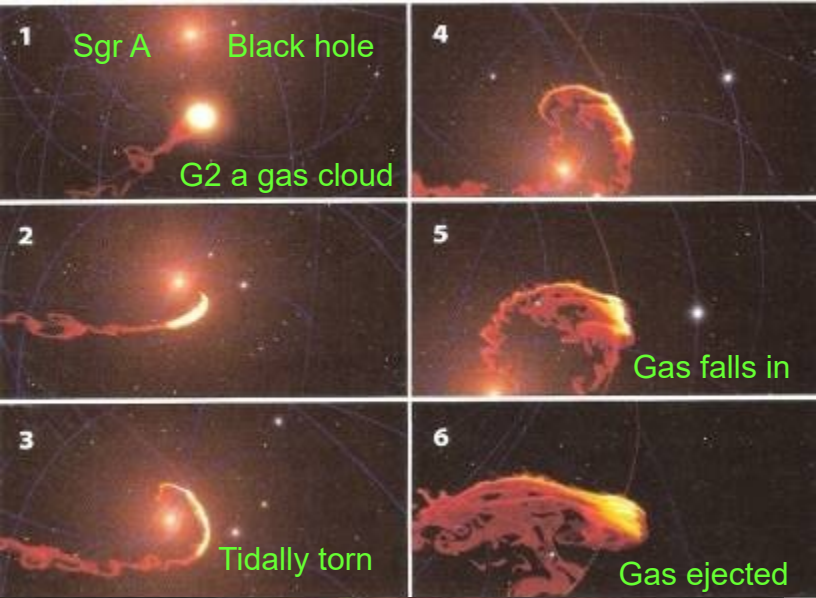
Some of the star's gas falls into the hole, creating a brief flare; most of the time, the hole would be quiescent (*bottom*).



Many stellar systems have multiple stars, while a single star orbiting into a galactic black hole can make a giant molecular cloud (GMC) jet, a cluster of stars falling in make the most massive GMC complexes as seen in active Seyfert galaxies. The relativistic central black hole's accretion disk fusions the impacting stellar material. While the half of the resultant blast aimed away from the black hole might escape, it is the half of the explosion aimed past the black hole that becomes focused into a relativistic jet. Of course the amount of material of the blast accreted or orbitally captured depends largely on distance. Precession of the outer disks of tidally disrupted stars creates the spiral arms. Barred spirals have had their central black hole's accretion disk become misaligned with the galactic disk.

Sagittarius A Eats a Cloud

Sagittarius A (Sgr A) at the Milky Way's center last fed about 2 million years ago. A small cloud called G2 recently fell in with little effect.



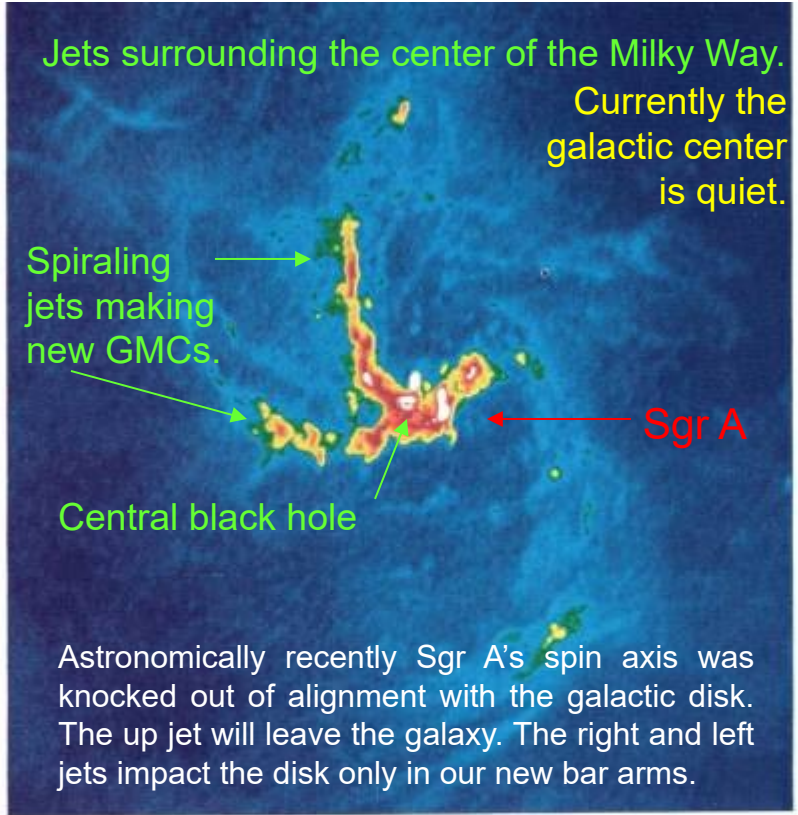
The star SO-16 comes within a Pluto's orbit of the 4.5 million solar mass of Sgr A and it's killing accretion disk. SO-2's orbit is <16 years. All the close stars are slowly deorbiting into this black hole. The 'fireworks' will eventually start up again and make us an active galaxy.

KEEPING WATCH. The Swift telescope has monitored the galactic center since 2006. This image merges data from all of 2013, showing the objects and regions that were consistently bright in X-rays as well as the objects and regions that produced X-ray flares. Sagittarius A*, our super-massive black hole, is in the center. G2, a cloud of gas approaching the black hole, is not yet visible, but scientists hope it will be soon. NASA/SWIFT/N. DEGENAAR (UNIV. OF MICHIGAN)

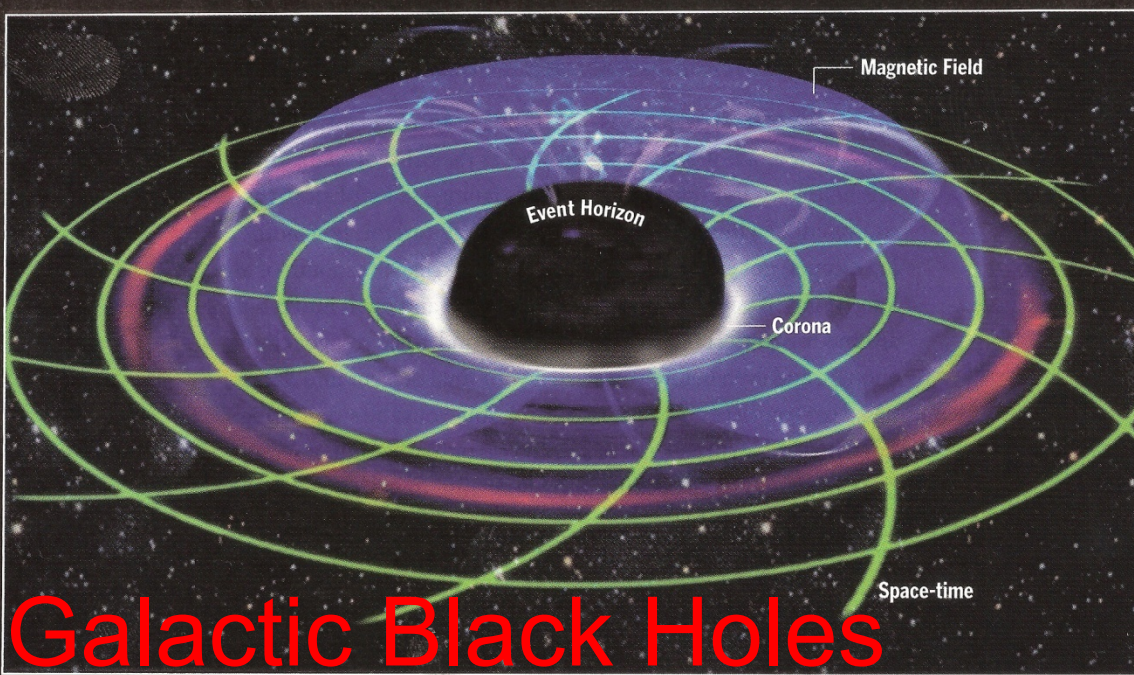
Milky Way's massive central black hole



GROWTH CHART. When material approaches a black hole, its speed increases, and friction between particles increases its temperature. Its newfound energy and the black hole's magnetism cause it to emit radiation. Scientists have discovered that 2 million years ago, our galaxy's black hole, normally dormant, went through a violent version of this process. NASA/DANA BERRY/SKYWORKS DIGITAL



RADIO MAP of the center of the Milky Way shows disturbed arms of gas, perhaps the result of the disruption of a star by a black hole. The motions of the gas and stars near the center also indicate the presence of a heavy, compact dark mass.



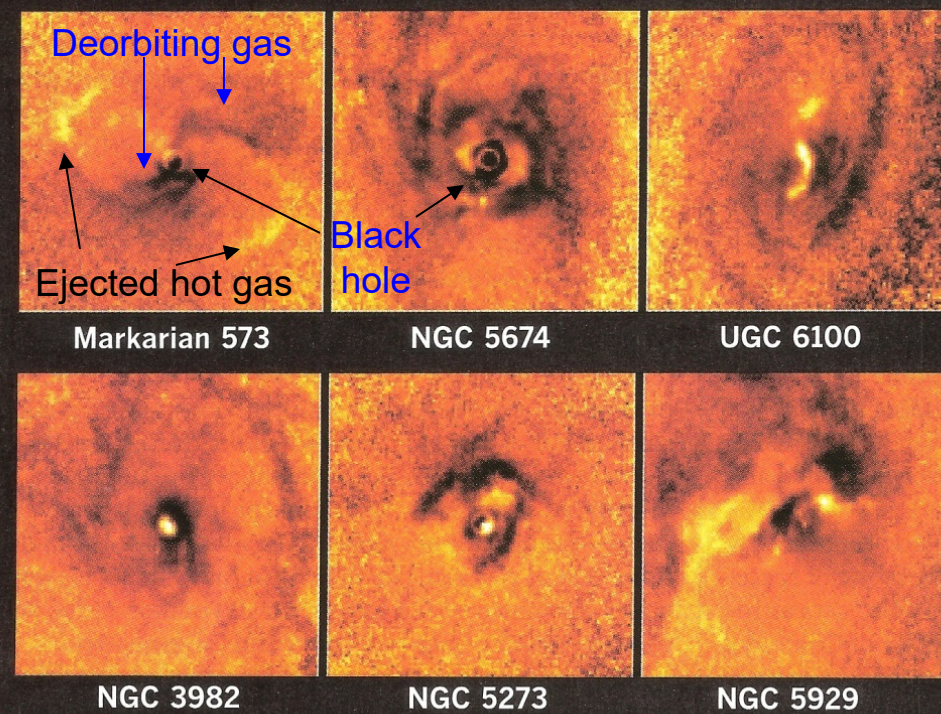
One of the weirdest implications of Einstein's general relativity theory is that as a black hole spins, it pulls space-time (represented below by green grid lines) along for the twisty ride. Recent observations of the galaxy MCG-6-30-15 suggest that the spinning of its central black hole inside a huge magnetic field produces power just like an electric generator. This energy contributes to the bright glow of iron atoms and other ultrahot matter swirling in a region called the corona.



Galactic Black Holes

Even though black holes are truly black, in active galaxies their effects can be clearly seen. The dark bands are clouds of dust and gas in decaying orbits that impact the black hole's accretion disk first on one side then half an orbit later it collides with the other side of the accretion disk. These mini-novas next to the black hole have the half of the explosion that passes the black hole gravitationally focused into a powerful jet. Precession of deorbiting debris means that the next jet half an orbit later is not exactly opposite the last jet. A spiraling precession of ejected jets of hot GMCs impact the galactic disk of cold gas making new stars.

Black holes at the center of six active galaxies are caught in the act of reeling in huge swirls of interstellar dust and gas in combined visible and near-infrared images taken by the Hubble Space Telescope. This matter spirals inward, heating up violently and finally plunging into a black hole's event horizon. Because event horizons are tiny compared with the size of the galaxies they inhabit, no one has ever seen one; the smallest measured black hole presumably has an event horizon on the order of six miles across. For reference, the top left image is about 6,000 light-years across.



Observed Properties of Jets and the Angle to the Line of Sight θ



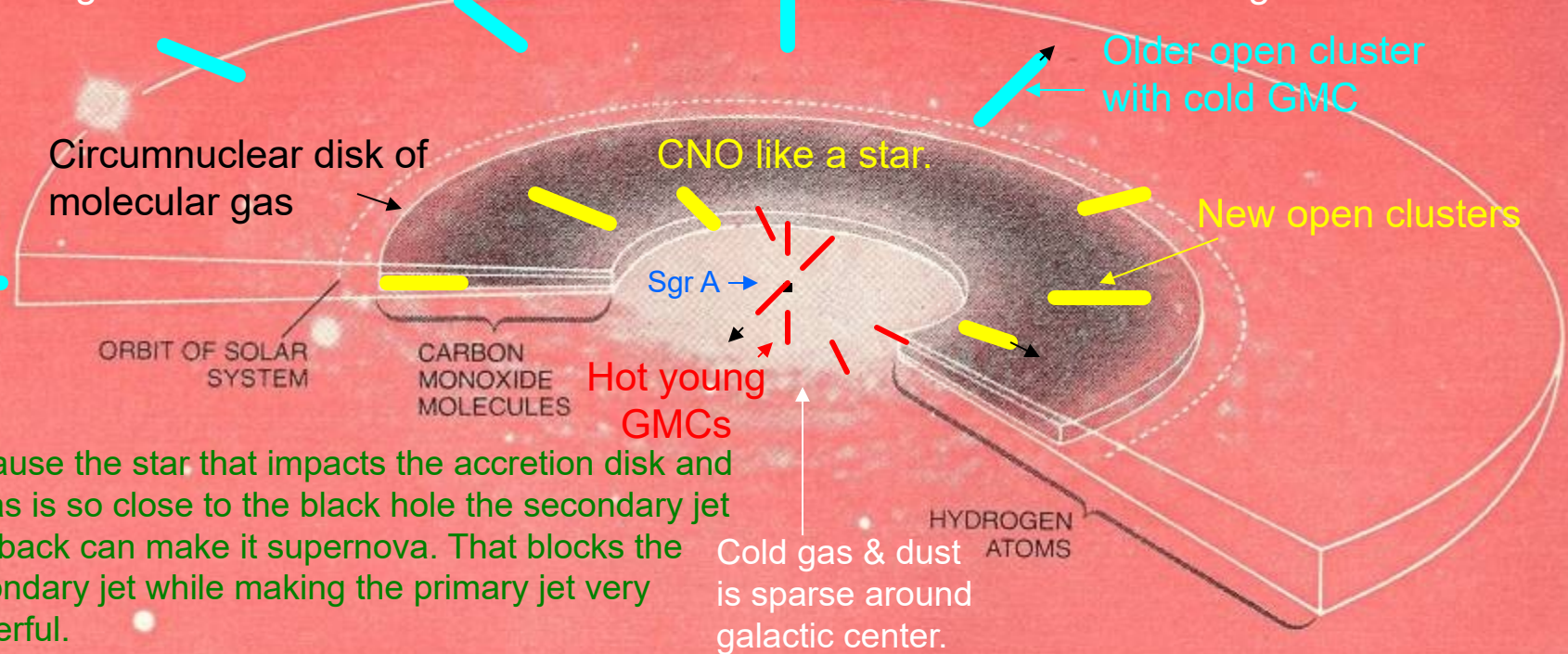
Star formation does not seem to be occurring currently at the Galactic Center, although the Circumnuclear Disk of molecular gas that orbits the Galactic Center at two parsecs seems a fairly favorable site for star formation. Mapping the gas density in a 400 light-year region around the Galactic Center has revealed an accumulating ring with a mass several million times that of the Sun and near the critical density for star formation. They predict that in approximately 200 million years there will be an episode of starburst in the Galactic Center, with many stars forming rapidly and undergoing supernovae at a hundred times the current rate. The starburst may also be accompanied by the formation of galactic jets as matter falls into the central black hole. It is thought that the Milky Way undergoes a starburst of this sort every 500 million years. (Ejected hot GMCs must impact cold disk gas to make new stars.)

In addition to the "paradox of youth", there is also a "conundrum of old age" associated with the distribution of the *old* stars at the Galactic Center. Theoretical models had predicted that the old stars, which far outnumber young stars, should have a steeply-rising density near the black hole, a so-called Bahcall–Wolf cusp. Instead, it was discovered in 2009 that the density of the old stars peaks at a distance of roughly 1/2 parsec from Sgr A*, then falls inward: instead of a dense cluster, there is a "hole", or core, around the black hole. Several suggestions have been put forward to explain this puzzling observation, but none is completely satisfactory. (Old stars near the black hole have been consumed.)

At 90 degrees the bright jet can be aimed at us while the disk is seen edge on. When the disk is face on (polar) the jet appears dim. Thus Seyfert galaxies with equal activity do not have the same brightness.

The majority of mass of a spiral galaxy lies in its disk of gas and stars. The central black hole is merely 4.1 million solar masses. Atomic mass decreases from the galactic disk's inner edge until it becomes atomic hydrogen at the extreme outer edge. The galactic disk has the same arrangement of heavy elements in shells as the supergiant stars but it is much more massive and cold enough to make complex molecules in radiation protected areas.

The cold molecular disk that orbits spiral galaxies is like a flattened metal rich star with the core missing. The dense central region grew the first and biggest stars which quickly went supernova clearing the center while the collection of black holes coalesced into the big central black hole.



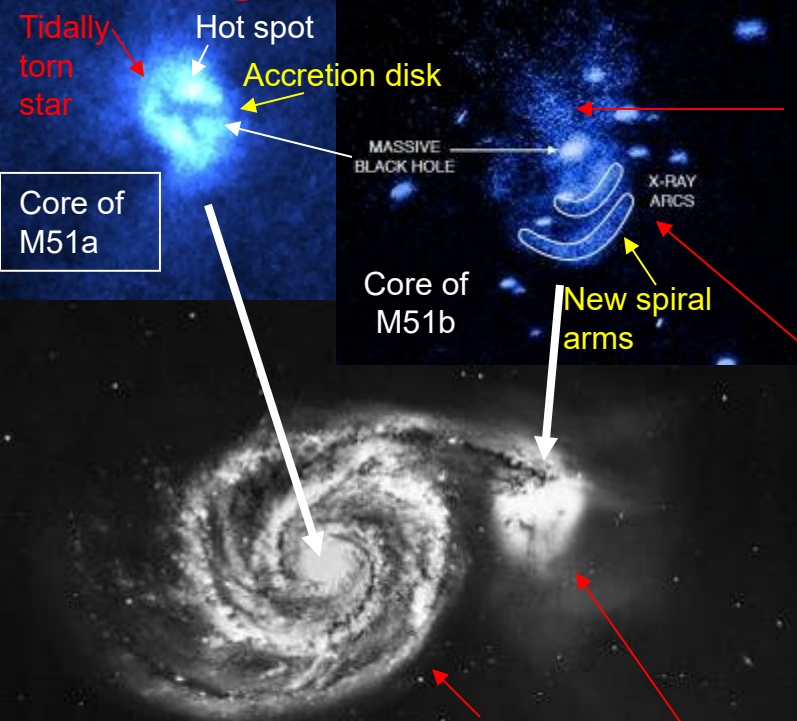
Because the star that impacts the accretion disk and novae is so close to the black hole the secondary jet feedback can make it supernova. That blocks the secondary jet while making the primary jet very powerful.

Milky Way's Galactic Disk of Gas & Dust

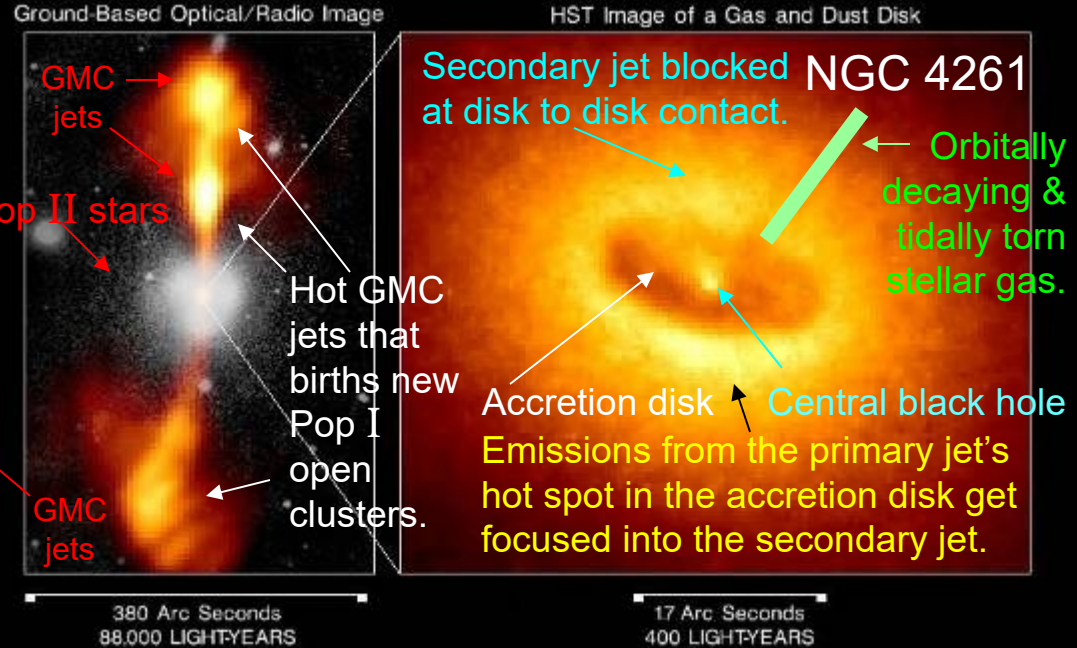
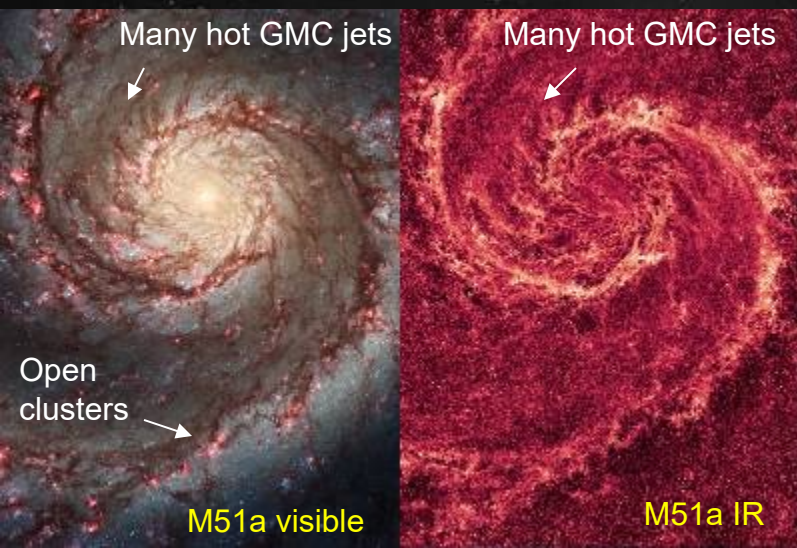
RING OF MOLECULES around the core of the Milky Way galaxy extends from a galactic radius of about 12,000 light-years to one of 24,000 light-years, attaining its highest density at approximately 17,000 light-years (*gray area*). In contrast, the radius of the sun's orbit around the galactic center is 30,000 light-years (*broken line*). The layer of cold, star-forming clouds defined by the observations of carbon

monoxide molecules appears to be about 300 light-years thick. The molecular ring lies within a much larger and thicker disk of interstellar gas, composed predominantly of hydrogen atoms, which radiate at a characteristic radio wavelength of 21 centimeters. The overall radius of the galaxy is estimated to be some 50,000 light-years. The colored background is a photograph of a comparable spiral galaxy.

Making GMCs in Spirals



Whirlpool Galaxy M51a & M51b

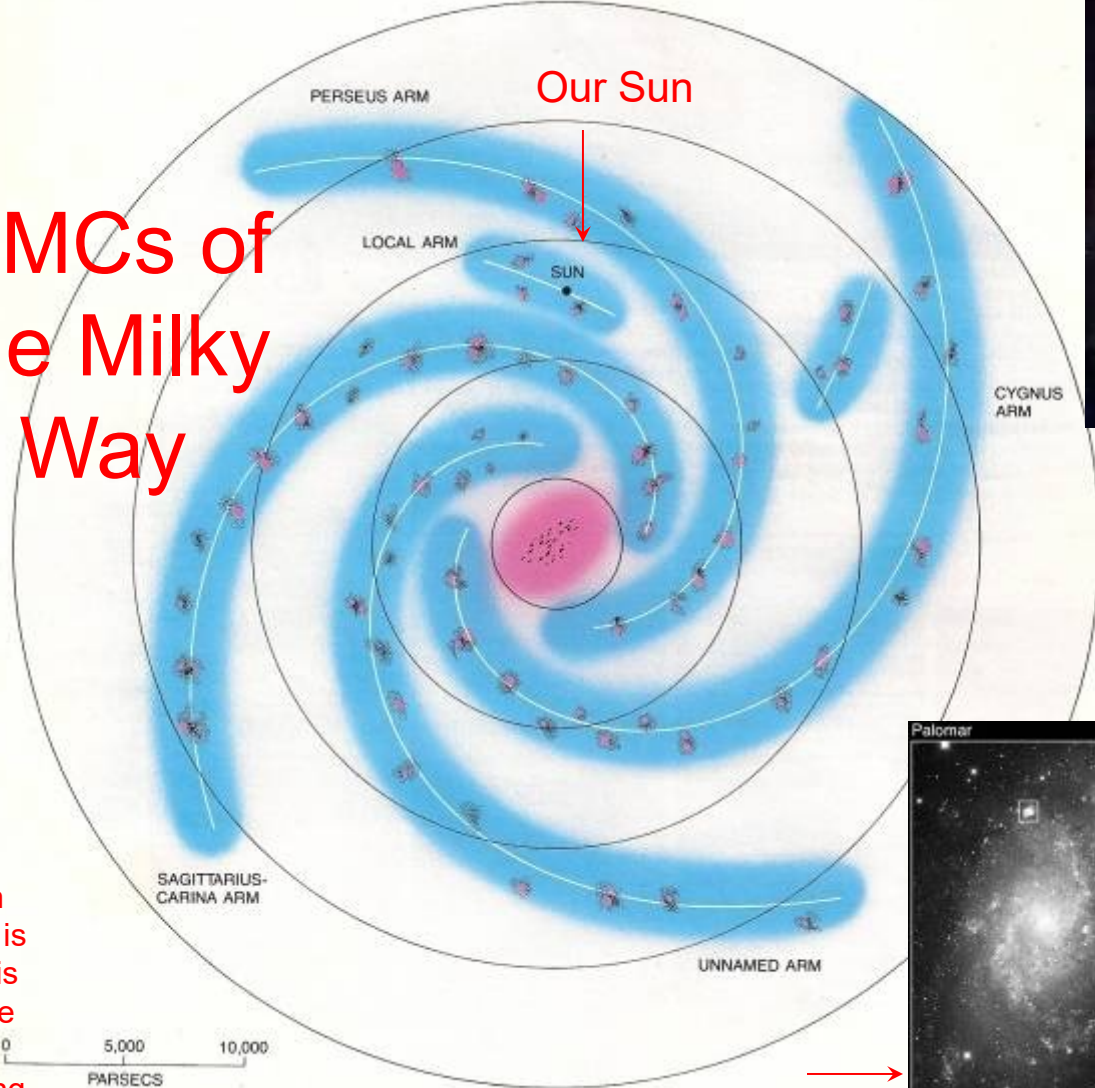


In NGC 4261 the core shows the accretion disk and the inclined, deorbiting, tidally torn, doomed stellar disk. The two hot spots in the ring line up with the jets. When a cluster of stars is captured by the spiral galaxy's black hole the stars tend to impact the accretion disk one at a time so jets turn on and off. Decaying orbits of stellar clusters precess, rotating these hot spots around the outer edge of the accretion disk. This makes a staccato series of hot GMCs that defines a spiral galaxy's spiral or barred arms. The GMC jets are richest in metals when accretion disk collisions are with a tidally torn star's former core. GMC's add mass to existing stars they impact and a few will nova or supernova while inside the irregular clouds, which also precipitates Pop I open cluster formation.

GMCs of the Milky Way

The precursor to an H II region is a giant molecular cloud (GMC). A GMC is a cold (10–20 K) and dense cloud consisting mostly of molecular hydrogen. GMCs can exist in a stable state for long periods of time, but shock waves due to supernovae, collisions between clouds, and magnetic interactions can all trigger the collapse of part of the cloud. When this happens, via a process of collapse and fragmentation of the cloud, stars are born.

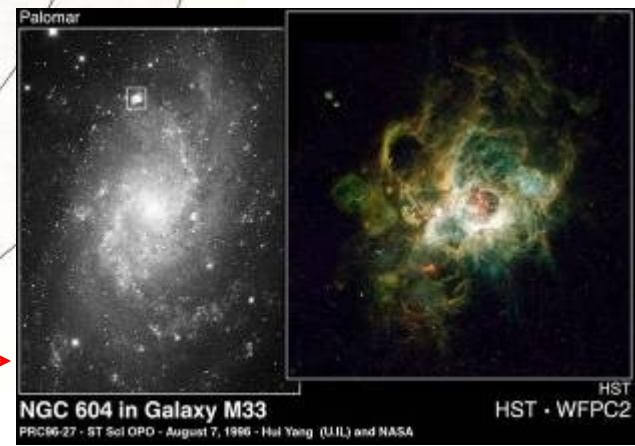
Take a ruler to any face-on spiral galaxy. Where there is a star forming GMC there is a blank spot in the opposite arm. Precession of the antipodal jets form opposing pairs of galactic spiral arms.



M33 Triangulum Galaxy's largest star forming GMC.



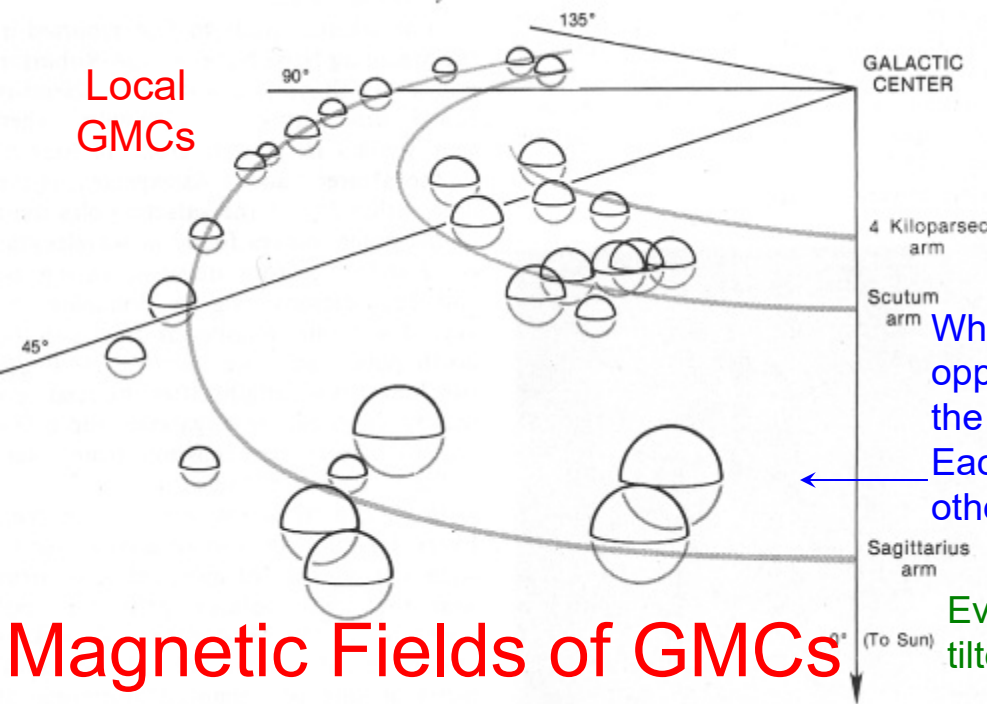
Nearby giant molecular cloud (GMC) the Orion Nebula is forming new population I stars.



PROPOSED PATTERN of the galaxy's spiral arms shows that giant molecular-cloud complexes (*black*) and H II regions (*magenta*) are confined more or less to a set of four arms. (The solar system lies in what seems to be an incomplete arm or the spur of an arm.) The densest concentration of molecular gas is shown, however, to lie within about 350 parsecs of the center of the galaxy, or a thirtieth of the distance

from the center to the sun. Young, bright stars (*blue*) follow the pattern of the arms; older, fainter stars (*red*) are more evenly distributed, except that the center of the galaxy is given a barlike distribution of stars. The pattern of the arms is based on a study of interstellar atomic hydrogen in the galaxy done by the author and Shrinivas Kulkarni and Carl Heiles of the University of California at Berkeley.

Local
GMCs



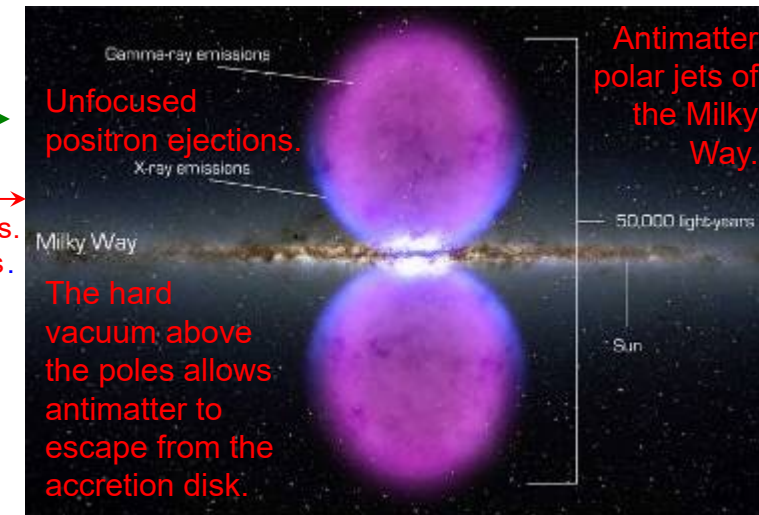
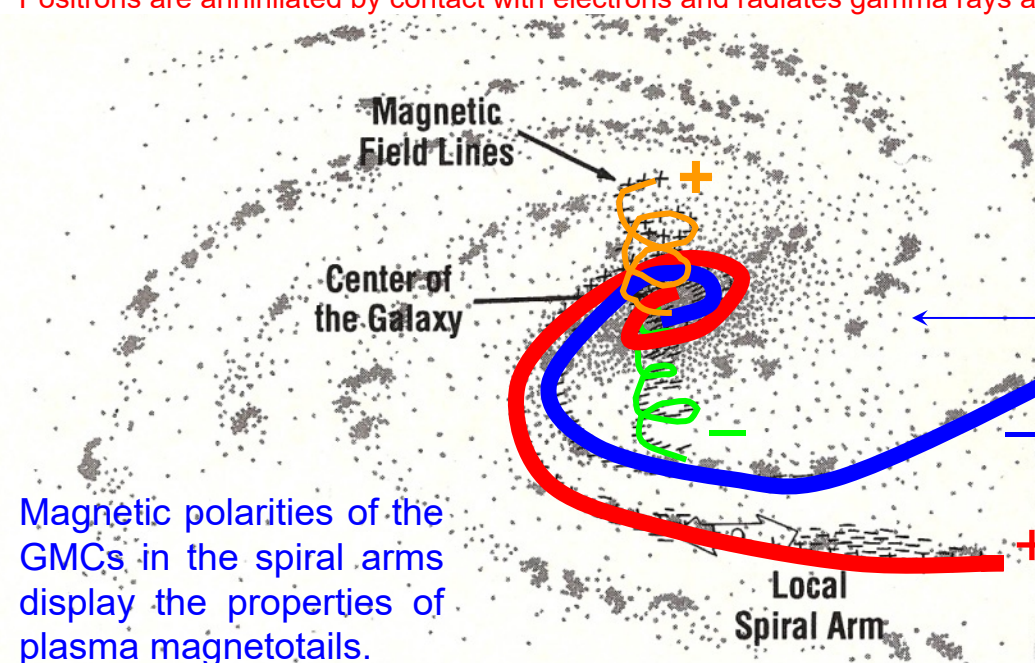
A perspective view of the giant molecular complexes in an inner part of the Milky Way as seen from a vantage point some 6,500 light-years above the Sun (toward the north galactic pole). The more massive and closer a cloud is to Earth, the larger it is drawn. Note how the Sagittarius spiral arm is traced out by molecular complexes that lie along it like beads on a string. The situation for the two inner arms is not so clear, and their positions have been indicated on the basis of 21-cm radio observations. The angles give various lines of sight from the Sun, as seen from the galactic center. Adapted from a diagram in the *Astrophysical Journal*.

Where a GMC is in one arm there will be a gap in the opposite arm. The beads on a string analogy of GMCs in the galactic arms is repeated at smaller and larger scales. Each opposing arm is like a flipped negative image of the other arm.

Magnetic Fields of GMCs

Positrons are emitted from the galactic center as two low density unfocused polar clouds. Positrons are annihilated by contact with electrons and radiates gamma rays and X-rays.

Event that →
tilted Sgr A?



The two magnetic string polarities of each jet make a series of hot giant molecular cloud complexes separated into opposing magnetically oriented clouds within each galactic arm. Polar magnetic mass ejections are also magnetically polarized and follow a corkscrewed path.

MAGNETIC FIELD LINES SPIRAL around the Galaxy then twist into a tornado-like structure at the center of the Milky Way. The field lines of opposite polarity emerge at the opposite poles of the Galaxy.

Magnetic polarities of the GMCs in the spiral arms display the properties of plasma magnetotails.

Our galaxy has been slammed by collisions of both dwarf galaxies and small dark galaxies which has given us a distinct warp to the spiral disk.

Galactic Warp Factor

The disk of our Milky Way galaxy, which contains most of its stars and gas, has roughly the proportions of a vinyl LP record or compact disk. The warp in the galaxy looks like what happens when you mistreat an LP or CD.

Milky Way Galaxy

An Old Hypothesis Revisited

A hypothesis dating to the 1950s attributed the warp to the gravity of two satellite galaxies, the Large and Small Magellanic Clouds. It fell into disfavor because those satellites are too lightweight to have much effect on our galaxy. Astronomers now know that the visible part of the Milky Way is surrounded by a huge ball of dark matter. In recent years they have shown that dark matter could amplify the clouds' gravitational influence, explaining the warp.

Classic view of Milky Way

Some warp explained by Magellanic Clouds

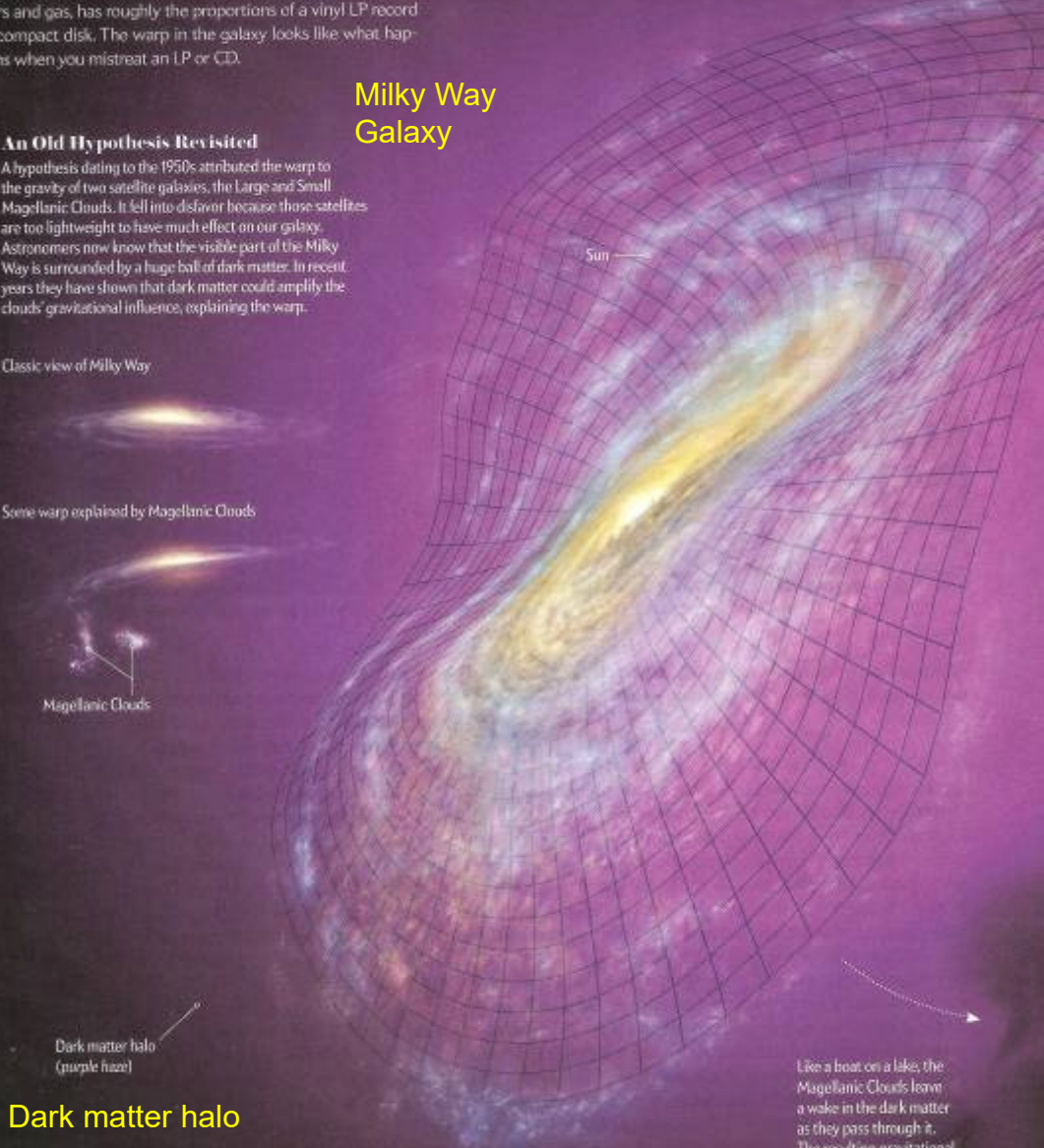
Magellanic Clouds

Dark matter halo (purple haze)

Dark matter halo

Vertical scale exaggerated

Dwarf Galaxy Collisions Damage the Milky Way Disk



Like a boat on a lake, the Magellanic Clouds leave a wake in the dark matter as they pass through it. The resulting gravitational disturbance creates the observed warp.

Vibrating Like a Giant Gong

The warp represents a wave motion captured at one moment in time. The wave has three distinct components corresponding to three natural frequencies of the disk—as though the galaxy were a giant gong. The gravity of the Magellanic Clouds, aided by dark matter, acts as the hammer.



Dark matter disturbance

Large Magellanic Cloud

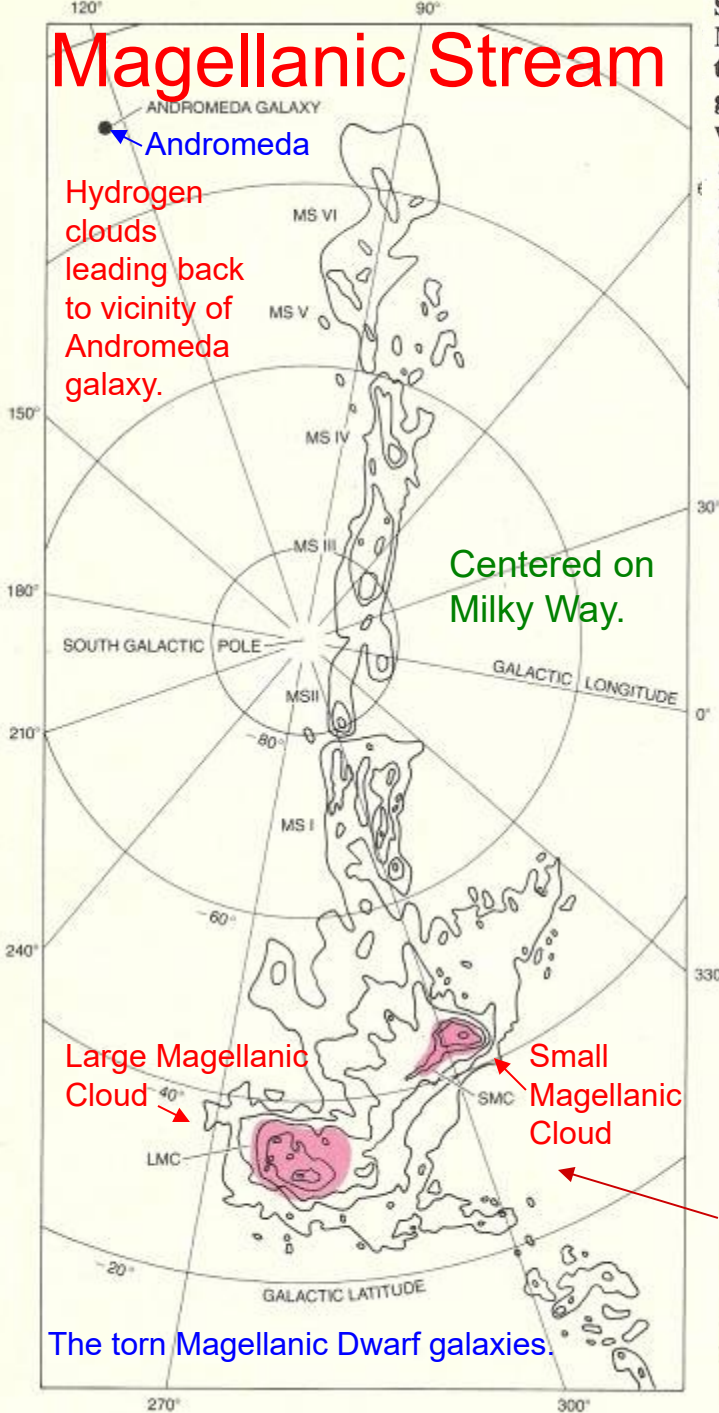
Large Magellanic Cloud

Small Magellanic Cloud

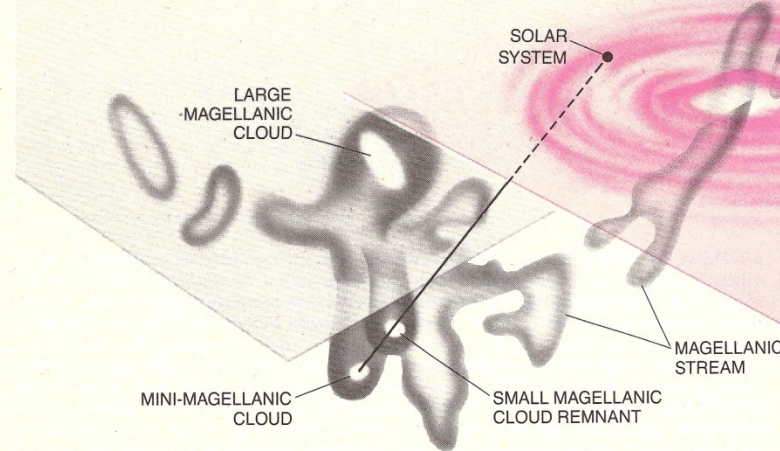
Small Magellanic Cloud

The visible and dark mass of our galaxy has slowly grown to 1.5 trillion SM (solar masses). If Hubble expansion of the universe was real we would not be having collisions with these local dwarf galaxies, or with the Andromeda galaxy and it's group of dwarf galaxies in ~4 byr. Recent collisions have been with the Sagittarius Dwarf and both Magellanic Cloud Dwarfs.

Magellanic Stream



SYSTEM OF GALAXIES made up of the Milky Way and the Magellanic clouds is shown in an artist's rendering of what the system might look like if it could be seen from the outside and if the gaseous hydrogen that permeates and surrounds the clouds were visible. The Milky Way is seen to be a majestic spiral galaxy, with a lenticular nucleus and pinwheel arms. The clouds are smaller and less symmetrical; moreover, a higher fraction of their mass is hydrogen gas. The two components of the SMC are clearly distinguished, as is the hydrogen bridge connecting the clouds. The Magellanic Stream is shown in the configuration assumed in the tidal model.



The leading edge of debris of the Sagittarius Dwarf collision with the Milky Way is now plunging through our part of the disk. Star Ross 248 of this dwarf galaxy will be our closest star in 33,000 year.

The Milky Way is still accreting its umbilical cord of hydrogen gas.

The Milky Way sweeps up nearby dwarf galaxies such as the Magellanic Clouds. A stream of hydrogen nearly connects our group of galaxies with Andromeda's group of galaxies. Andromeda was born from a bigger, faster jet pulse soon after the Milky Way jet erupted. The umbilical cords of gas associated with the formation of Andromeda and the Milky Way galaxy also birthed a multitude of dwarf galaxies. These dwarf galaxies can have both the oldest Pop II stars and the youngest of the metal rich Pop I stars.

MAGELLANIC STREAM is a lumpy trail of neutral hydrogen that follows a great-circle path from the neighborhood of the Andromeda galaxy past the south galactic pole to the clouds. Its total angular extent, as seen from the solar system, is 110 degrees, or more than a quarter of the sky. The contours represent the large-scale distribution of neutral hydrogen determined by radio-frequency observations. Shaded areas indicate the optical extent of the LMC and the SMC. Six concentrations of gas are designated MS I through MS VI.

The Impossible Galaxy Plane

Simulations of the Milky Way galaxy predict that dozens of small satellite galaxies should surround it in all directions. Yet when astronomers observe the night sky, they find that satellite galaxies form a single plane—one that stretches roughly perpendicular to the plane formed by the Milky Way's spiral arms. Studies of the nearby Andromeda galaxy reveal that its satellite galaxies also form a plane. How did these satellites get into their peculiar alignments?

Local dwarf galaxies and the Milky Way were made from the same jet from M87 ~8 bya. As the most massive of the local disks of gas and old Pop II stars our galaxy is still slowly capturing the smaller galaxies and gas.

The dwarf galaxies around the Milky Way lie in or near a plane that aligns with the galactic axis.

Milky Way's disk plane is perpendicular to galaxy plane

Best-fit plane formed by the Milky Way's satellite galaxies

Spin axis of Milky Way aligns with galaxy plane and direction of motion of the group of dwarf galaxies.

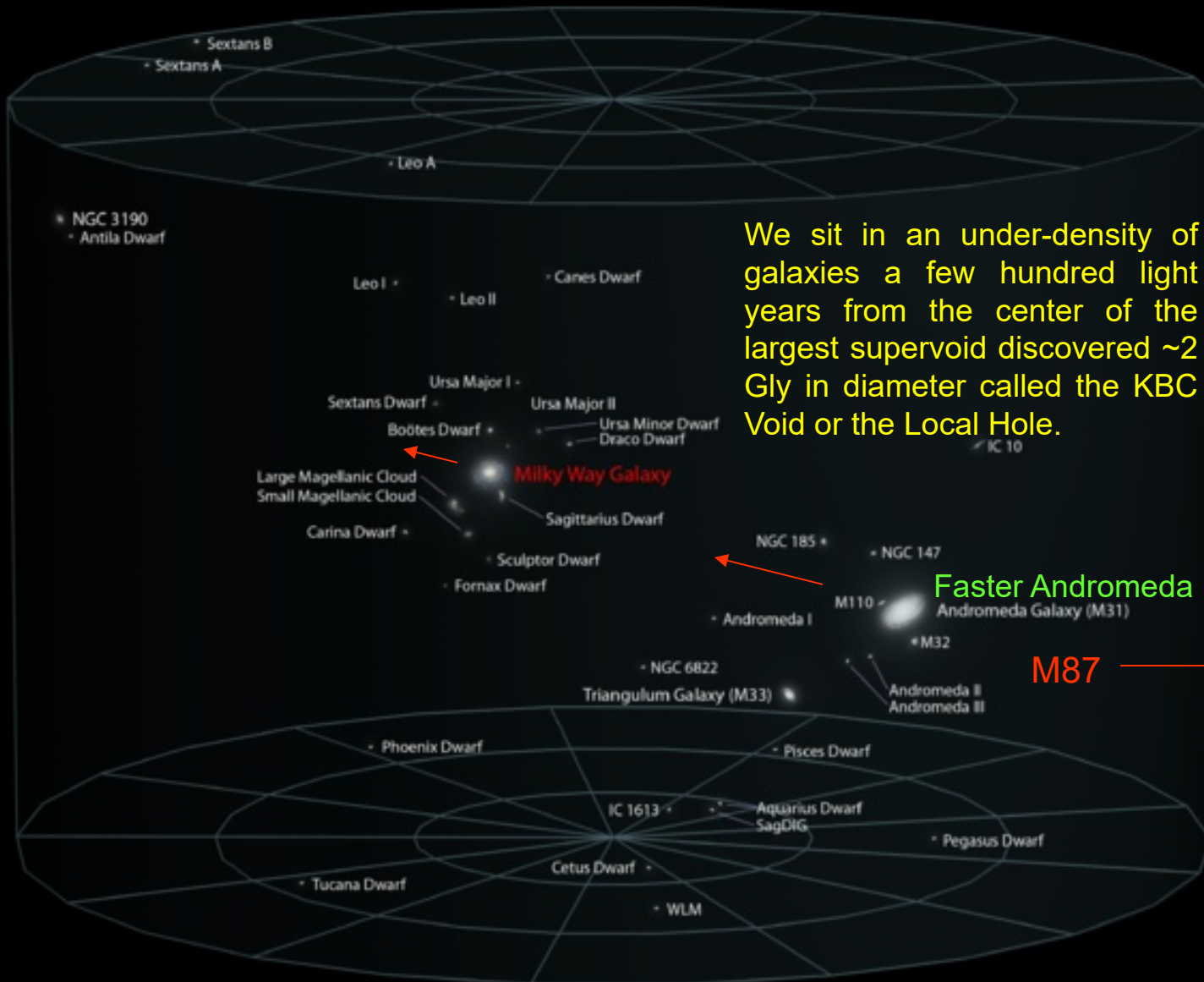
Satellite galaxies below plane

Satellite galaxies above plane

Milky Way

The jets that made the Milky Way and Andromeda galactic groups were from the center of the giant elliptical galaxy M87. At 54 Mly away M87 sits at the center of the Virgo Cluster of galaxies. Giant elliptical (cD) galaxies are typically more than thousands of times more massive than our galaxy and all have very powerful quasar jets that make thousands of spiral and dwarf galaxies.

Local Galactic Group



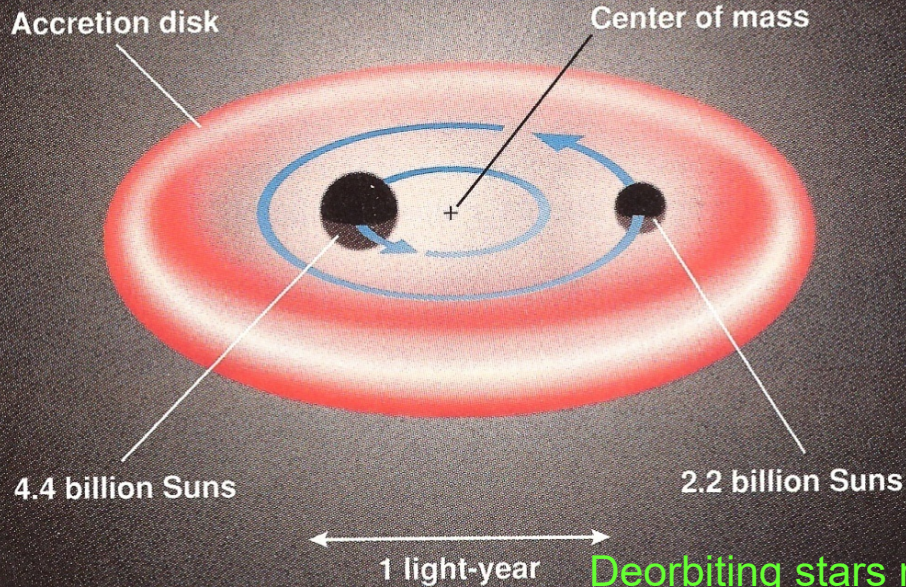
We sit in an under-density of galaxies a few hundred light years from the center of the largest supervoid discovered ~2 Gly in diameter called the KBC Void or the Local Hole.

Our part of galactic space may be sparse in galaxies yet the larger Andromeda Galaxy will collide with our Milky Way in about 3.75 byr. There are many examples of colliding spiral galaxies. We sit on the outer edge of a disk made of spiral galaxies surrounding M87 called the Virgo Cluster. The lighter slower Milky Way was born ~8 bya in a quasar event while the larger faster Andromeda was ejected from M87 slightly later. Both galaxies have now traveled over 54 Mly away from M87 but it has taken about 8 byr to get here. Pop I stars are 8 byr or less because they were born from an ejected gas jet. M87 made the older stars.

Binary Black Holes

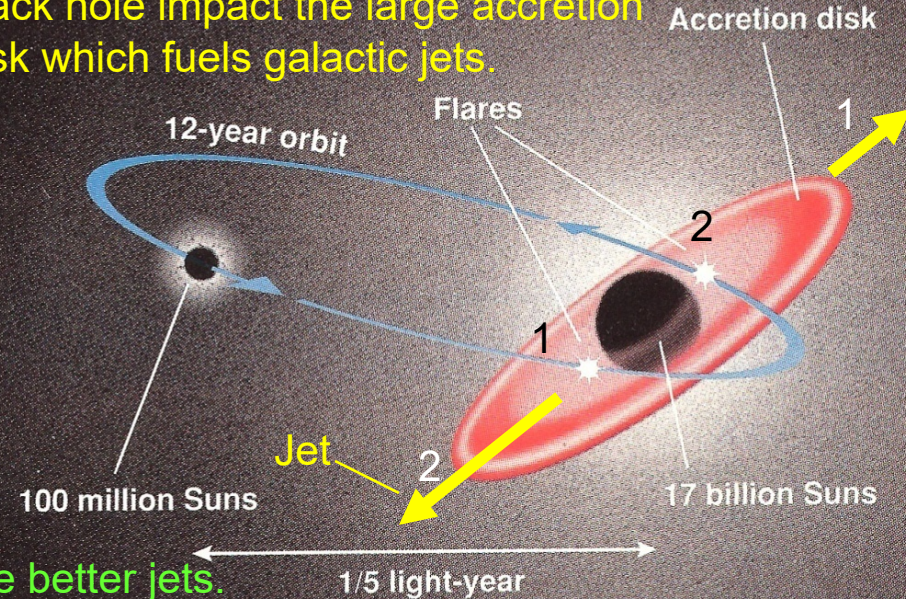
3C 390.3

Disk plane emissions and rapid orbital decay.



OJ 287

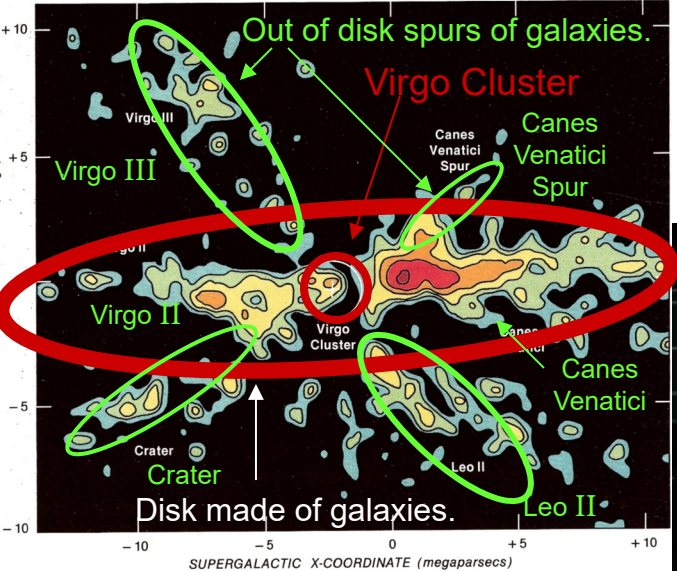
The accretions around the small black hole impact the large accretion disk which fuels galactic jets.



Deorbiting stars make better jets.

Astronomers have put forth very different kinds of evidence for binary black holes in the cores of two distant quasars. *Left:* Emission from one of 3C 390.3's regions of glowing gas suggests a steadily accelerating source, as could occur if a supermassive black hole, surrounded by gas, were in orbit around another comparably massive body. *Right:* OJ 287's light curve, tracked for nearly a century, shows flaring every 12 years. One black hole in an eccentric orbit may periodically smack into an even bigger black hole's accretion disk, causing the flares. OJ 287's light curve can be monitored by amateurs with CCD equipment.

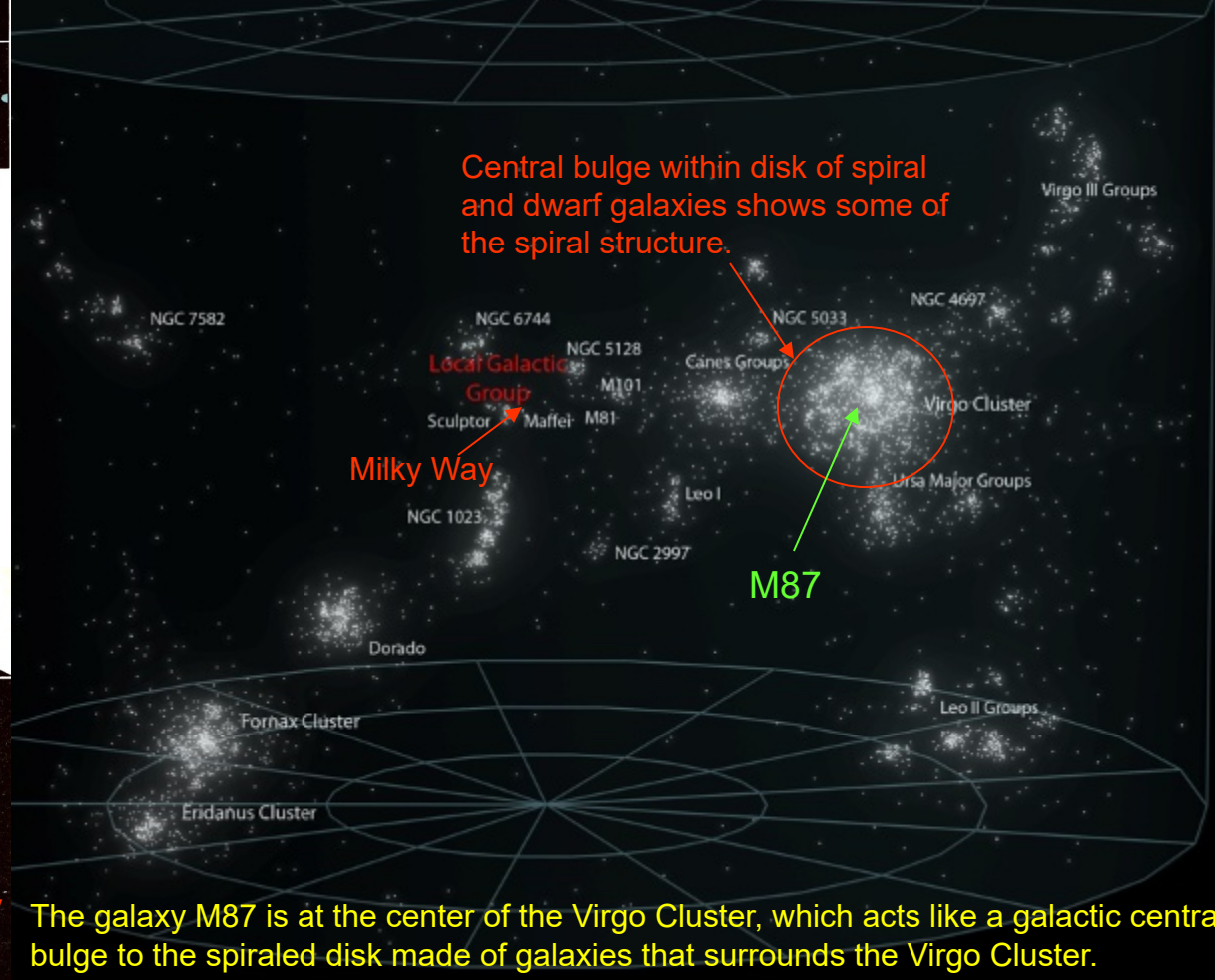
When Andromeda hits the Milky Way the collision will scatter stars and gas in arcs. Stellar collisions will be rare but cloud to cloud impacts will birth new stars. The cores of both galaxies will continue to have fireworks that make giant molecular clouds. The grand event will be when the two central black holes begin to merge. In rare cases the orbital planes are the same and it will have continuous disk plane emissions instead of periodic jets. It will be like OJ 287 for us when our smaller black hole star penetrates the Andromeda accretion disk, about half of the flares emissions would pass the black hole and be focused into a primary jet. The secondary jet would feed into the smaller black hole while brightening the primary jet. There is precession between successive jets.



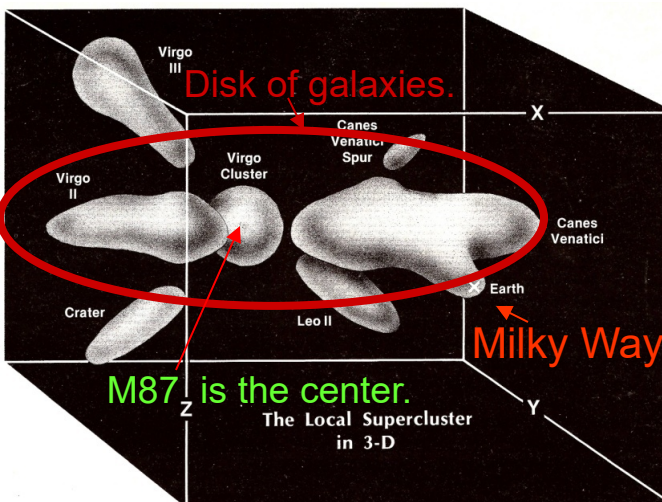
One projection of the distribution of galaxies in the Local Supercluster three-dimensional view ← The progression of cool to warm colors indicates increasing numbers of galaxies in the line of sight. Here the viewer is in the plane of the supercluster (evident by the horizontal concentration of galaxies) and can see six distinct clouds. The Virgo cluster has been omitted from the density contours, but is represented by a 12°-diameter circle. A value of the Hubble parameter of 100 km per second per megaparsec has been adopted for this presentation; a change in this value would alter the spatial scales.

Overall the Virgo cluster looks like a huge spiral galaxy with the cD galaxy M87 at the center.

The Larger Virgo Supercluster of Galaxies



We see the disk of galaxies that surrounds M87 edge on as we are an outer member of the group that includes Canes Venatici. The massive Virgo disk that surrounds M87 has small galaxies arranged like widely spaced beads on a string similar to galactic spiral arms. Antipodal jets out of this disk plane are Virgo III and Leo II and the other pair are Crater and Canes Venatici Spur. A globular cluster that directly impacts M87's black hole can make pairs of straight jets outside it's equatorial plane. Globular clusters can have hundreds of thousands of stars that when destroyed by a cD galaxy's black hole makes a series of spiral and dwarf galaxies. The Virgo disk galaxies arrange into spiral arms.



The galaxy M87 is at the center of the Virgo Cluster, which acts like a galactic central bulge to the spiraled disk made of galaxies that surrounds the Virgo Cluster.

The Local Supercluster has been pictured schematically in three dimensions by Rob Hess. Directions of the three axes used in the density-contour diagrams are also shown, as well as the location of the Earth.

Hot Gas in the Virgo Cluster

Hot gas around M87 and its nearby galaxies.

Nearby stars obscured to improve sensitivity.

M87 at center

Surrounding M87 are hundreds of black holes feeding on thin gas not found in M87. They are widely spread in the spaces between the galaxies emitting x-rays from 30 million degrees Kelvin gas. The jet effectively sweeps up normal Pop II stars older than 10 byr because of the reaction of stellar atmospheres to the jet's impact. Condensed stars are left behind as a dark mass halo around M87.

Jets remove gas and old stars from M87.

Jet

M87

Very hot X-ray emitting gas.

Virgo Cluster
ROSAT PSPC

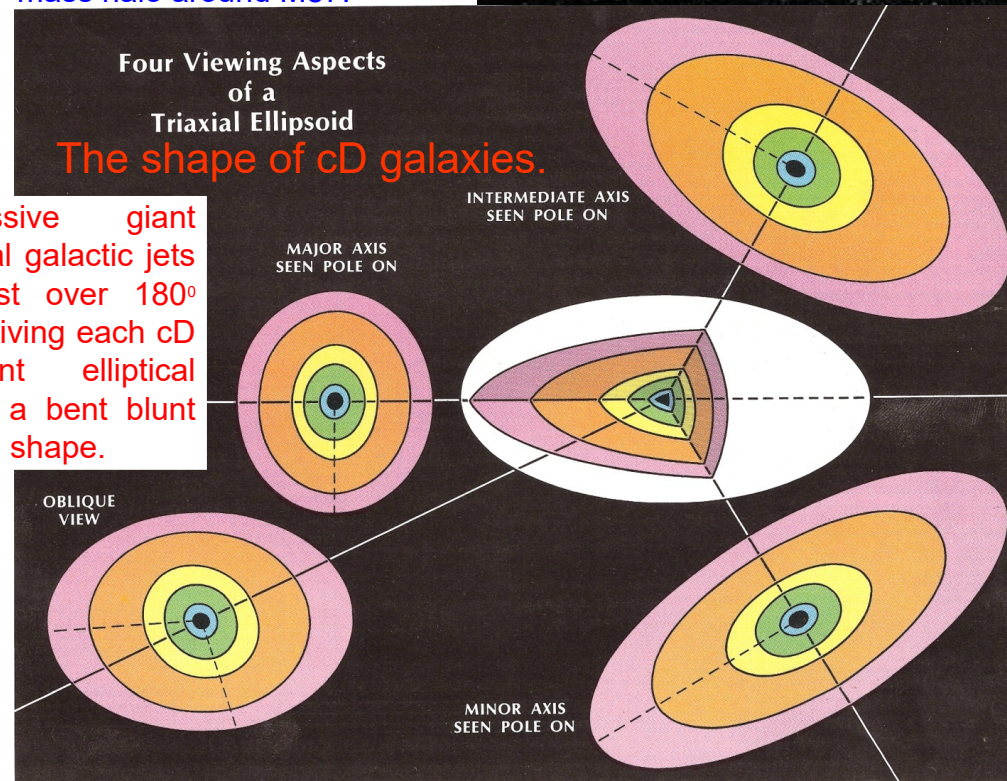
> 0.4 keV, smoothed

M87

Gas of 30 million degree Kelvin is falling into hundreds of dark matter black holes surrounding M87.

Successive giant elliptical galactic jets are just over 180° apart giving each cD galaxy a bent blunt football shape.

Four Viewing Aspects of a Triaxial Ellipsoid
The shape of cD galaxies.



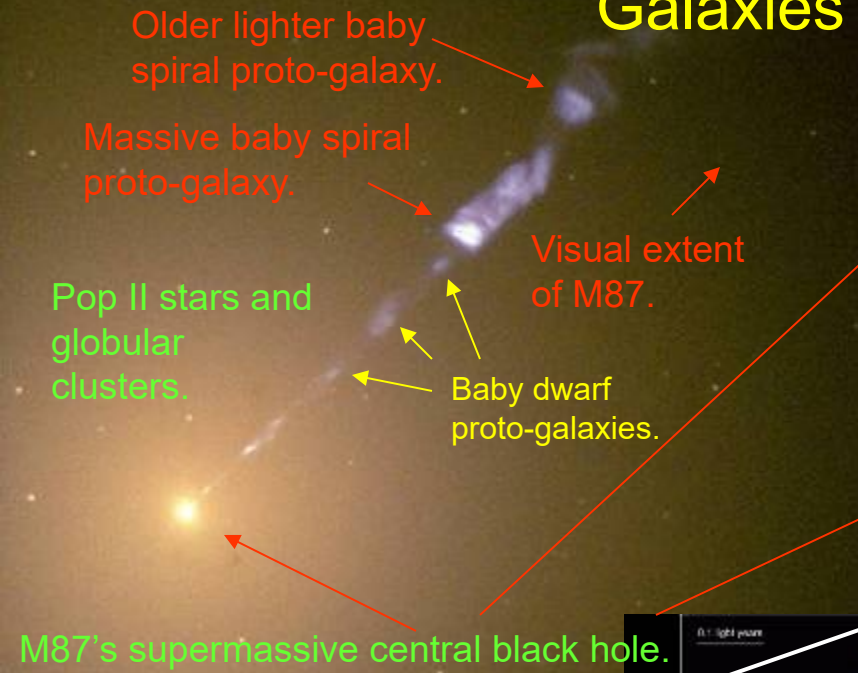
One of T. Williams' possible models of light distribution to explain the observed isophotes of NGC 596. In this case the ellipsoids used are triaxial and coaxial, but *not* similar in shape — the ratios of the three axes to each other change from one ellipse to another. If the galaxy is viewed along any one of the three principal axes the observed isophotes are coaxial ellipses of varying eccentricity. When viewed at any other angle the resulting isophotes are still nonsimilar, but now they also exhibit the twisting phenomenon of their major axes at varying distances from the center.

MPE

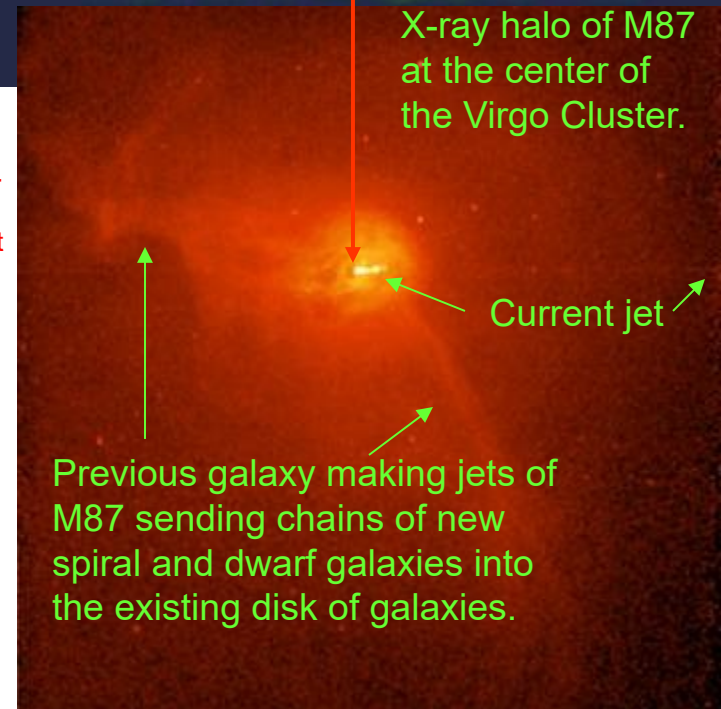
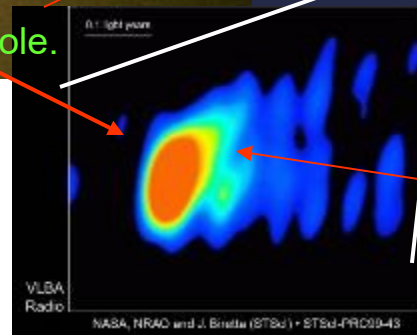
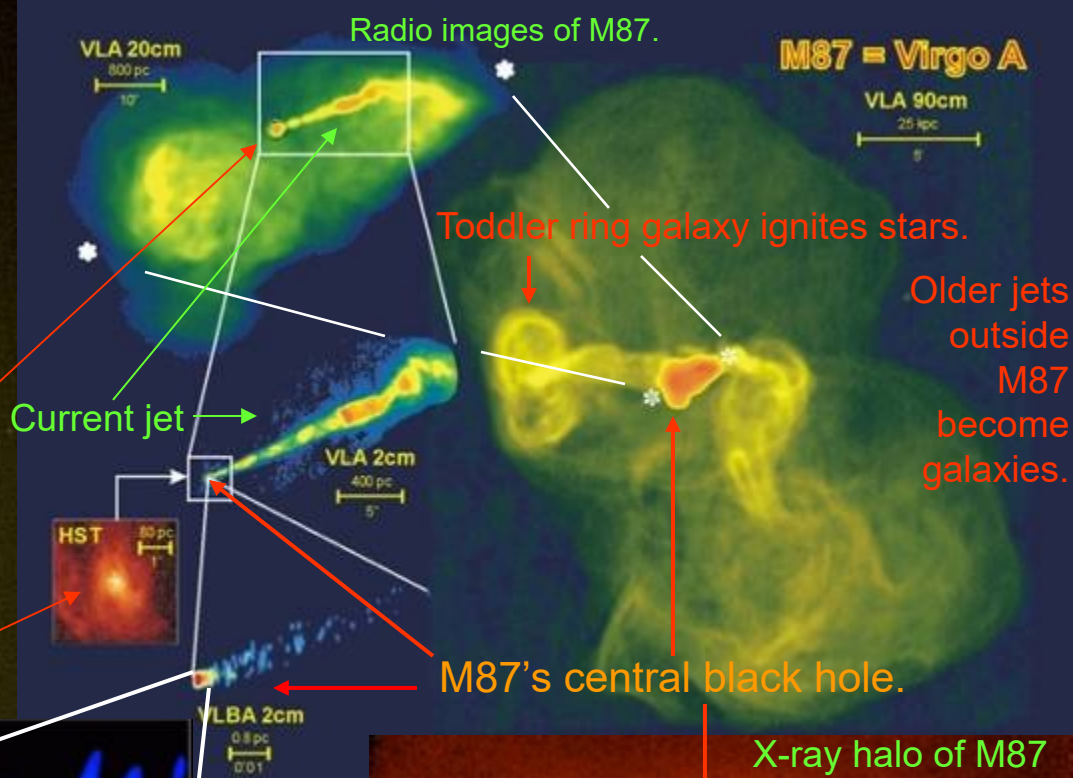
All-Sky-Survey

2 deg

The Birth of Spiral and Dwarf Galaxies

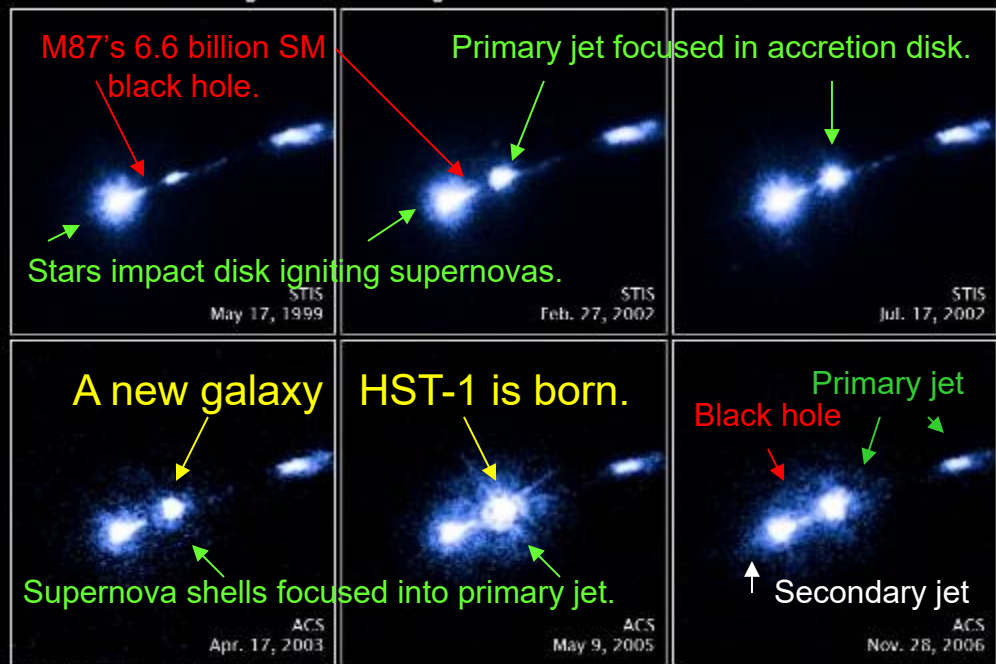


As long as each star of M87 has an atmosphere for the quasar jet to impact, old stars are swept up with the jet into newborn galactic disks. Condensed stars and stars striped of gas aren't effectively accelerated. A vast halo of dark matter around M87. The gas and dust removed from M87 became the torn umbilical cords of dwarf and spiral galaxies. Our galaxy's globular clusters no longer have black holes at their center where a massive Pop III progenitor was born and quickly died. Our central black hole formed after the galactic disk was ejected from M87 ~8 bya. All of the Pop II stars from ~10 to 12 byr in the Virgo Supercluster were born in the uniform gas of a young M87. Dwarf and spiral galaxies births should be estimated by their oldest Pop I stars.



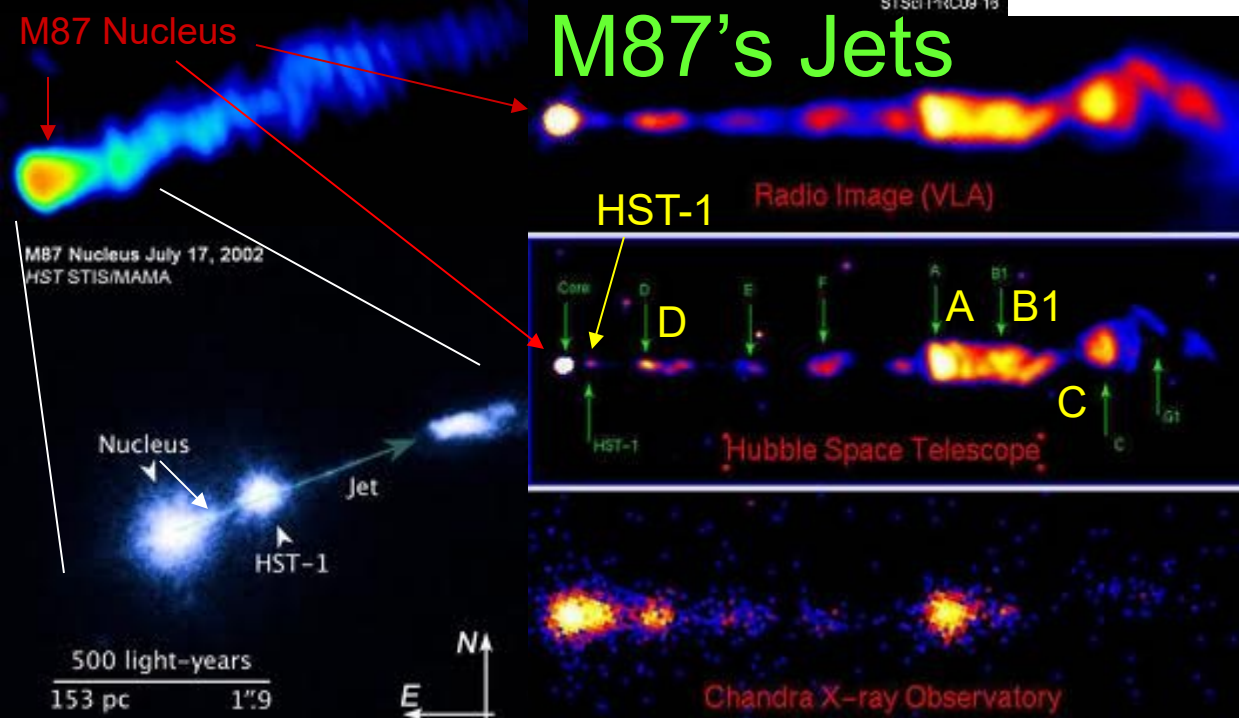
M87 Nucleus and Bright Knot in Extragalactic Jet

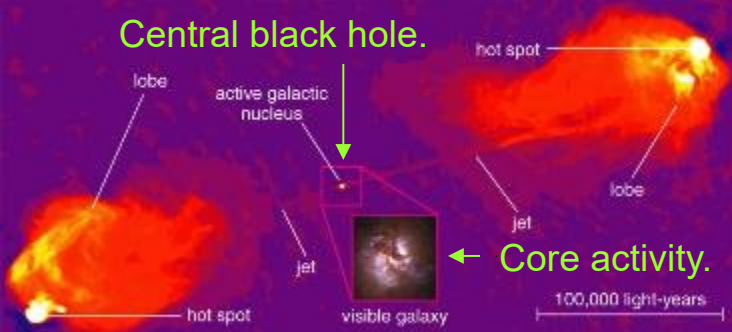
HST • STIS/MAMA • ACS/HRC



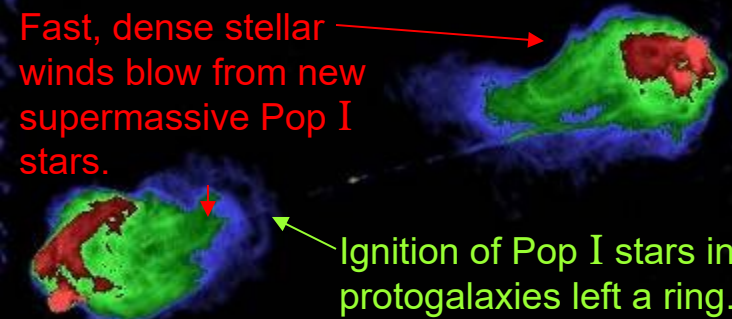
When any star from a deorbiting globular cluster impacts M87's accretion disk it novae or supernovas. This makes a primary jet which then makes a secondary jet aimed back at the cluster. The first star and every star of the globular that the 2nd jet impacts now supernovas. Half the supernova shells are now gravitationally and magnetically focused into a massive particle beam by passing the black hole. The 1st jet strengthens while the 2nd jet becomes blocked by supernova shells. The precessing globular twice every orbit passes through the accretion disk plane and the jets reverse position. It can lose a few hundred stars at every event and do this for a long time. The newest relativistic pulse HST-1 has the appearance of a flattened supergiant star with its onion layers of elements but is much more massive. This fast disk accelerates the Pop II stars it impacts as long as there is atmosphere to burn. Dead compact stars are too hard to accelerate and fall behind. Stars accelerated by the iron rich center of the beam quickly become gargantuan by position D.

Their short lives end as hypernovas by position A. The hypernova shells spread outward like a ring of fire igniting the disk's first Pop I stars. By position B1 the central stars and the multitude of first born black holes have merged into a massive central black hole. With a nucleus come the hot GMCs that become the spiraling galactic arms with the next generation of Pop I stars. At position C the young spiral leaves M87's envelope of Pop II stars and becomes an independent spiral galaxy with trailing dwarf galaxies. A globular cluster that directly impacts M87's black hole is not in the disk plane so it makes straight jets of galaxies above and below M87's accretion disk plane. Jets made by impacts with cD accretion disks make strings of galaxies that are like spiral arms around the Virgo Cluster.

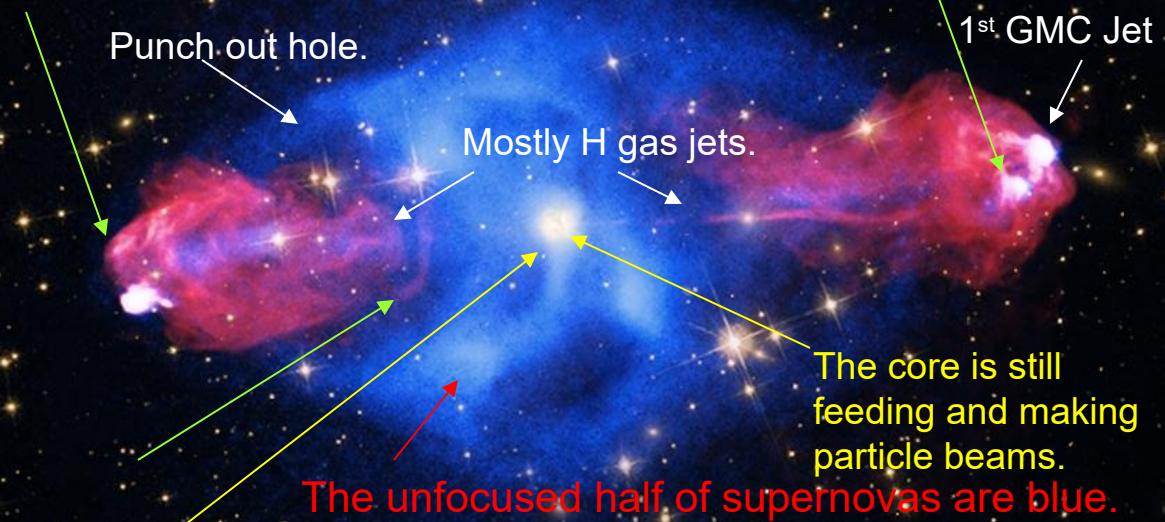
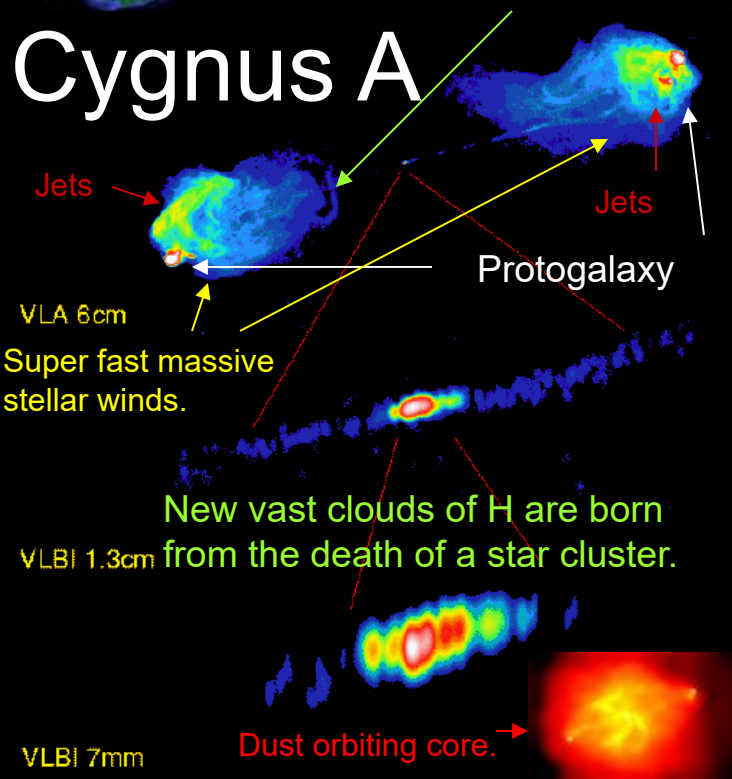




New 10 myr old protogalaxies. Very metallic Pop II stars are gargantuan in the center of the jet but outside the core is a disk of high density hydrogen gas. These fat stars will quickly hypernova.



Cygnus A



Cygnus A or 3C405 is the center of another galactic cluster. This brightest active quasar is the closest at only 730 Mly.

Cygnus A (3C405) is imbedded in a gargantuan cloud of extremely hot gas (tens of millions K). Cygnus A's black hole is a billion solar masses. It grinds entire globular clusters into plasma and recycles the parts it didn't eat as jets or hot clouds. The edges of the new jets are eroded from punching out of the center of the cD. Cygnus A's old Pop II stars with atmospheres, for the duration of jet impact, will have a hemispheric reaction that accelerates them into being swept up by the beams, forming disks rich in old stars and globular clusters. The cores of these gas disks are rich in iron and other metals but all that quickly disappears into the fast growing massive central black hole. Ignitions of the first supermassive Pop I stars at the core of each jet blew superfast stellar winds making a ring of new giant blue stars in the disk. Engorged with jet gas gargantuan Pop I & Pop II stars, in the center of the protogalaxies (at the tips of the jets), are about to go hypernova. The core of each disk is having their 1st GMC jets that will eventually make spiral arms. The galactic GMC jet impacting the dense H gas is making the large metal poor 2nd generation Pop I stars in 1st generation open clusters which spread out and later die as supernovae to make more metallic 3rd generation Pop I stars in 2nd generation open clusters.

New supermassive stars at center of jet hypervnova into black holes.



cD galaxy.

3C353

Hypervnovas make ring galaxy.

Youngest Galaxies



The Hoag galaxy has ignited super giant Pop I stars but not yet made spiral arms.

Baby spiral galaxy

Big stars die

cD galaxy

Ring made when supermassive stars are born.

Multiple hypervnova shells.

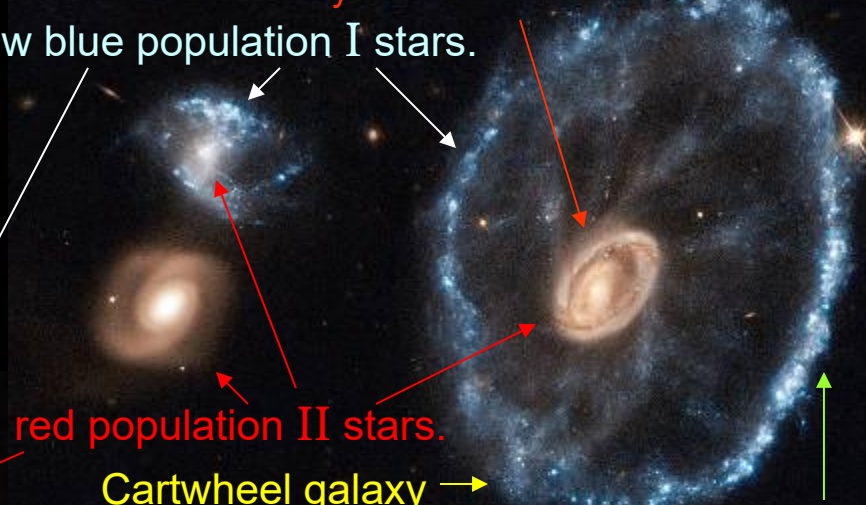
Intensity Gradients in Radio Galaxy 3C353

VLA 3.6cm image (Sobel filtered) (c) NRAO 1996

For awhile the spin axis of new spirals and dwarfs aligns with the direction of ejection. The relativistic quasar jet ejected out of the cD galaxy sweeps up old Pop II stars. All the central gargantuan stars hypervnova as a chain reaction. The shells merge into a growing ring of first generation Pop I stars in the new gas disk.

New spiral arms from first jets of new central black hole pushes older stars away from the center.

New blue population I stars.



Old red population II stars.

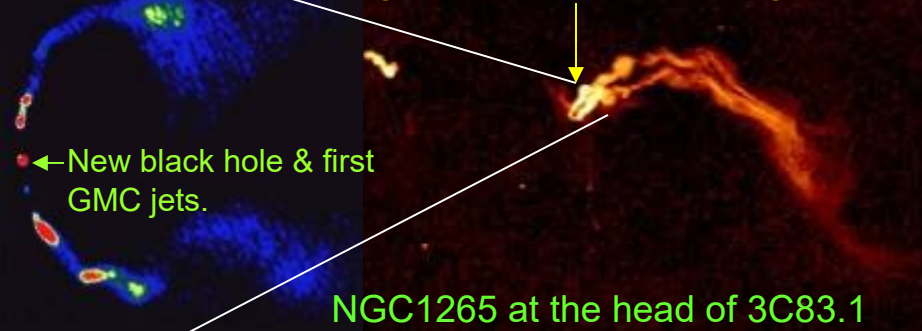
Cartwheel galaxy →

Hypervnovas ripple through the closely packed super giant stars spreading the jet pulse into a disk. Head-tail radio galaxies outline their umbilical cords.



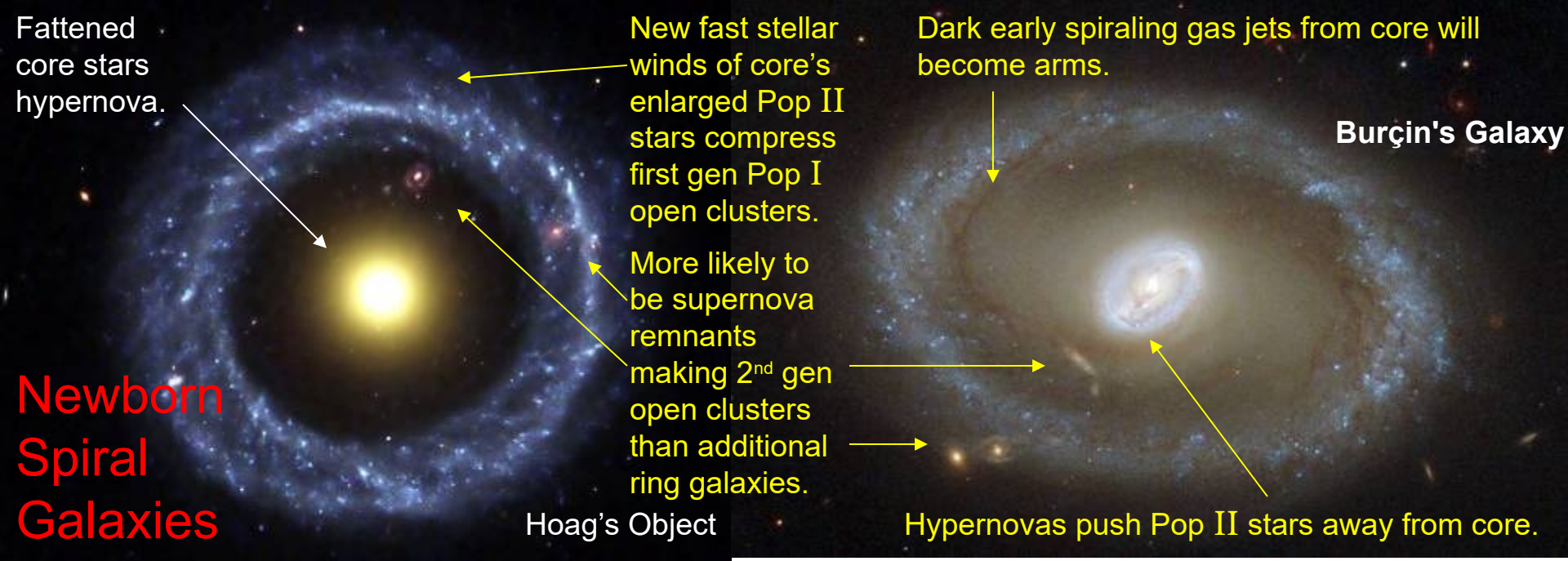
3C279

Fast toddler disk galaxies with spiraling GMCs.



← New black hole & first GMC jets.

NGC1265 at the head of 3C83.1



A nearly perfect ring of young hot blue stars circles the older yellow nucleus of this ring galaxy c. 600 million light-years away in the constellation Serpens. The diameter of the 6 arcsecond inner core of the galaxy is about 17 ± 0.7 kly (5.3 ± 0.2 kpc) while the surrounding ring has an inner 28" diameter of 75 ± 3 kly (24.8 ± 1.1 kpc) and an outer 45" diameter of 121 ± 4 kly (39.9 ± 1.7 kpc). The galaxy is estimated to have a mass of 700 billion suns. By way of comparison, the Milky Way galaxy has an estimated diameter of 150-200 kly and consists of between 100 and 500 billion stars and a mass of around 1.54 trillion suns. The gap separating the two stellar populations may contain some star clusters that are almost too faint to see. Though ring galaxies are rare, another more distant ring galaxy (SDSS J151713.93+213516.8) can be seen through Hoag's Object, between the nucleus and the outer ring of the galaxy, at roughly the one o'clock position in the image shown here. Noah Brosch and colleagues showed that the luminous ring lies at the inner edge of a much larger neutral hydrogen ring.

The structure and photometry of LEDA 1000714 was studied with significant detail in 2017. The core of the galaxy appears to be similar to an elliptical galaxy, and is almost perfectly round, not flattened into a disk. Unlike some ring galaxies, the central core shows no signs of a bar structure connecting the outer ring to the center of the galaxy. This is similar to Hoag's Object, and a number of other galaxies have been found that have a perfectly round center. The outer galaxy is relatively bright and contains many luminous stars indicative of star formation. However, upon further inspection of the galaxy, it was found that inside the outer ring there is also a faint, diffuse, red inner ring closer to the core. The outer ring appears to be fairly young, at about 0.13 byr old, while the core is much older, at 5.5 byr old. The age of the inner ring is, as yet, undetermined. Many stars orbiting the core are inside of the hypernova front and pushed into the central black hole.

Baby galaxies can have the outer ring of new Pop I stars collisionally eroded from the core of old Pop II stars during the trip out of the center of a cD galaxy and you get two gravitationally bound galaxies from just one cD jet pulse. Asymmetrical hypernovas around a fast growing black hole can also kick the red Pop II galactic center away from the new blue Pop I edges.



AM 0644-741, also known as the Lindsay-Shapley Ring, is an unbarred lenticular galaxy, and a ring galaxy, which is 300 million light-years away in the southern constellation Volans. The yellowish nucleus was once the center of a normal spiral galaxy, and the ring which currently surrounds the center is 150,000 light years in diameter. The ring is a region of rampant star formation dominated by young, massive, hot blue stars. The pink regions along the ring are rarefied clouds of glowing hydrogen gas that is fluorescing as it is bombarded with strong ultraviolet light from the blue stars. Galactic simulation models suggest that the ring of AM 0644-741 will continue to expand for about another 300 million years, after which it will begin to disintegrate.

Asymmetrical hypernovas around a fast growing black hole can also kick the red Pop II galactic center away from the new blue Pop I edges.

Arp 147 (also known as IC 298) is an interacting pair of ring galaxies. It lies 430 million to 440 million light years away in the constellation Cetus and does not appear to be part of any significant galaxy group. The main ring contains nine bright X-ray sources which are black holes, each with a mass 10–20 times the mass of the Sun. The edge-to-edge expansion of the ring is 225 ± 8 km/s and there is very little rotation seen (47 ± 8 km/s). It also has a star formation rate of approximately 4.68 solar masses per year. The reddish bulge in the main ring comprises 30–50% of the total mass of the galaxy. The collision produced an expanding wave of star production (shown as bright blue) traveling at an effective speed of ≈ 100 km s⁻¹ and began some 40 million years ago. The most extreme period of star formation is estimated to have ended 15 million years ago and as the young, super hot stars died (as exploding supernovas) they left behind neutron stars and black holes. The right-side galaxy is 30,000 light years in diameter and is located 21,000 light years away from its partner galaxy. The entire system extends some 115,000 light years across.

Baby Galaxies

Engorged old core stars hypernova.

Arp 147

Disk of old stars captured from cD galaxy.

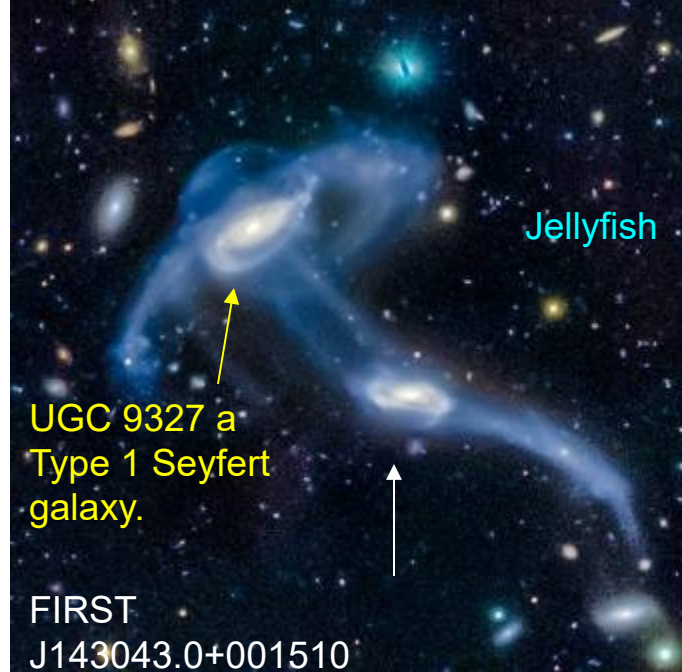
Ring of new stars eroded off outside of particle beam with ~50% of mass in new red core.



1st GMC's Toddler Galaxies

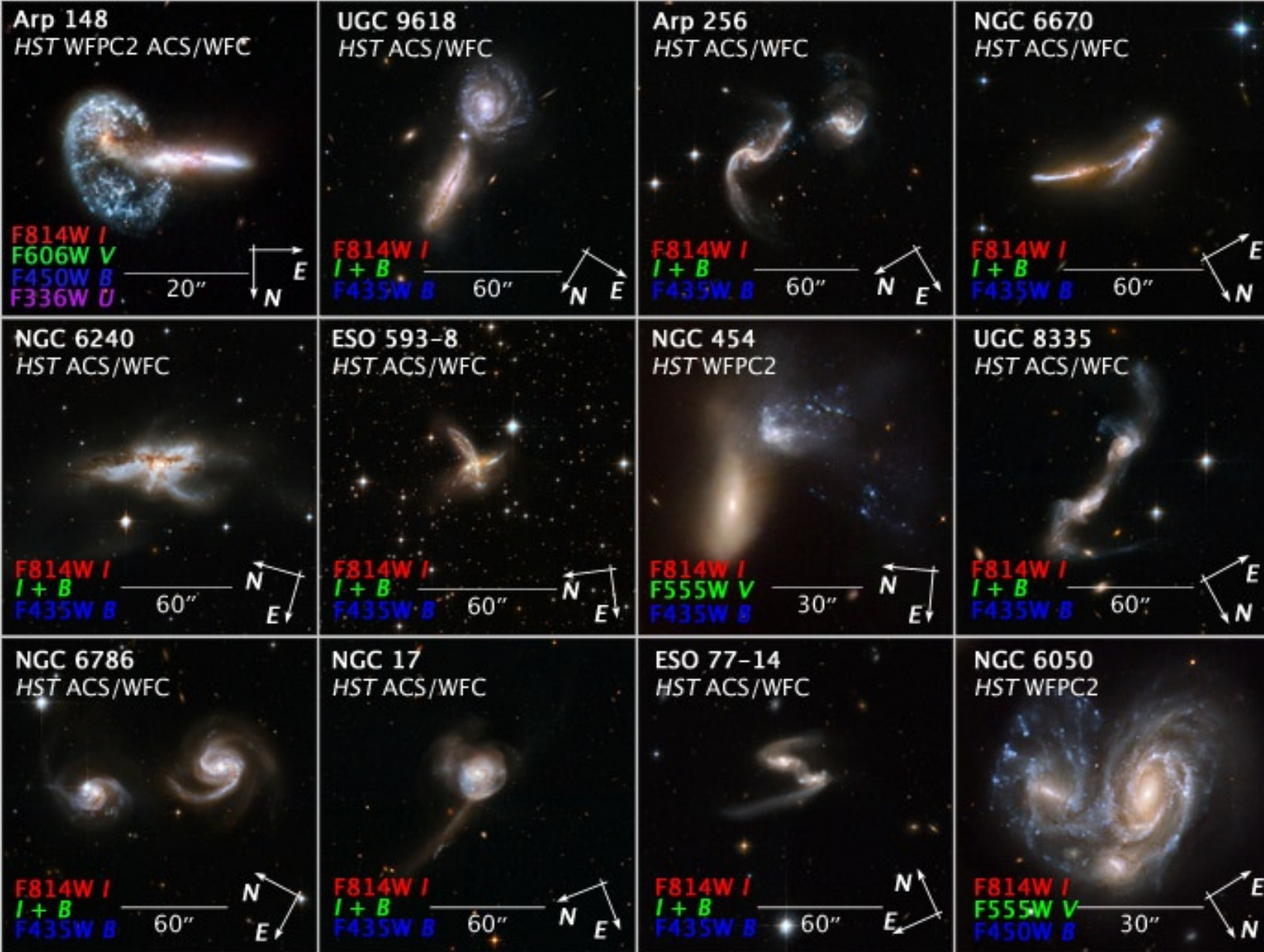


Distant galaxies background the spiral Tadpole Galaxy (Arp 188) 420 Mly away. The tail is about 280 kly long with massive, bright blue star clusters. This new large spiral galaxy will eventually collect its tail after their star clusters have formed into satellite dwarf galaxies.



Messier 106 (also known as NGC 4258) is an intermediate spiral galaxy. M106 is at a distance of about 22 to 25 million light-years away from Earth. M106 contains an active nucleus classified as a Type 2 Seyfert, and the presence of a central supermassive black hole has been demonstrated from radio-wavelength observations of the rotation of a disk of molecular gas orbiting within the inner light-year around the black hole. NGC 4217 is a possible companion galaxy of Messier 106. M106 has a water vapor microwave megamaser that is seen by the 22-GHz line of ortho-H₂O that evidences dense and warm molecular gas. These water vapors give M106 its characteristic purple color. Water masers are useful to observe nuclear accretion disks in active galaxies. The water masers in M106 enabled the first case of a direct measurement of the distance to a galaxy as an independent anchor for the cosmic distance ladder. M106 has a slightly warped, thin, almost edge-on Keplerian disc which is on a subparsec scale. It surrounds a central area with mass $4 \times 10^7 M_{\odot}$. It is one of the largest and brightest nearby galaxies, similar in size and luminosity to the Andromeda Galaxy. The supermassive black hole at the core has a mass of $(3.9 \pm 0.1) \times 10^7 M_{\odot}$. The active black hole core is making new open clusters where the hot GMC jet pulses have penetrated gas arms.





Galactic Pairs

Violet: F336W (U)
Blue: F450W (B)
Green: F606W (V)
Red: F814W (I)

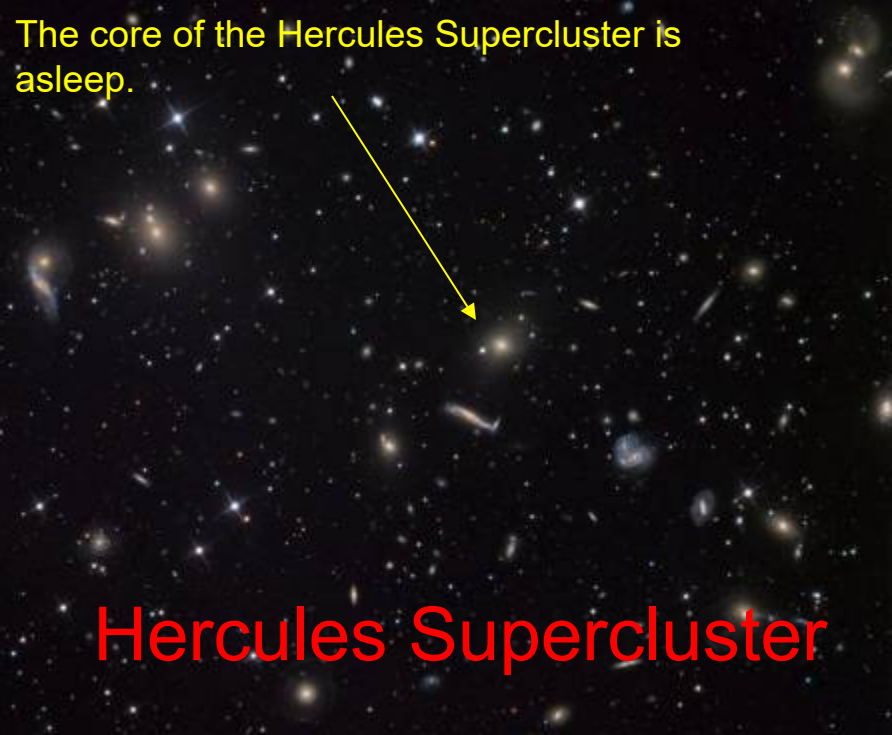
Gravitationally interacting galaxies cannibalistically grow. Eventually gravitational apexes will be reached and dying red galaxies returned to cD cores to be recycled but that entire trip may take hundreds of billions of years.

Whether it is one divided pulse, or two or more quick pulses, once freed of the cD the mutual gravity of interacting galaxies begins the long orbital dance that feeds the smaller galaxies into the locally largest galaxy. Spiral galaxies will slowly absorb surrounding dwarf galaxies with bright collisions but eventually the gas needed to make stars is used up or blasted away until only embers of red dwarf stars dimly light nearly dead galaxies.

The Hercules Superclusters are near the Coma Supercluster which make up part of the CfA2 Great Wall. Relative to other local superclusters, Hercules is considered particularly large, being approximately 330 Mly in diameter. The Northern Local Supervoid lies in front of the super-clusters, and is as big as the superclusters themselves. The redshifts of the member galaxies lie between 0.0304 and 0.0414. The region includes Abell 2147, Abell 2151 (Hercules Cluster), and Abell 2152 galaxy clusters. An extremely long filament of galaxies has been found, that connects this group of clusters to the Abell 2197 and Abell 2199 pair. Abell 2162 in the nearby constellation Corona Borealis is also a member. 

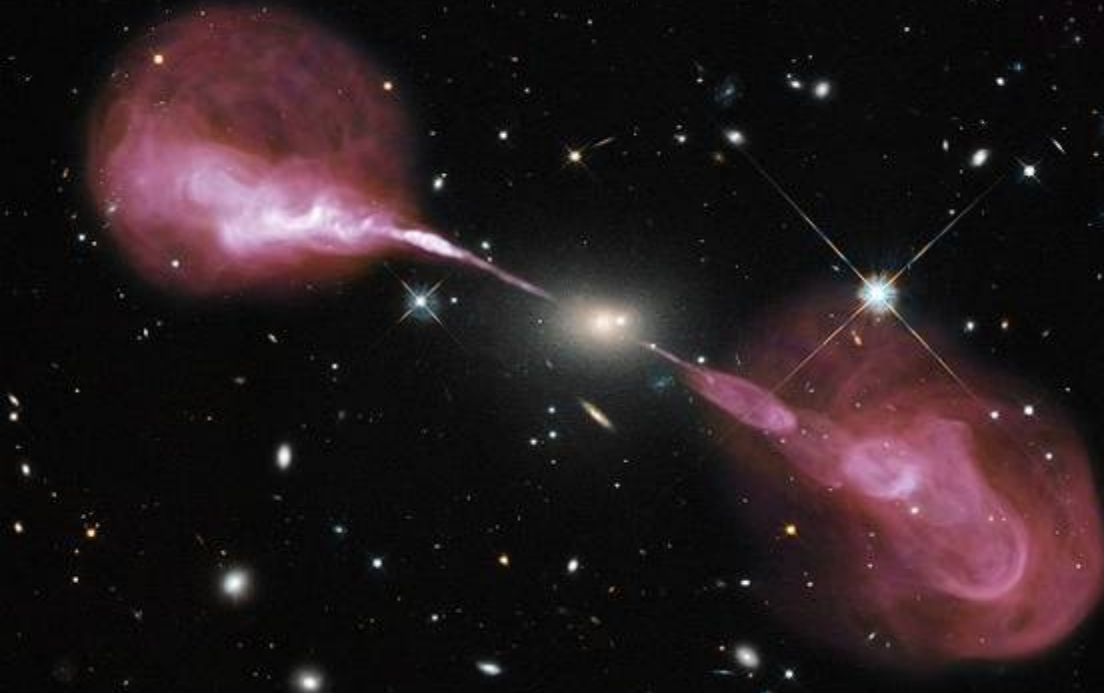
Hercules A or 3C 348 a distant quasar.

The core of the Hercules Supercluster is asleep.



Hercules Supercluster

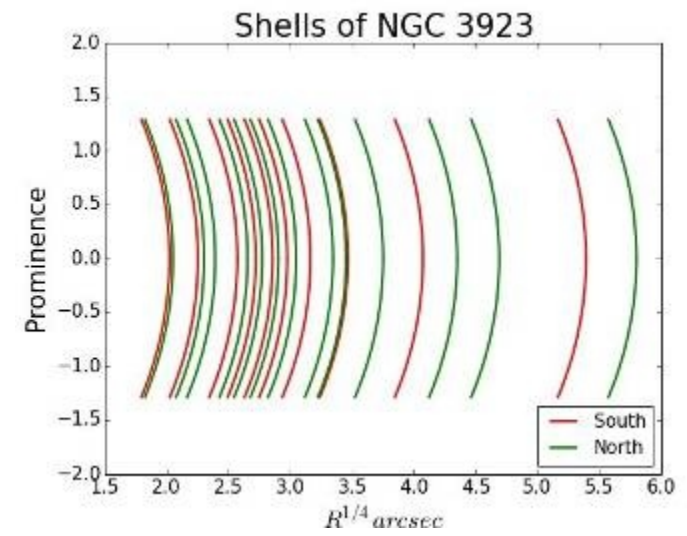
At 2.1 Gly distant Hercules A is burping smoke rings and new lenticular galaxies into its own galactic cluster but is too far away to be part of the nearby Hercules Supercluster. The quasar 3C 348 is a supergiant elliptical galaxy over 1,000 times more massive than the Milky Way Galaxy with a 4 billion solar mass black hole that powers equatorial plasma jets over one million light years long. Pop II star formation started in M87 ~12 bya but ended ~10 bya when central jets had removed the loose dust and gas while making galaxies. Different cD's will have different ranges for their old Pop II stars.



Galaxies close to us have a similar ranges of old and new

NGC 3923's 42 shells

Cooled jet against
bright background



A representation of the interleaving pattern of the shells in NGC 3923. R is the projected radius of the shell rim from the galaxy center. Green arcs indicate shells to the north of the center and red arcs are those to the south. Red and green arcs should alternate, but the outer shells do not follow this pattern. As a globular cluster is orbitally fed into the accretion disk it supernovas first on one side then the other so the most powerful jets that become spiral and dwarf galaxies tend to alternate sides.

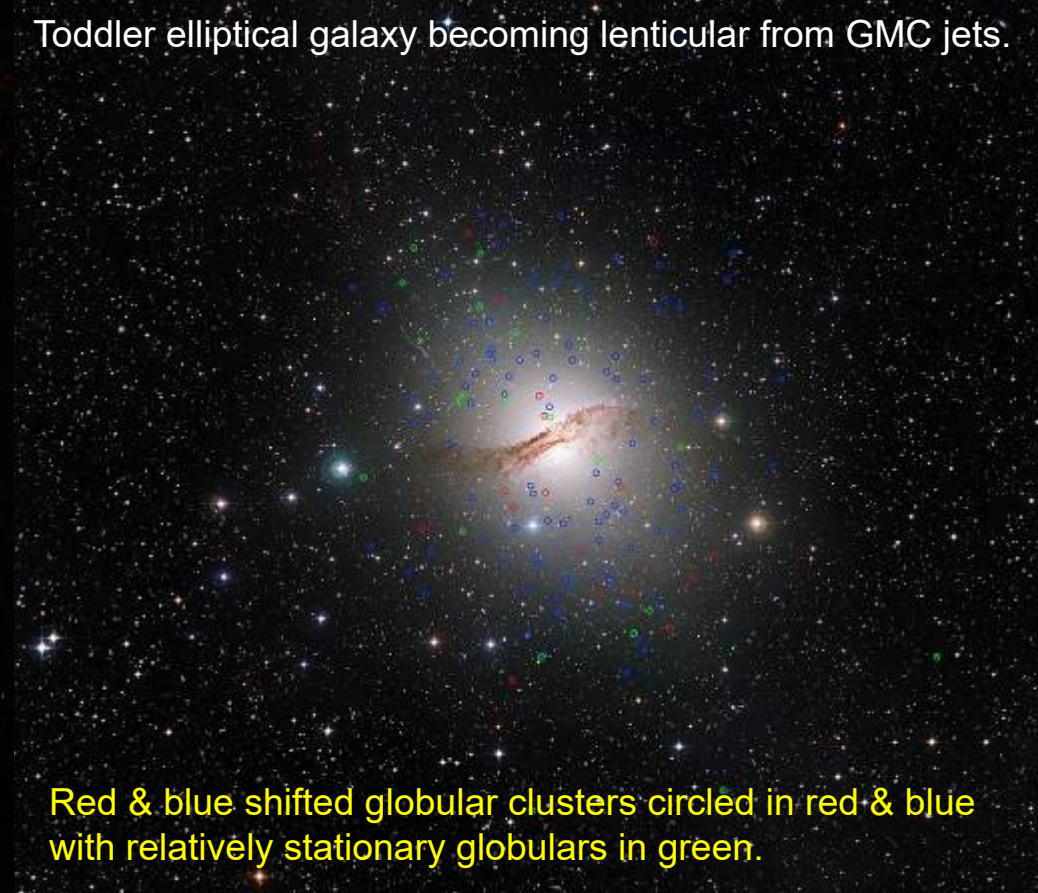
NGC 3923 about 155,000 light years across and 90 million light years away is an example of a shell galaxy where the stars in its halo are arranged in layers. NGC 3923 has up to 42 shells, the highest number among all shell galaxies, and its shells are much more subtle than those of other shell galaxies. The shells of this galaxy are also symmetrical, while other shell galaxies are more skewed. Concentric shells of stars enclosing a galaxy are quite common and are observed in many elliptical galaxies. In fact, every tenth elliptical galaxy exhibits this onion-like structure, which has never been observed in spiral galaxies. Based on the velocity dispersion of the globular clusters of NGC 3923 the mass of the supermassive black hole of the galaxy was estimated to be $(5.3 \pm 2.5) \times 10^8$ or half a billion solar masses.

Centaurus A

Toddler elliptical galaxy becoming lenticular from GMC jets.



Bent trapezoidal dust ring.
Dust was from cD jet but
has been pushed out of the
center of the particle beam.



Red & blue shifted globular clusters circled in red & blue
with relatively stationary globulars in green.

The center of the cD jet was rich in heavy elements that were fed to the swept up old Pop II stars of the core. The engorged stars blew fast stellar winds that pushed the dust and gas away from the center and ignited open cluster Pop I star births. The lives of fattened old stars in the core were drastically shortened and chains of supernovas & hypernovas around the core quickly compressed the stars of the center into a massive black hole. When the shells of supernova's pass the black hole the shells become focused into equatorial jets that impact the equatorial dust and gas disk to eventually form spiral

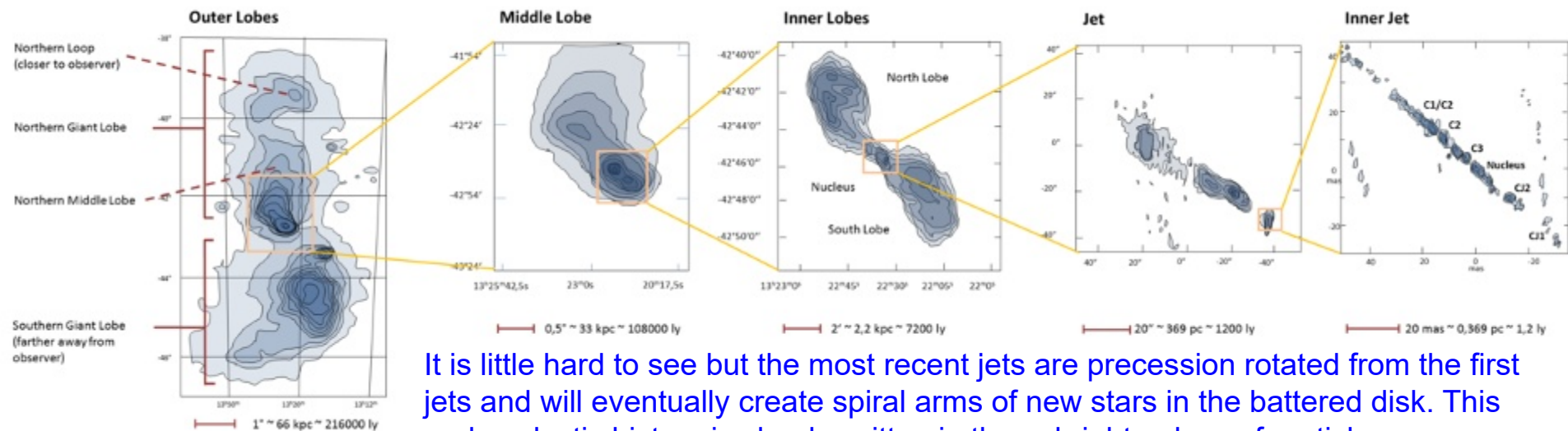
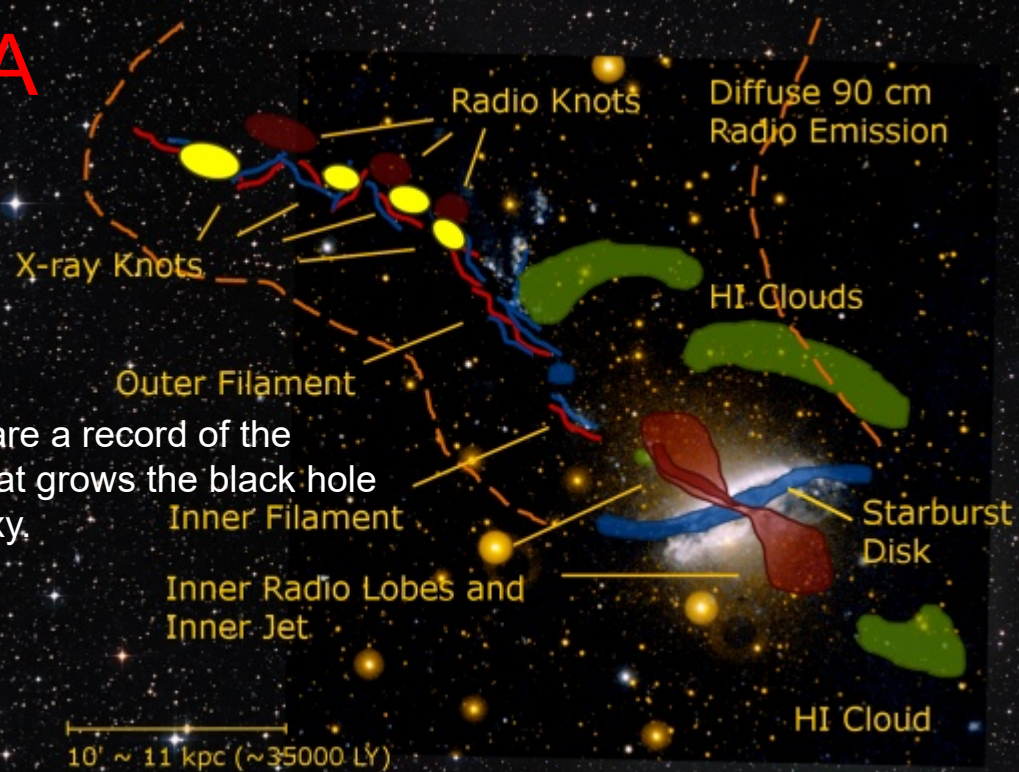
Not only did the cD jet pulse flatten to a disk during the time it punched its way out of the cD core it robbed the elliptical of its old stars to the point of sweeping up the many globular clusters that now orbit this new elliptical that is evolving into a lenticular galaxy. With each supernova near the core jets are made that push the older stars away from the new elliptical's core, out into the disk. Plasma jets cool with distance into hot giant molecular cloud complexes (GMC's) that collide with the now cold gas and dust of the disk to make new, more metallic, open cluster stars. GMC jets remove the gas and dust from around the core and move it into the disk.

The Jets of Centaurus A



The jets are a record of the events that grows the black hole and galaxy.

The equatorial jets punches through the gas disk and dust ring redistributed from the core. Pop I open cluster stars are born in the disk from the staccato of fast GMC's emitted from the new black hole.

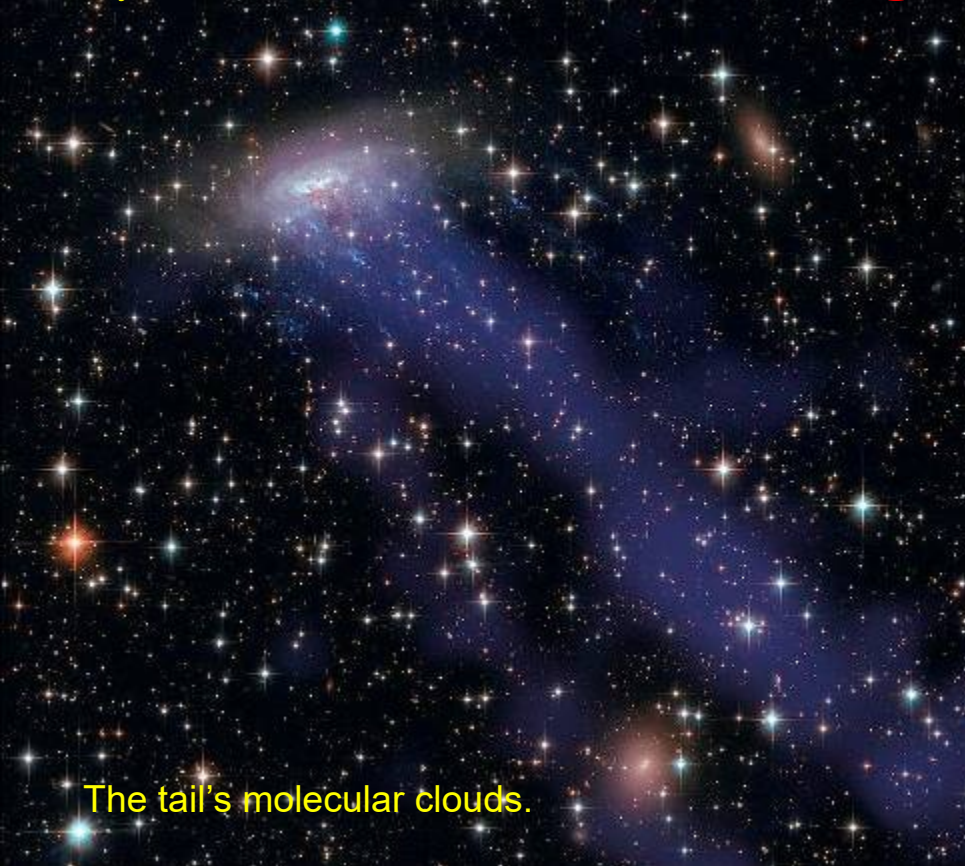


It is little hard to see but the most recent jets are precession rotated from the first jets and will eventually create spiral arms of new stars in the battered disk. This early galactic history is clearly written in these bright pulses of particles.

Runaway Galaxy or Jellyfish
Galaxy 12952512944 ISO 137-001

Losing Dark Stars

Trailing condensed stars
with antipodal jets and
various redshifting.



The tail's molecular clouds.



Red and blue shifted jets from lost stars.



ESO 137-001 is a barred spiral galaxy located in the cluster Abell 3627. As the galaxy moves out of the center of the cluster at 7 million kilometers per hour it is stripped by hot gas creating a 260 kly long tail by ram_pressure stripping. The plowed intergalactic gas in Abell 3627 is 100 million degrees Celsius (180 million degrees Fahrenheit) which helps star formation in the tails. The tail is massive enough to rotate with the red parts moving away and the blue parts coming at us. Condensed stars that are trailing the spiral have paired jets that are also red and blue shifted into red/orange pairs on the left, yellow/green in the middle, and blue/white pairing to the right, often centered on an active white spot. Lost condensed stars add mass to the dark halos around new and old galaxies.

The streams of hydrogen show up in hues of bright purple and bright hotspots of carbon dioxide emission show up as flares of orange-red.

Central cD galaxy of Centaurus Cluster NGC 4696 feeding on deorbiting clouds of gas and strings of stars ejects massive jets.

NGC
4696

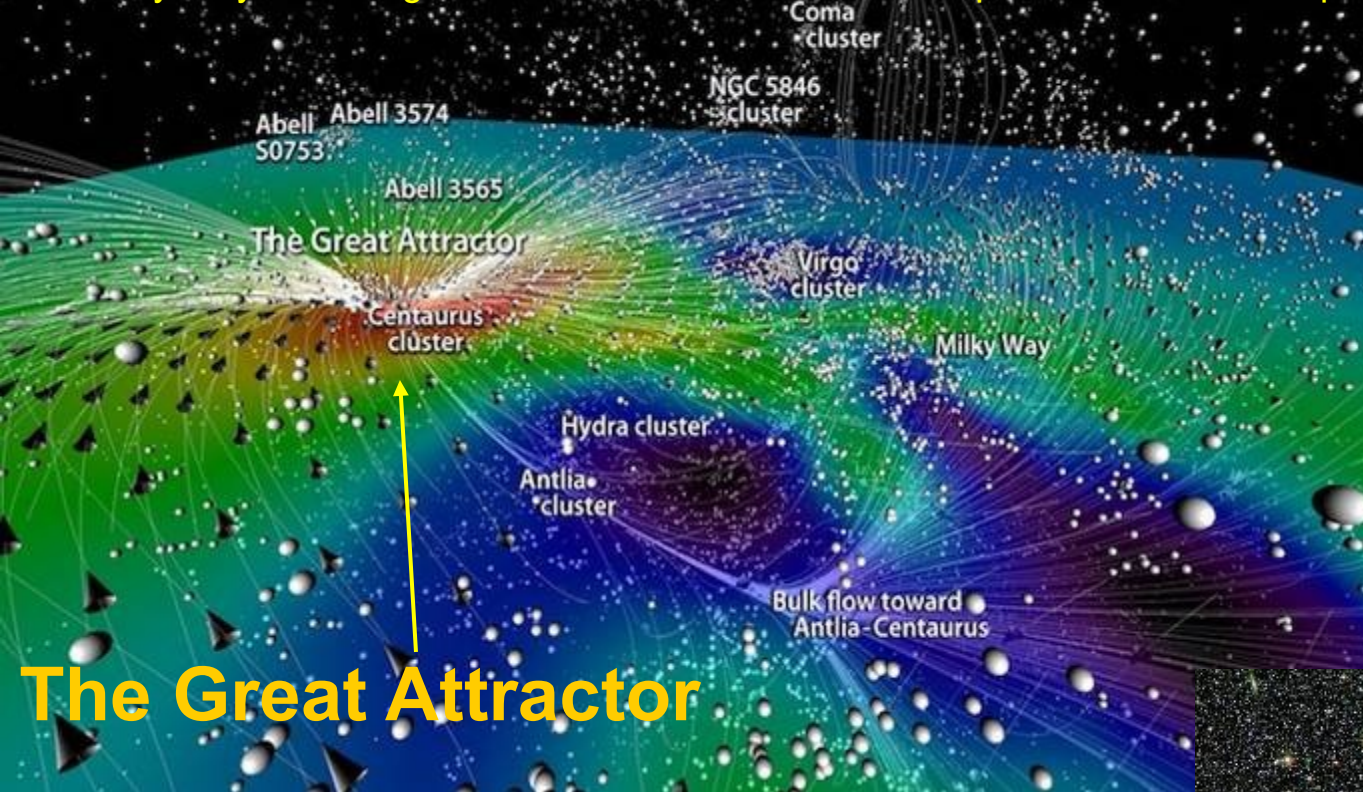
Old Pop II stars, dust, and gas of disrupted globular clusters or dwarf galaxy deorbited.

The supernovas and galaxy forming jets intermingle in the cD giant elliptical's core but the plasma pulses mostly miss the in falling material as it has orbital plane inclinations to the accretion disk. Retrograde in fall is the most powerful.

NGC 4696 is a cD giant elliptical galaxy ~145 Mly away. Central galaxy of the Centaurus Cluster it is the most massive and brightest of a large rich cluster of galaxies similar to M87 at the center of the Virgo Cluster. NGC 4696 is surrounded by many dwarf elliptical galaxies, such as Centaurus A, in the process of blowing their lenticular disks. There is a supermassive black hole at the center of the NGC 4696 that is deorbiting a string of open clusters or a dwarf galaxy. The nonaligned orbital plane of the deorbiting spiral of gas and stars insures high velocity impacts with the outer edges of the accretion disk. The impacted stars ignite supernovas that has the part of the blast that passed the cD black hole focused into myriad relativistic jets which tear out of the center to become dwarf and spiral galaxies.

X ray emitting hot plasma ejected by NGC 4696.

The Milky Way is moving toward The Great Attractor at a speed of 1.4 million mph.



The Great Attractor

Flow of local galactic supercluster towards the ultra massive Great Attractor of the Abell 3627 next to the Centaurus Supercluster.

This image covers a field of $0.5^\circ \times 0.5^\circ$ in the Southern constellation of Norma (The Level) and in the direction of the "Great Attractor". This region is at an angular distance of about 7° from the main plane of the Milky Way, i.e. less than 15 times the width of the image shown. In this color composite, the foreground stars in the Milky Way mostly appear as whitish spots (the "crosses" around some of the brighter stars are caused by reflections in the telescope optics). Many background galaxies are also seen. They form a huge cluster (Abell 3627) with a number of bright galaxies near the center — they stand out by their larger size and yellowish color. —————>



While the Centaurus Supercluster ~ 220 Mly is massive just beyond that is the more massive Abell 3627, a huge galactic cluster and the center of the nearby ~ 250 Mly Great Attractor. The Milky Way is in an outer region of gravitational inflow of local galactic material into the Great Attractor. Larger black holes make the larger elliptical galaxies by recycling deorbited dwarf and spiral galaxies. The bigger the meal the bigger the eruption.

IC 1101 Center of Massive Supercluster Abell 2029

Milky Way
Galaxy

Andromeda
Galaxy

M 87

Jet of cD makes
spiral galaxies.

Jet makes cD galaxies.

IC 1101

Central cD galaxy is 2 million ly across.

Abell 2029 has thousands of galaxies and dark matter of more than a hundred trillion Suns.

A gigantic cloud of very hot
gas.

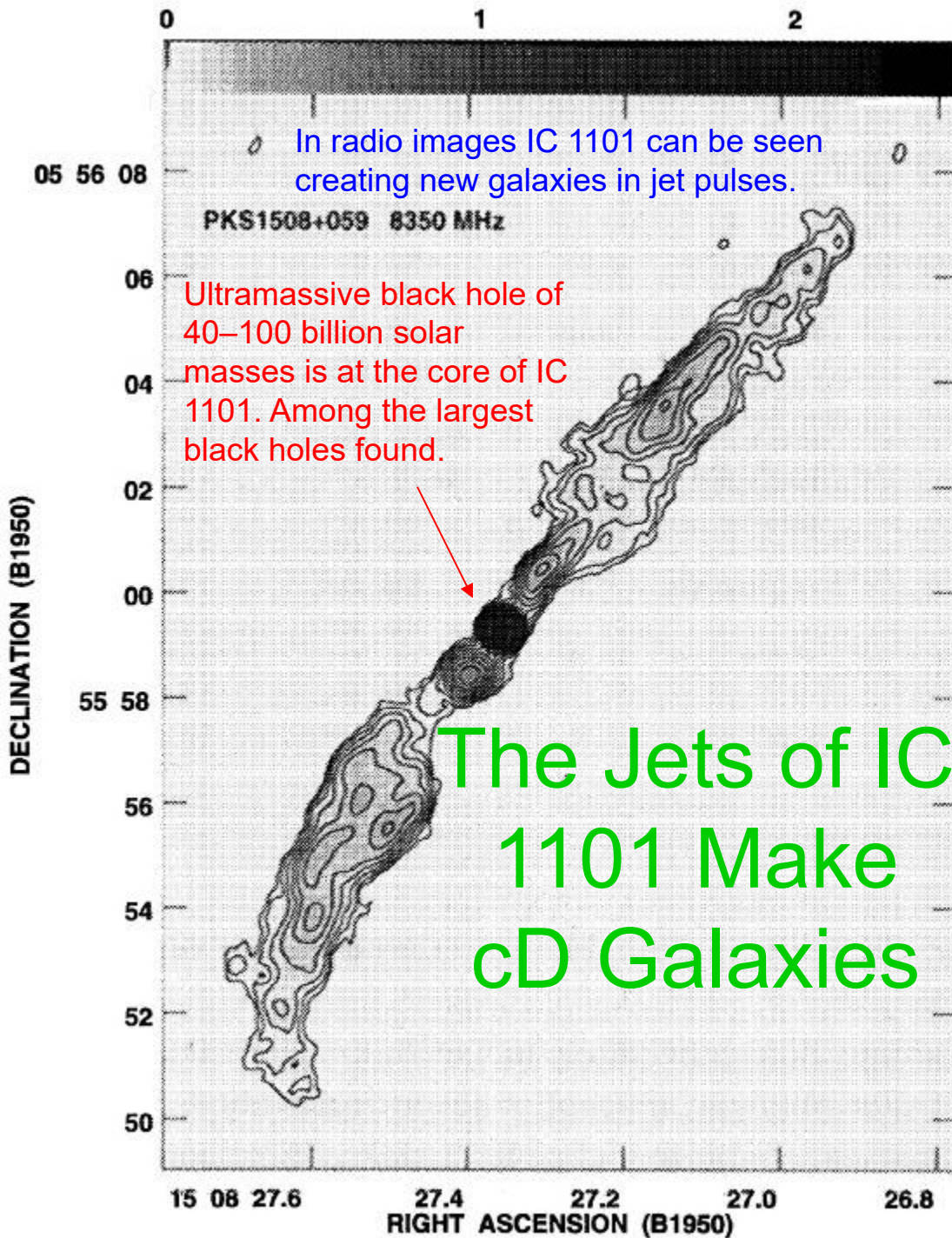
Black hole of forty billion solar
masses currently third largest.

CHANDRA X-RAY

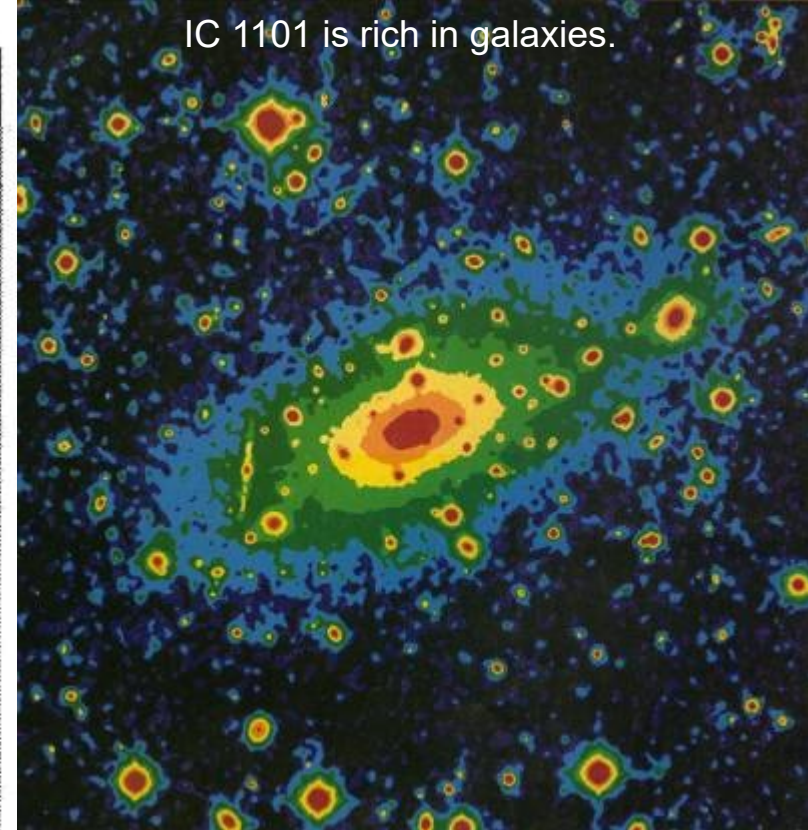
IC 1101 has metal-rich stars that
are >12 billion years old giving it a
golden yellow color.

DSS OPTICAL

Ultramassive black holes have bigger appetites and spit out cD galaxies like M87. ~1/2 of the mass of a collection of superclusters can be in one object. Abell 2029 is a large cluster of galaxies 1.027 Gly away in the constellation Virgo. A2029 is a Bautz–Morgan classification type I cluster due to its large central galaxy, IC 1101. Abell 2029 has a diameter of 5.8–8 million light-years. This type of galaxy is called a cD-type brightest cluster galaxy and may have grown to its large size by accreting nearby galaxies.



IC 1101 is rich in galaxies.

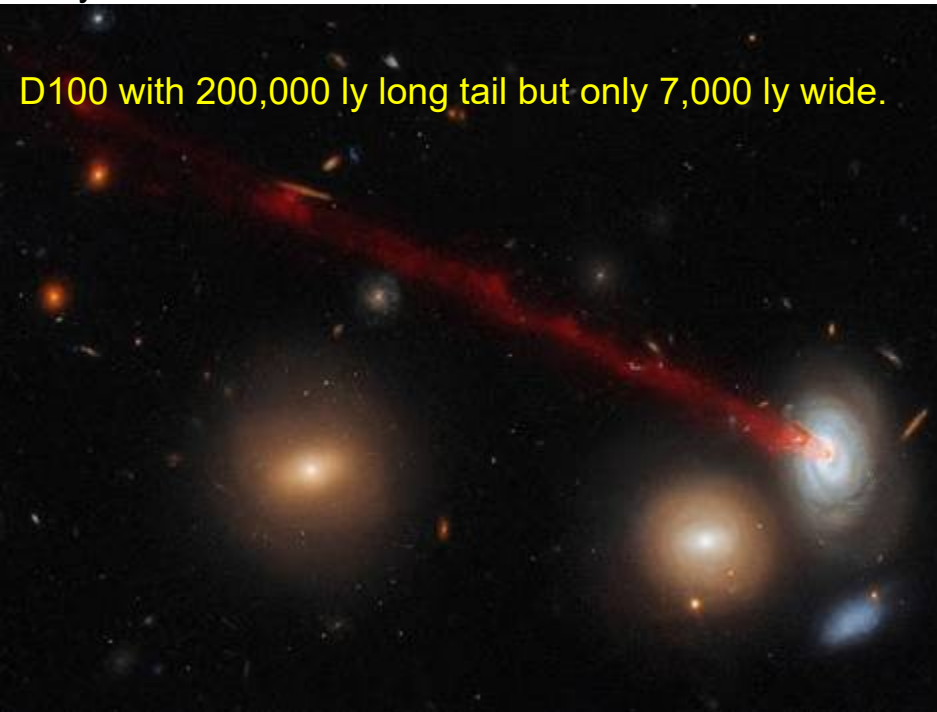


IC 1101 shines with the light output of a trillion suns or $\frac{1}{4}$ of total light output of Abell 2029 composed of thousands of galaxies. The false color image of the center of Abell 2029 shows the many galaxies near the ultramassive cD galaxy IC 1101. The older galaxies are falling back in to be recycled and the young cD galaxies are being ejected from the core of IC 1101. The very oldest stars are torn from IC 1101 but another generation of Pop II globular clusters is born from supernova's in the uniform gas of the new jets making giant elliptical galaxies.

Old Spirals Die, Reborn as New Giant Elliptical Galaxies.

A long streamer of hydrogen gas is being stripped from a spiral galaxy called D100 as it plunges toward the center of the Coma cluster (also known as Abell 1656), a large group of galaxies approximately 330 million light-years away in the northern constellation of Coma Berenices.

D100 with 200,000 ly long tail but only 7,000 ly wide.



Massive new giant elliptical galaxy in Abell 2670.



Old galaxies fall back in and when ground up by the accretion disk a spiral galaxies' worth of stars supernova. The very massive particle beams make new giant elliptical galaxies such as the one above. The also massive tail has enough gravity to independently rotate (redshifted velocity map below) with the knots also becoming galaxies.

Figure 2. (a) the H α flux map and (b) the velocity offset map from the H α of the whole field of view. The zoom-in areas for blue blobs of Figure 5 are indicated with boxes (5.a and 5.b) in the H α map. **Abell 2670 & tail's rotation.**

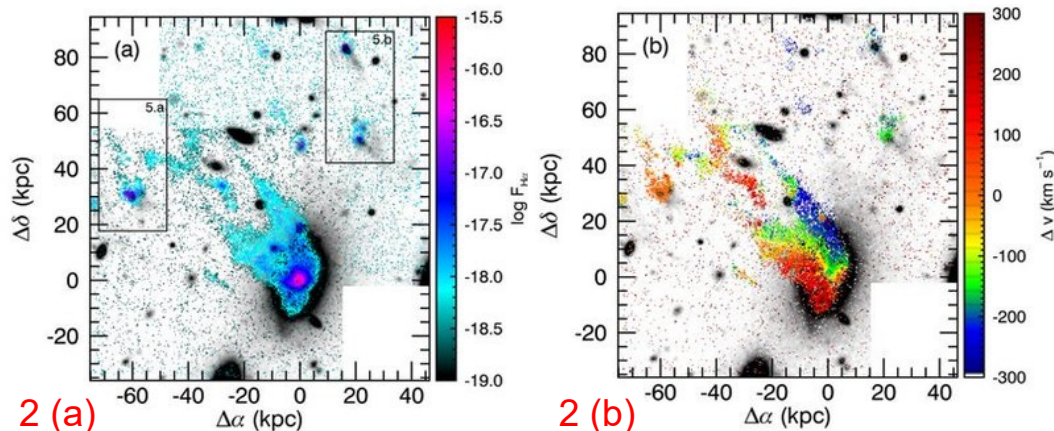


Figure 2 (b) presents a velocity map of the ionized gas using the H α emission line. There is a clear indication of rotation in the gas disk of the galaxy, and this velocity field extends into the dynamics of the ionised gas tails. The star-forming blobs also seem to well match the velocity field of the rotating gas disk and stripped gas. This behaviour was also reported in ESO137-001 (Fumagalli et al. 2014), a spiral galaxy experiencing extreme ram-pressure stripping, but this is the first time, to the authors' knowledge, that similar behaviour has been reported for an elliptical galaxy.

Abell 1689
HST ACS/WFC

F475W *g*
F625W *r*
F775W *i* + F850LP *z*

Abell 1689

1 million light-years
306 kiloparsecs 94''



elliptical
galaxies

globular
clusters

spiral
galaxies

Hot
gas

Abell 1689 is one of the biggest and most massive galaxy clusters known and acts as a gravitational lens, distorting the images of galaxies that lie behind it. It has the largest system of gravitational arcs ever found. Abell 1689 shows over 160,000 globular clusters, the largest population ever found. There is evidence of merging and gases in excess of 100 million degrees. The red galaxies and most of the blue galaxies are gravitationally focused by the mass of the cluster only ~2.5 Gly away. Galaxies older than Big Bang are yellow or red. The gravitationally focused images show that more distant red galaxies are so old they are nearly dead but there is also very distant new blue galaxies with them.



ULAS J1120+0641

Distant Ancient Galaxies

This artist's impression shows how ULAS J1120+0641, a very distant quasar powered by a black hole with a mass 2 billion times that of the sun, may have looked. This quasar is the most distant yet found and is also the brightest object yet discovered in the early universe.

Credit: ESO/M. Kornmesser

Most distant quasar has lived long enough to acquire a 2 billion solar mass central black hole.

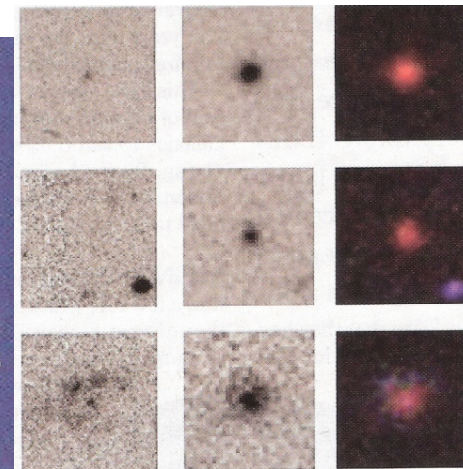
The oldest black hole found yet, officially known as ULAS J1120+0641, was born about 770 million years after the Big Bang that created our universe. (Scientists think the Big Bang occurred about 13.7 billion years ago.) The ancient age of this black hole actually poses some problems for astronomers. This brilliant enigma appears to be 2 billion times the mass of the sun. How black holes became so massive so soon after the Big Bang is difficult to explain.

This artist's impression shows two galaxies in the early universe. The brilliant explosion on the left is a gamma-ray burst. As the light from the burst passes through the two galaxies on the way to Earth (outside the frame to the right), some colors are absorbed by the cool gas in the galaxies, leaving characteristic dark lines in the spectrum. Careful study of these spectra has allowed astronomers to discover that these two galaxies are remarkably rich in heavier chemical elements.

Since quasars exhibit properties common to all active galaxies, the emissions from quasars can be readily compared to those of smaller active galaxies powered by smaller supermassive black holes. To create a luminosity of 1040 W, or Joules per second, (the typical brightness of a quasar), a supermassive black hole would have to consume the material equivalent of 10 stars per year. The brightest known quasars devour 1000 solar masses of material every year. The largest known is estimated to consume matter equivalent to 600 Earths per minute. Quasars 'turn on and off' depending on their surroundings, and since quasars cannot continue to feed at high rates for 10 billion years, after a quasar finishes accreting the surrounding gas and dust, it becomes an ordinary galaxy.

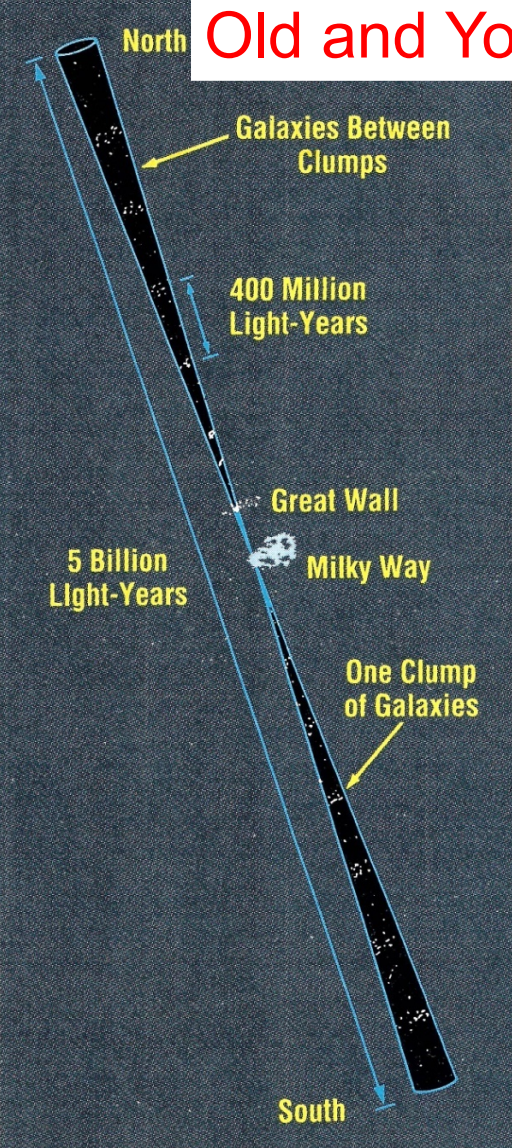
The more metal found in a galaxy the older the galaxy has to be. It takes generations of star birth and death to enrich a galaxy in heavy elements. Very large, very old galaxies were found at the distances astronomers thought would show young, no metal galaxies. Even at that distance small galaxies continue to be made by cD galaxies but their Pop II stars will be ancient. Do not be fooled by the young, extremely metal rich Pop I stars of these distant galaxies, their base Pop II stars will be very old.

GALACTIC MENAGERIE — A few of the galaxies imaged in a tiny patch of sky known as the Hubble Deep Field South. Left column shows the galaxies recorded in visible light; middle depicts them in the near-infrared, and right, in a combination of those wavelengths. Three old galaxies that lie far from Earth show up brightly in the near-infrared. The galaxy at bottom is nearly as large as the Milky Way yet hails from a time when the universe was only 2 billion years old.



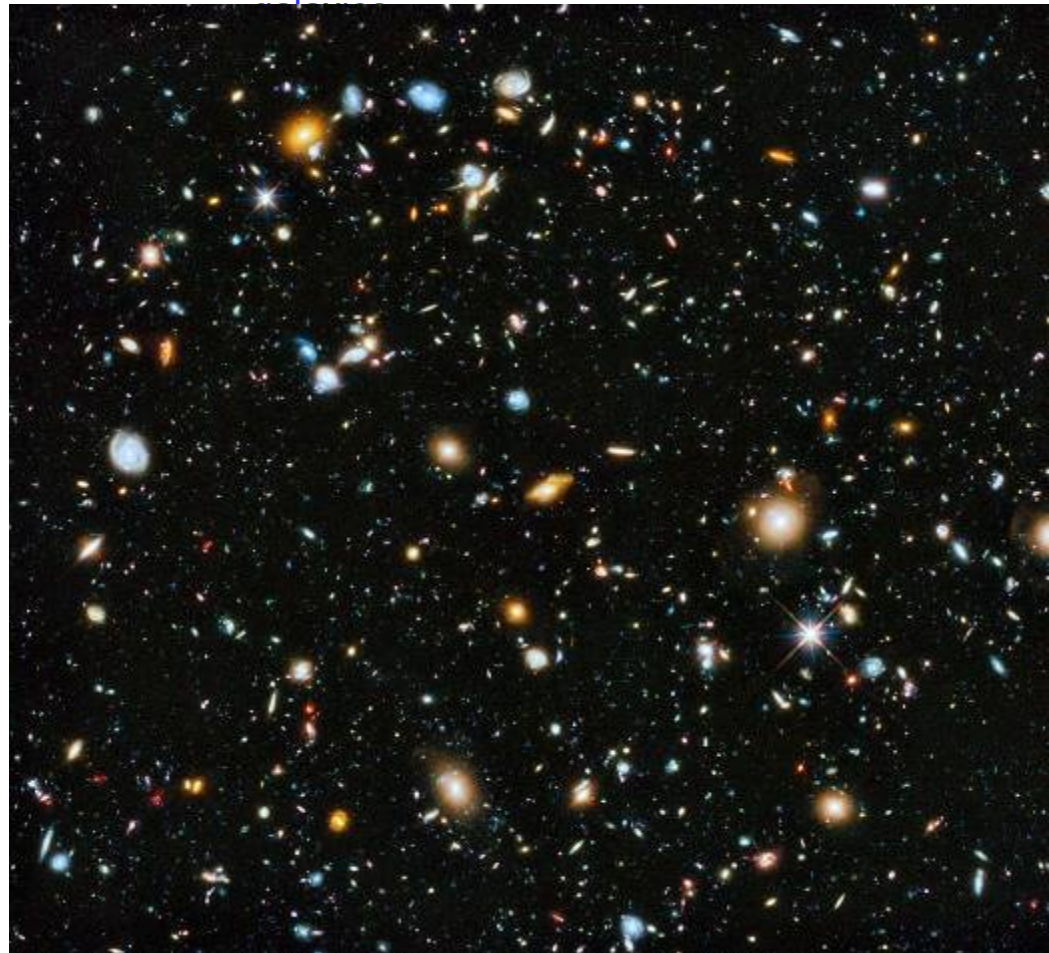
Old and Young Distant Galaxies

Hubble ultra-deep field, all objects are galaxies at various distances. More than 10,000 in this field are small red dying galaxies. They greatly outnumber the new blue very metallic



CLUMPS OF GALAXIES were seen at regular intervals over a distance of 5 billion light-years by astronomers looking in opposite directions in the sky.

All of the Pop II stars in this view are >20 byr. Older than our <13.8 byr stars. These distant ancient galaxies with huge black holes do make new blue Pop I stars strangely rich in metals. Not the hallmarks of new galaxies in nearly pristine hydrogen of Big Bang. We are looking back in time at a much older universe of what we will become, not at a young universe of what we were.



Each wall of superclusters of galaxies gets more ancient with distance. The lowest metal poor Pop III stars will not be found in this field even though they are supposed to be the first stars made. This is looking back in time billions of years and light years to an older universe of trillions of years of galactic evolution. It is clear that the brighter parts of the universe is expanding but galaxies age, stars die or dim. Eventually every dying galaxy reaches its gravitational apex and returns to our universe's center of gravity. These very ancient dark dying galaxies are difficult to see and may be so numerous they may outweigh all the galaxies found so far by ~70%.

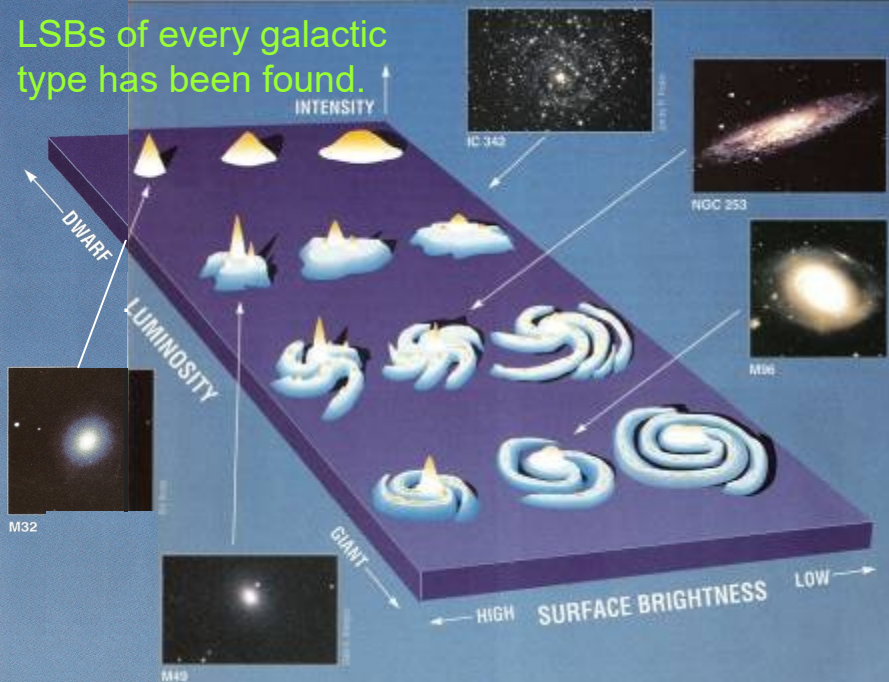
Dying dark galaxies are blacker than the background sky.

Low-surface-brightness (LSB) or dark galaxies.

Every class of galaxy has an ancient dark analog.

Nearby LSB Dying Galaxies

THREE SPIRAL GALAXIES show why low-surface-brightness galaxies escaped detection for so long. All of the conventional galaxy (*left*) is brighter than the background of the night sky. In the middle galaxy the central bulge and some of its surrounding spiral exceed the night sky's brightness; it might be detected as a galaxy. But almost all of the low-surface-brightness galaxy (*right*) has a surface brightness almost the same as that of the night sky. Against a night sky full of innumerable luminous objects, astronomers relying solely on optical techniques would probably miss this galaxy completely or perhaps mistake its barely visible central bulge for a faint star.



Better CCD's in the 90's found these dark LSB Malin galaxies.

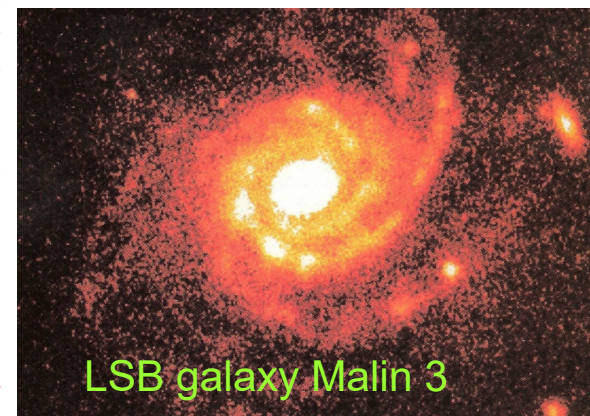
SEEING INTO THE HEARTS OF GALAXIES. Low surface brightness galaxies (along right-hand edge of diagram) run the gamut from dwarfs (upper right) to giant, Malin-type galaxies (lower right). Examples of galaxies may be found all along the spectrum.



MALINIZATION TECHNIQUE enables the imaging of low-surface-brightness galaxies. This one is known, appropriately enough, as Malin 2; it was discovered in 1990 and was the second such galaxy to be found. It is about 450 million light-years away and, with a scale length of 15 kiloparsecs, is about five times the size of the Milky Way.

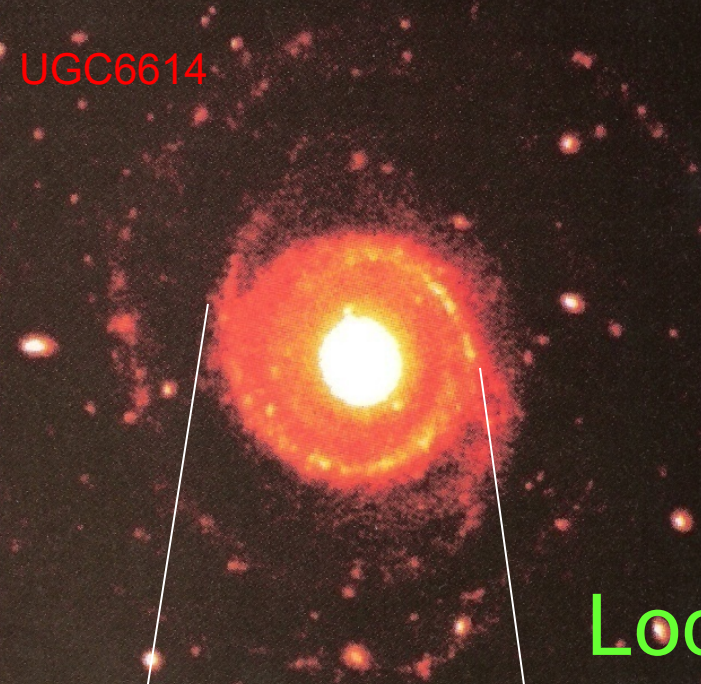
Malin's spiral galaxies are the largest discovered but are so ancient their stars have mostly died. The dark galaxies could be much more numerous than the bright newer galaxies as they are difficult to see. Dark galaxies can be bigger as they have already gravitationally captured surrounding galaxies.

A HUGE VAULT OF HIDDEN MASS, the giant galaxy Malin 3 nonetheless has a much lower density of stars than the Milky Way. The night sky of a planet in this galaxy would contain merely dozens of stars, not thousands.

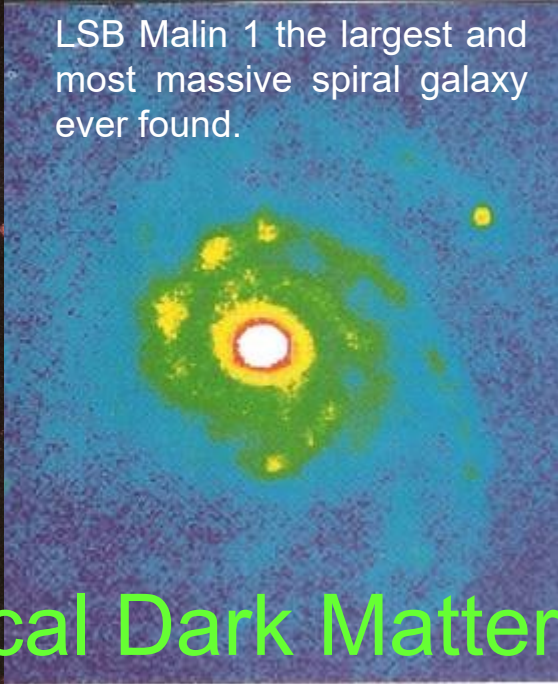


LSB galaxy Malin 3

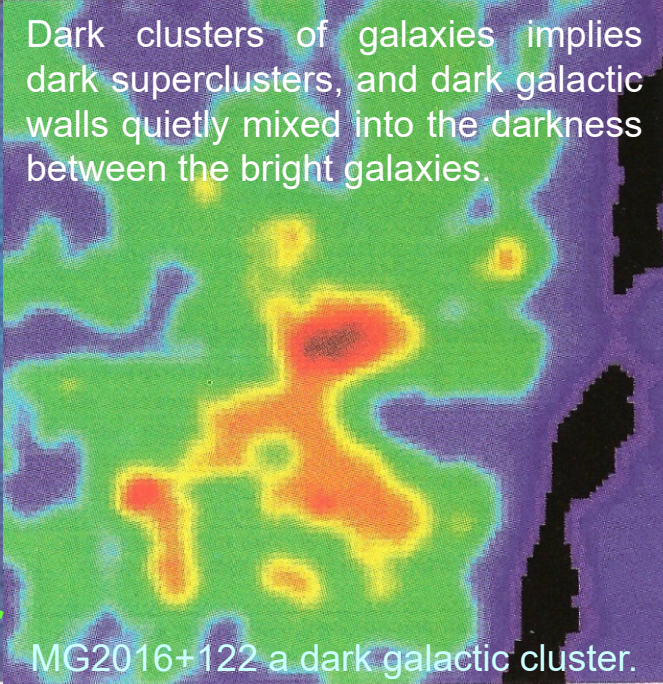
UGC6614



LSB Malin 1 the largest and most massive spiral galaxy ever found.

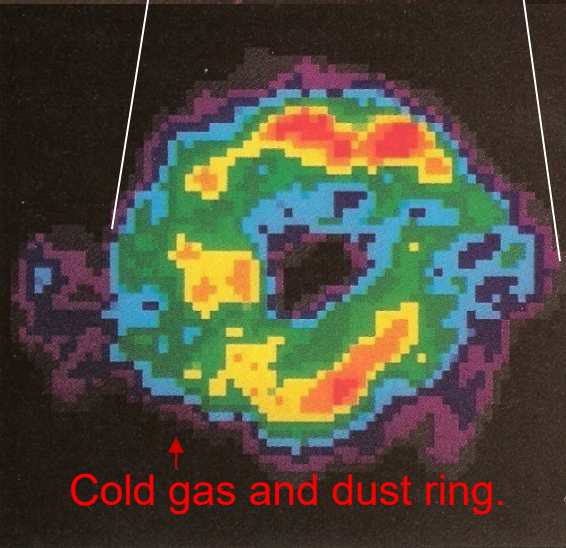


Dark clusters of galaxies implies dark superclusters, and dark galactic walls quietly mixed into the darkness between the bright galaxies.



Local Dark Matter

MG2016+122 a dark galactic cluster.



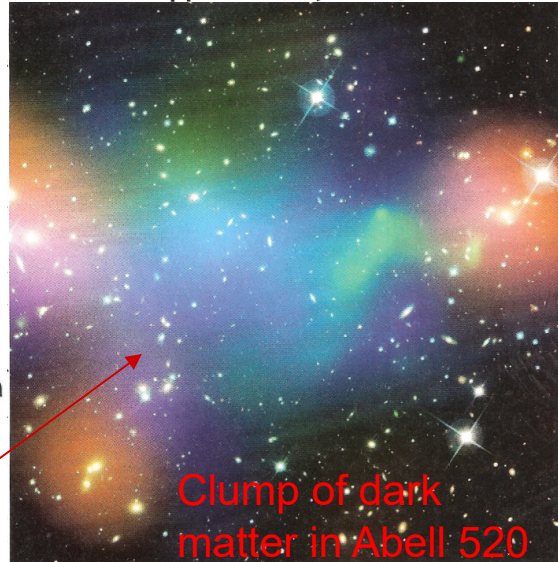
Cold gas and dust ring.

Very large dark galaxies that could be quintillions of years old have returned to our local space but even being nearby they are difficult to spot. The central black holes have become gargantuan but are feeding poorly on the surrounding mostly dead stars. Giant molecular cloud complexes are no longer being effectively made in the core so the cold ring of galactic gas is not impacted into making new very metal rich stars. Dark galaxies can associate in their own dark clusters and have vast great walls made of ancient dim galaxies.

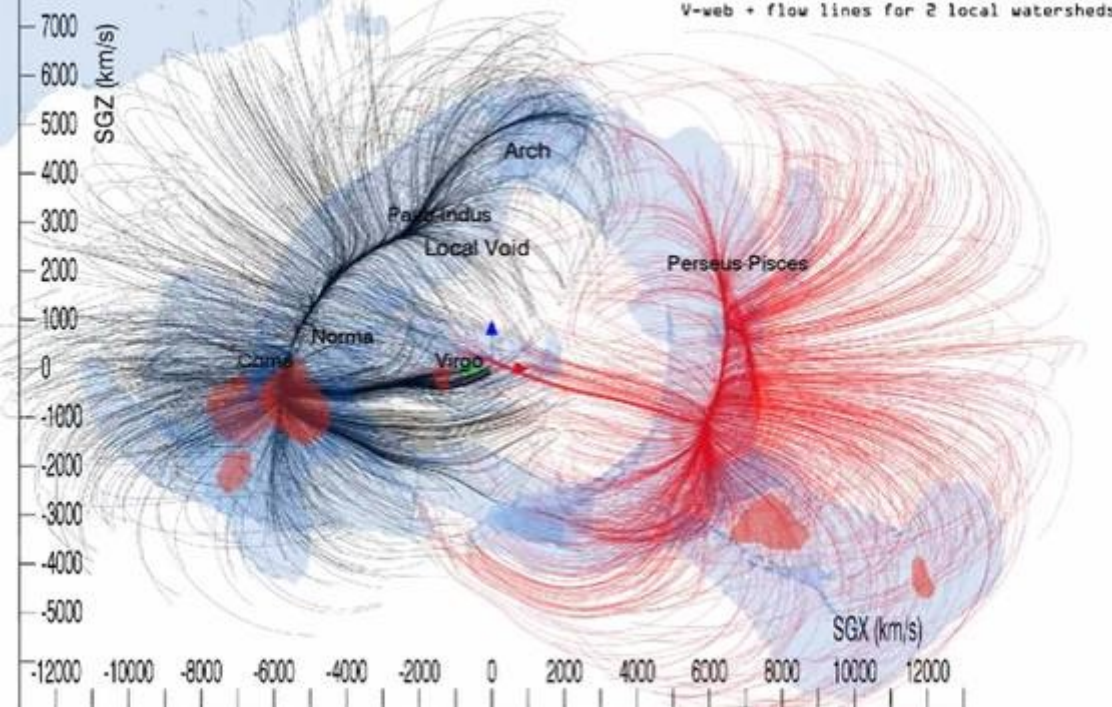
A false-color X-ray image of MG2016+112, a cluster of galaxies with a mass-to-light ratio some 30 times higher than average. A class of such "dark clusters" might harbor enough mass to reverse the universe's expansion. The field is approximately 10' square. ▲

Low surface brightness galaxies have compact disks in visible light and vast amounts of cold gas as seen in radio. Despite the gas few new stars have been born in UGC6614.

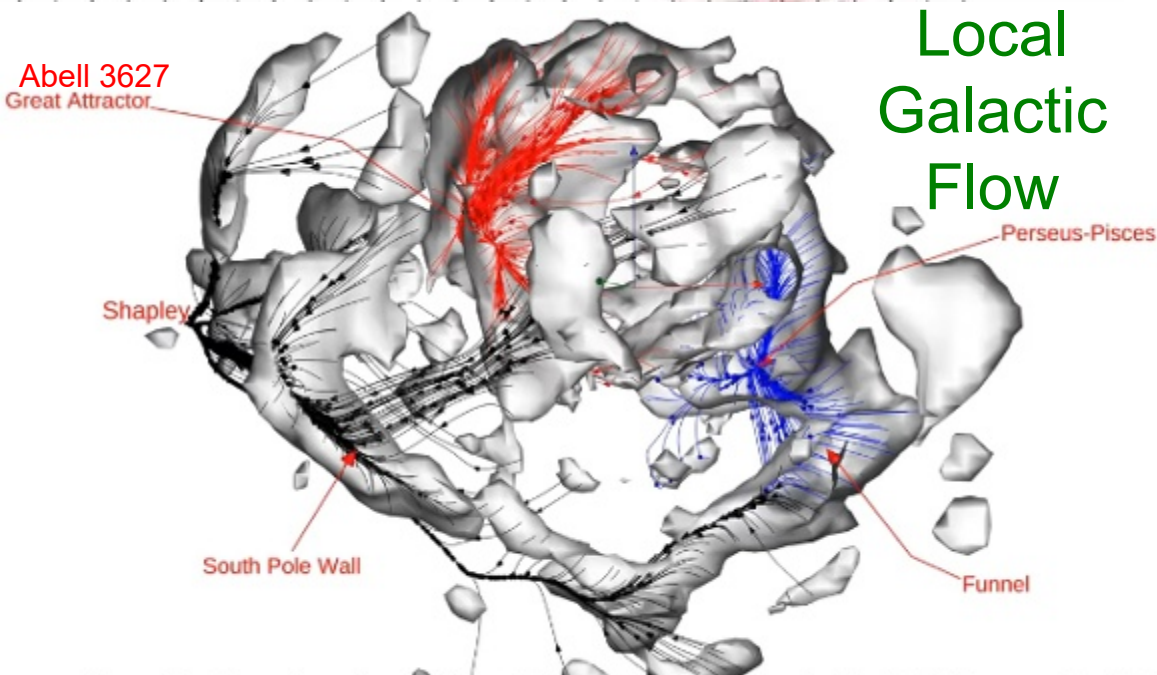
Dark matter discovery. This composite image of Abell 520 reveals a clump of dark matter in blue near the center, with starlight colored orange and hot gas in green. The relative absence of galaxies to accompany the dark matter throws current theories about the enigmatic material into question.



Clump of dark matter in Abell 520



The superclusters of galaxies pulled into Great Attractor has been called Laniakea, our local wall of superclusters (in blue in top figure but in red in bottom figure) but it is better described as being half of a 'smoke' ring with the Perseus-Pisces supercluster wall as the other half of the ring. Supermassive black holes have a tendency to be jugglers in that much of the jets that becomes galaxies eventually reach gravitational apexes just to fall back into the black hole's accretion disk and gets recycled. Dark matter stars and galaxies are swept up in the flows but many end up in decaying orbits that eventually feed into local central black holes.

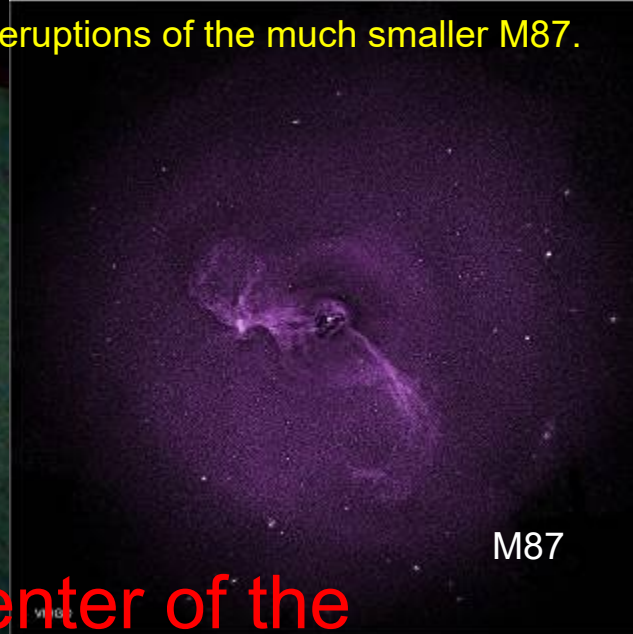


Locally, superclusters of galaxies are slowly flowing into three massive gravitational centers. The lightest is the Great Attractor (red) centered on Abell 3627 just past the the Centaurus Supercluster. The Perseus-Pisces Supercluster (blue) with NGC 1256 at the cluster's center has more mass with more galaxies but the Shapley Supercluster (black) is even more massive with even more galaxies. Walls of galaxies connect the vast collections of superclusters to make an enormous ball of related galactic groups. Their oldest Pop II stars will be just less than the date of Big Bang 13.8 bya. Of course this is not counting the much older dark matter stars.

... and transition from the observed (radial) peculiar velocities to the full 3D reconstructed velocity field visualized with streamlines seeded in the high density isosurface.

The eruptions of Perseus A verses the eruptions of the much smaller M87.

Perseus A at the Center of the Massive Perseus Supercluster



M87

The Perseus Cluster (Abell 426), located 237 million light-years away in the constellation of Perseus, contains thousands of galaxies immersed in a vast cloud of multi-million degree gas. At the cluster's center is the cluster's dominant galaxy NGC 1275 (also known as Perseus A). The surrounding orbiting galaxies are stripped of cold gas from the many focused jets, and unfocused nova's, supernovas, and hyper-novas that emanate from Perseus

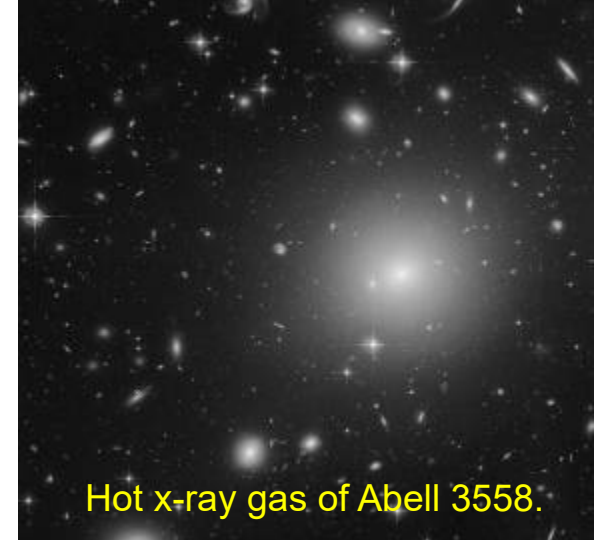


A's core. Only by staying in the jet can an ejected galaxy keep the gas and dust needed to make the new blue Pop I stars. It takes relativistic jets to escape these very large black holes but a jet's power, size and mass can vary considerably.

Shapley Supercluster

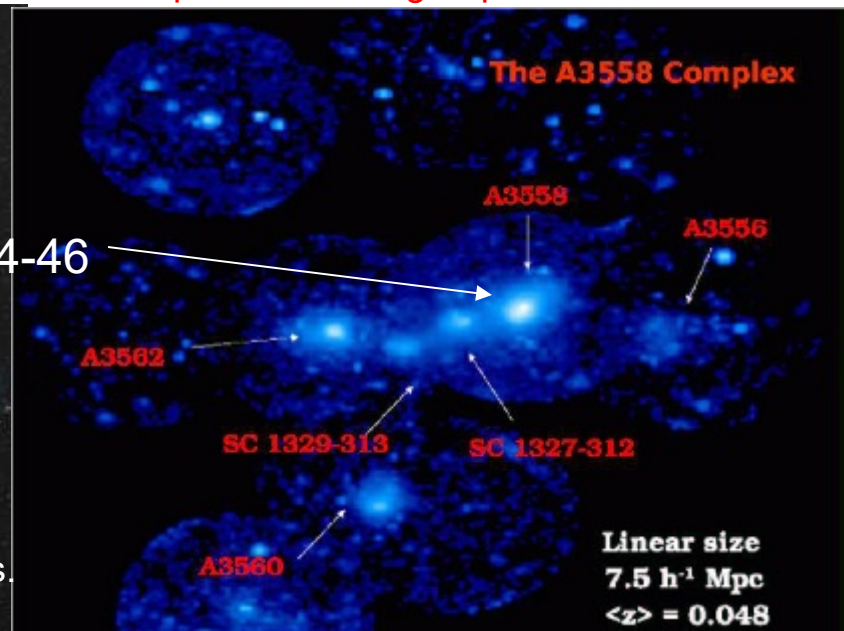
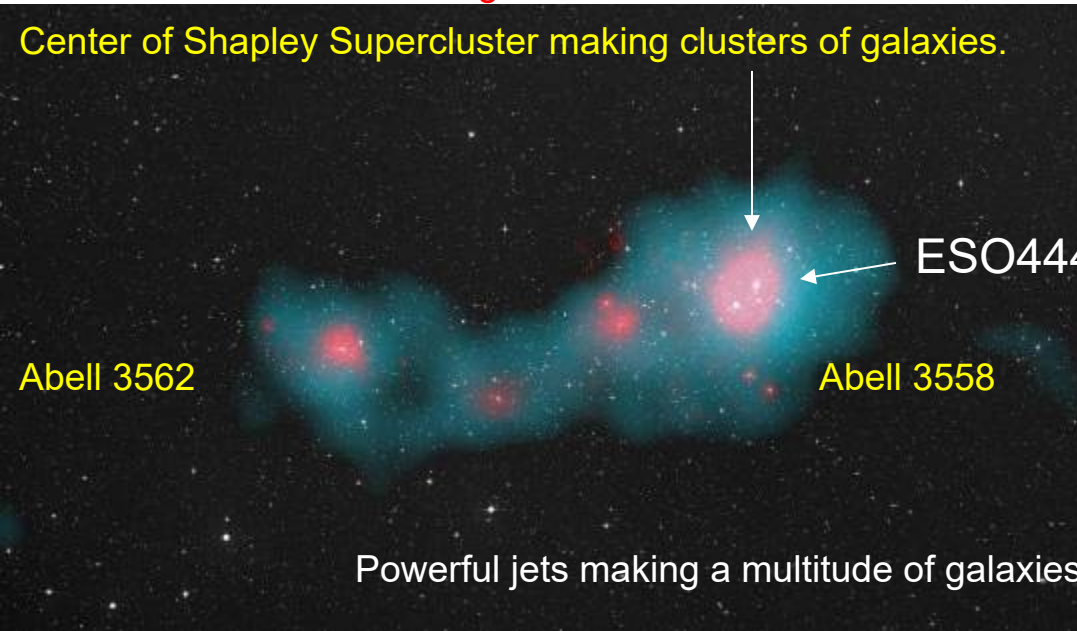


This extremely rich galaxy field is situated at a distance of 650 million light years in the constellation Centaurus. At the center of the image is an enormous elliptical galaxy (ESO444-46) with a diameter larger than 340,000 light years, part of the galaxy cluster Abell 3558 or the Shapley Concentration. With at least 25 clusters of galaxies it has the mass of approximately 10,000 Milky Way galaxies concentrated in a volume of space similar to our own Virgo Supercluster.

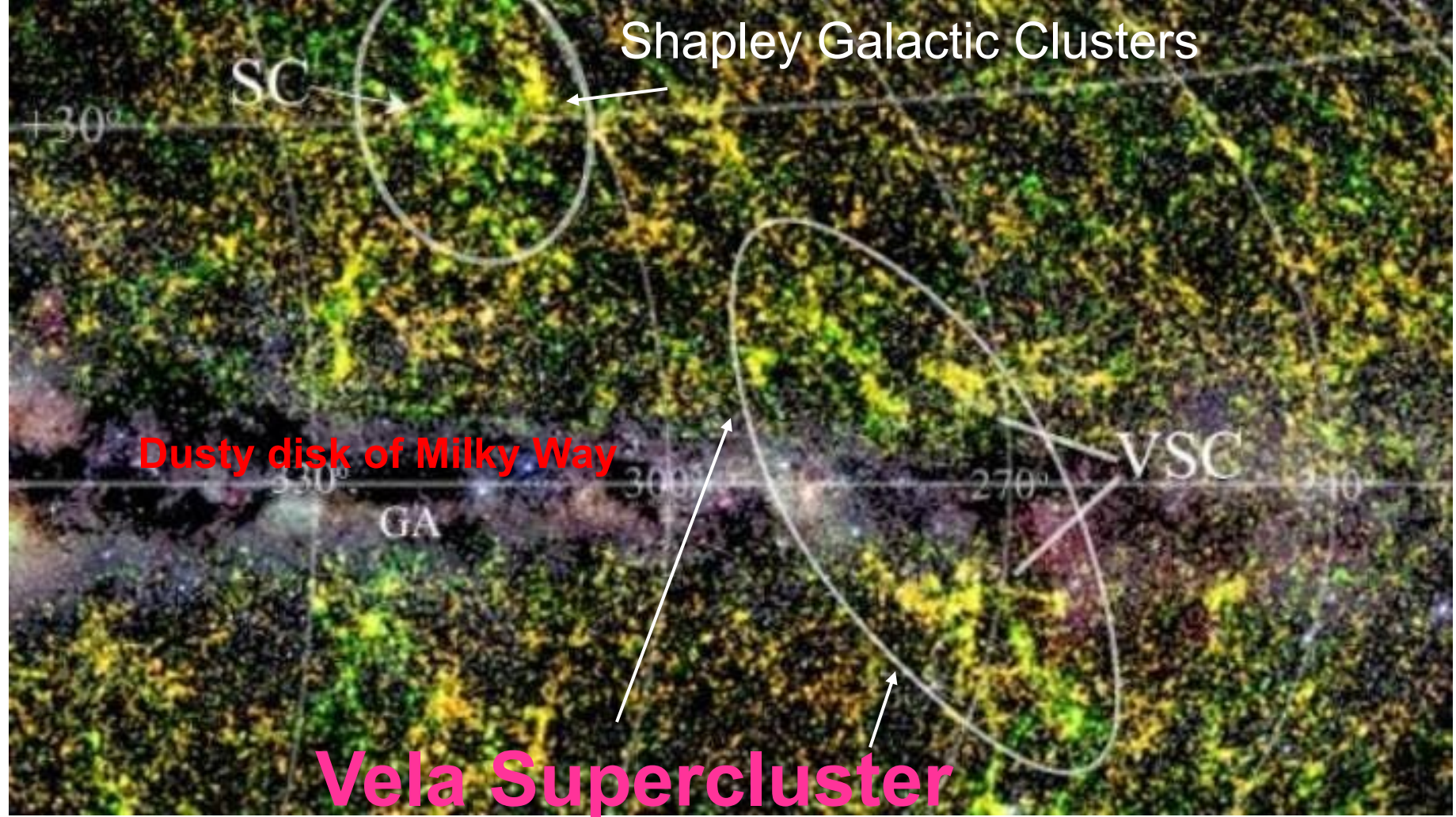


Hot x-ray gas of Abell 3558.

Shapley has more than 8,000 galaxies and a total mass of more than ten million billion times the mass of the Sun. This composite image of the core of the Shapley Supercluster combines the gas detected with Planck at large scales between the members of the supercluster (shown in blue) with that detected in X-rays within the galaxy clusters of Shapley using the Rosat satellite (pink), as well as a view of its rich population of galaxies as observed at visible wavelengths in the Digitised Sky Survey. The largest pink blobs of X-rays identify the two galaxy clusters Abell 3558 on the right and Abell 3562 on the left, as well as a couple of smaller groups between them.



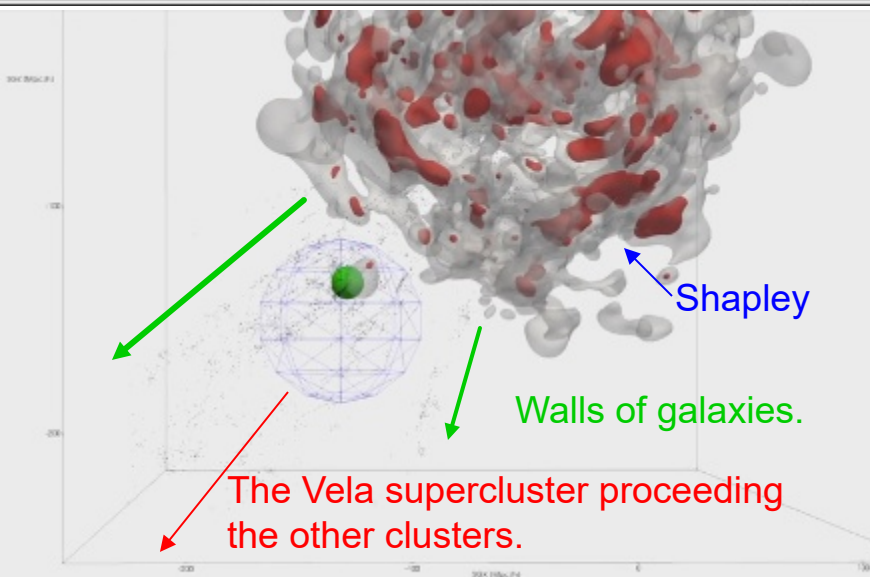
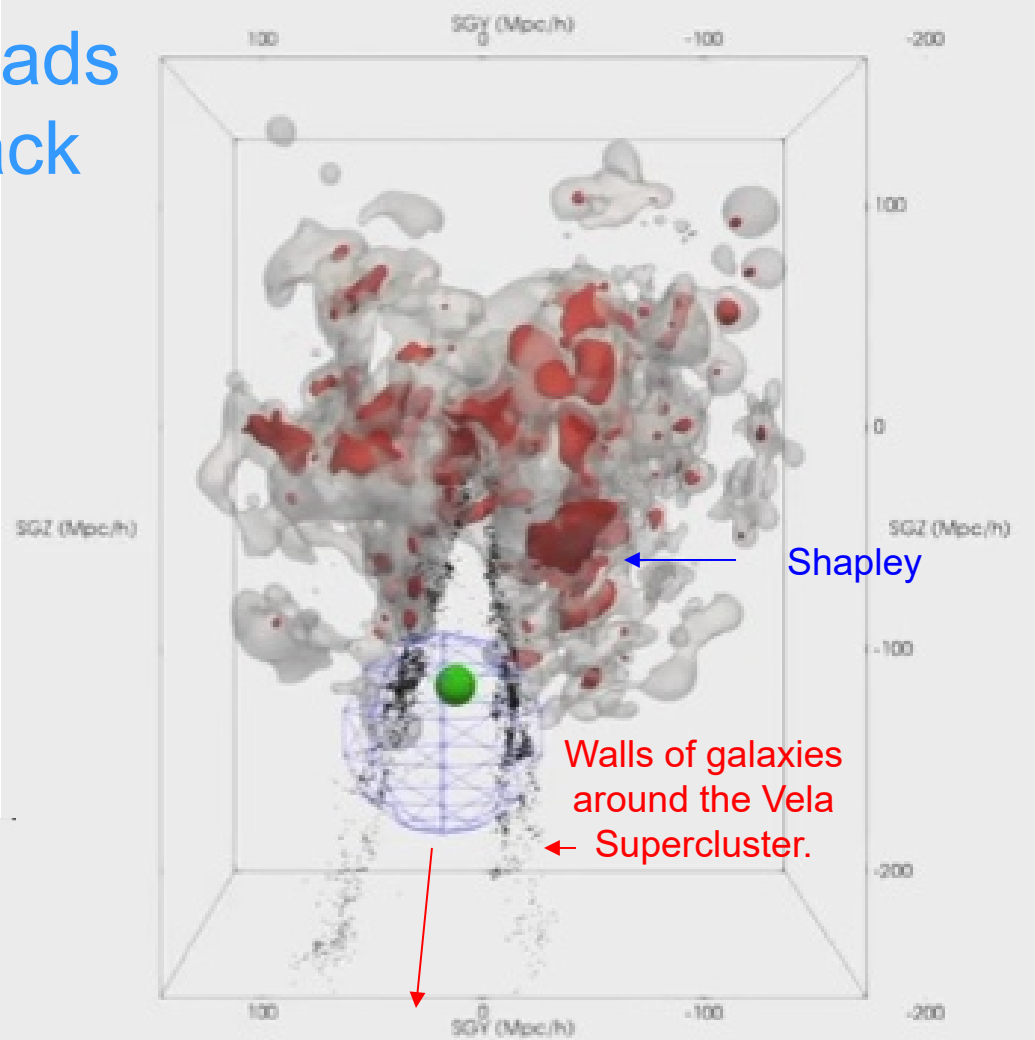
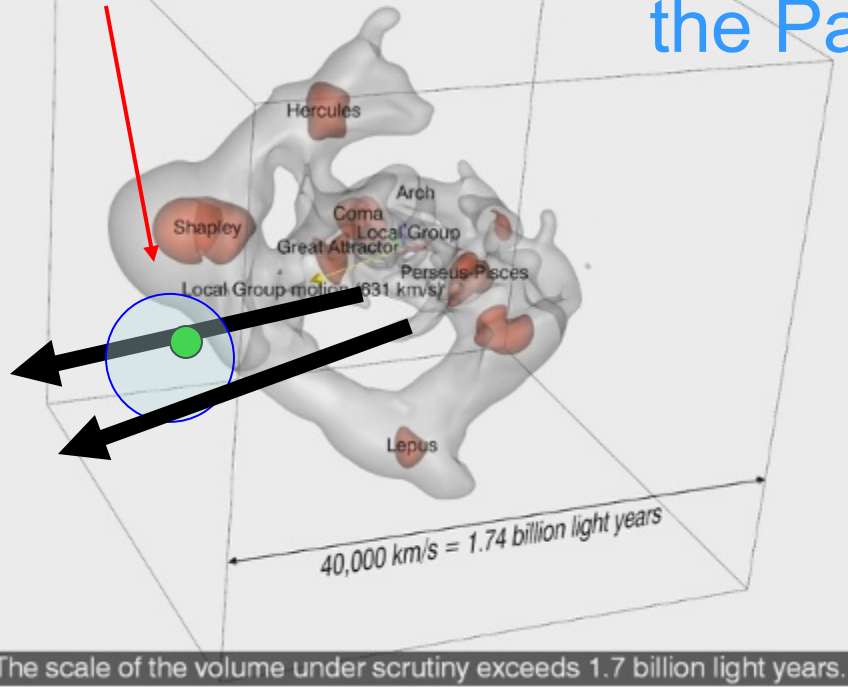
Powerful jets making a multitude of galaxies.



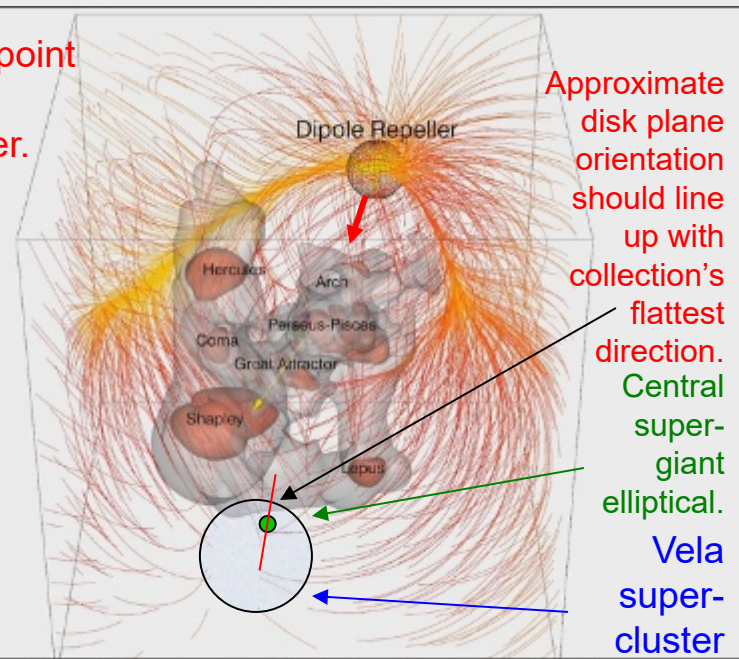
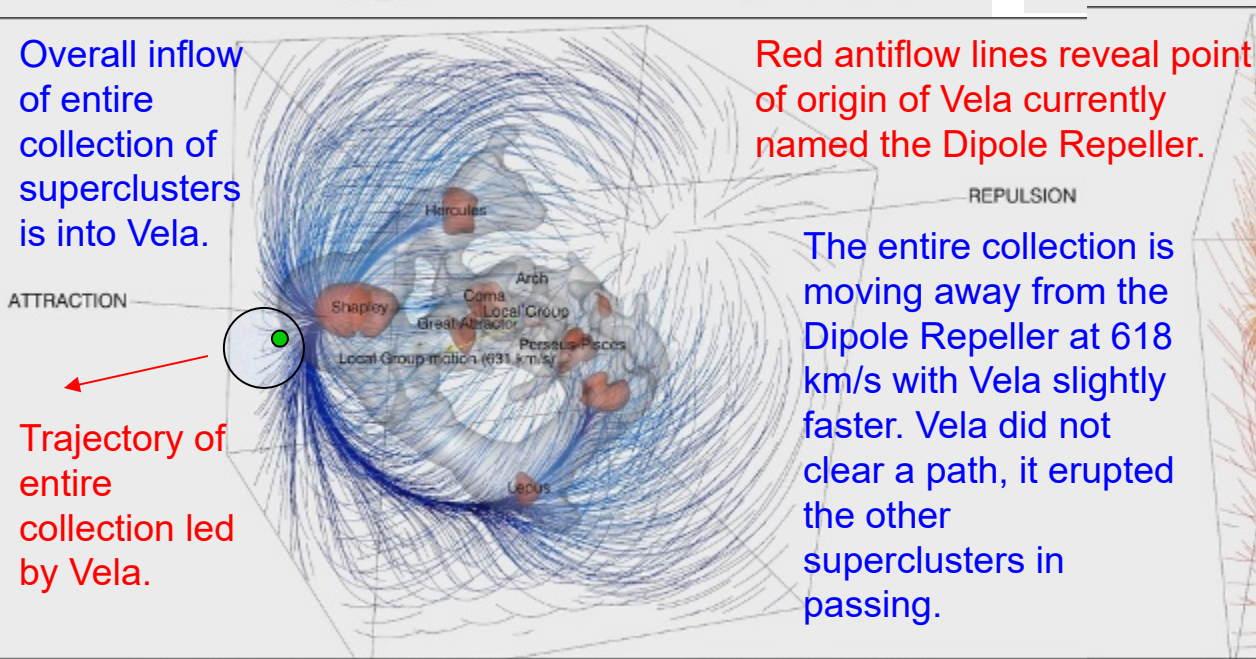
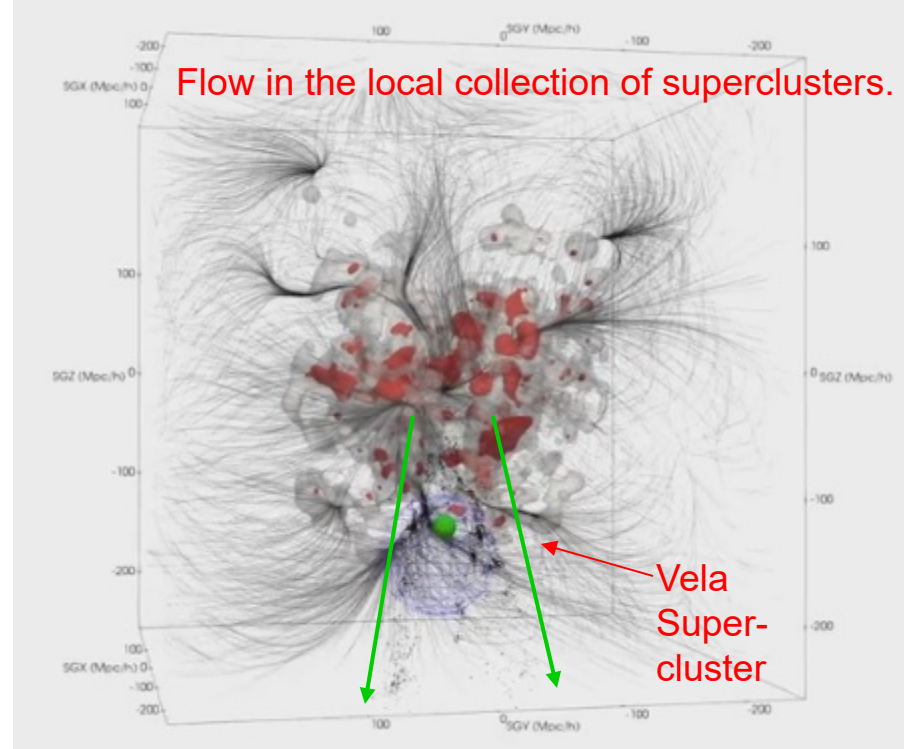
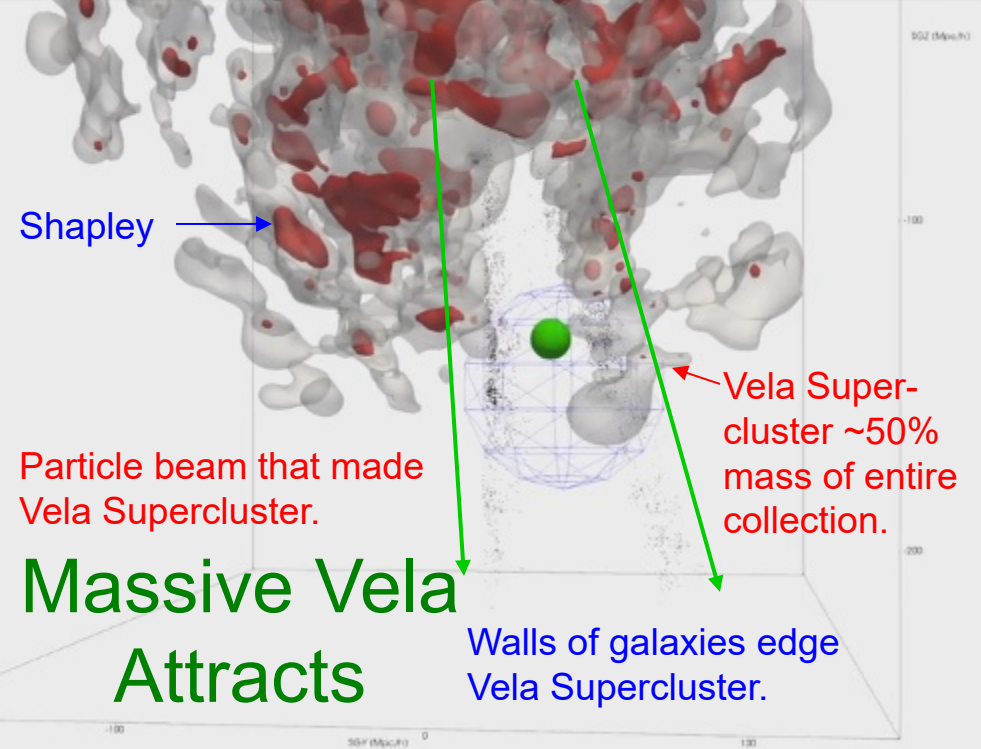
The **Vela Supercluster (Vela SCI, VSCL)** is a massive galactic supercluster only 870 Mly away, behind the disk of our galaxy making it hard to image. It is the largest local supercluster structure found covering about 25×20 degrees of the sky. It has two walls: a broad main wall and a secondary merging wall. The combined dimensions of the walls are 385 million and 300 million light years, respectively. It may have 100,000 galaxies and have more than 50% of the mass of the entire bubble of local superclusters. This supercluster is close to the direction trajectory of the Milky Way's movement with respect to the cosmic microwave background (+CMB) currently called the dark flow. While the nearby Shapley Supercluster and the Great Attractor at the center of the Laniakea Supercluster contribute attractive velocities, the more distant Vela Supercluster is estimated to contribute at least 50 km/s (180,000 km/hr) of this bulk movement.

The fast Vela Supercluster and faster moving walls.

Vela Leads the Pack

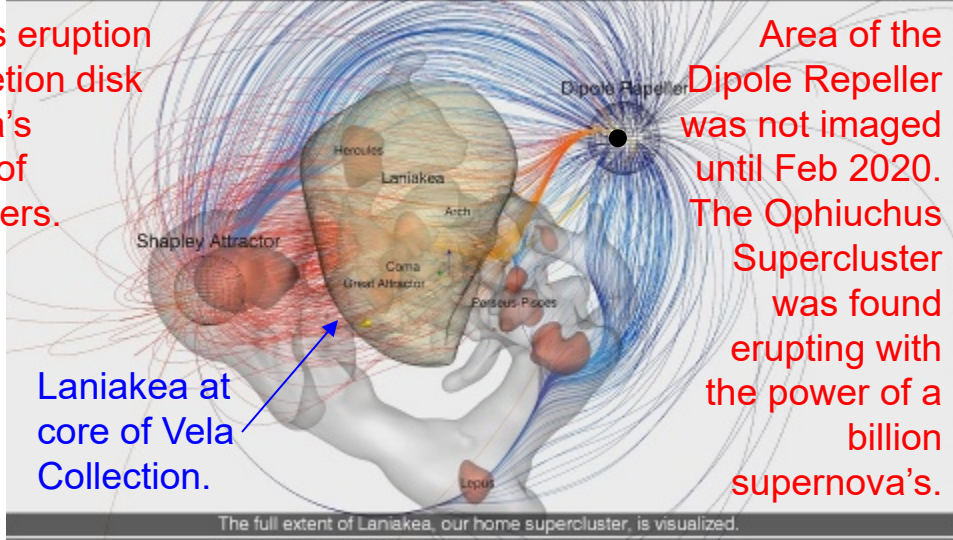
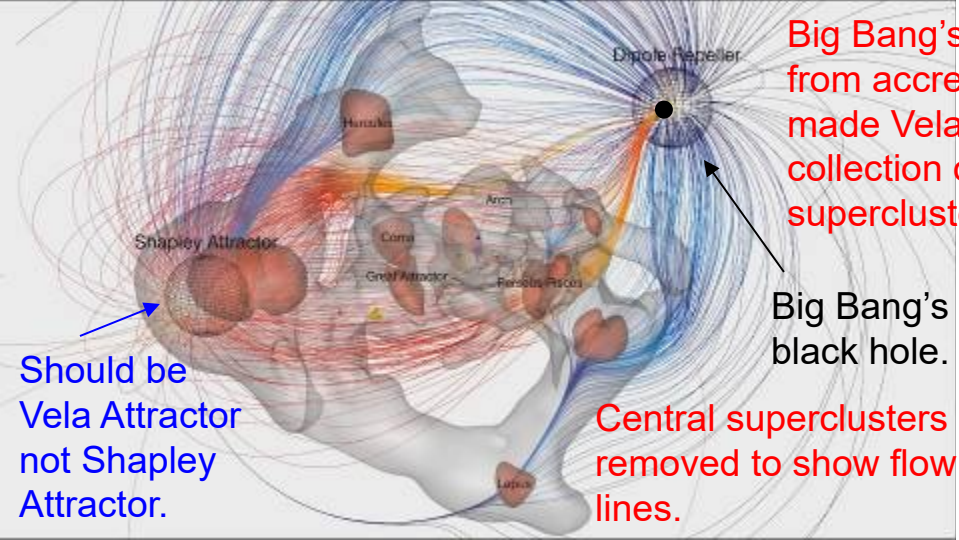


The Vela Supercluster is faster than the rest of the collection of local superclusters going only 618 km/s but Vela is outlined by two even faster walls that seem to separate it from the rest of the cluster. As it passed through our part of space the core of the Vela Supercluster ate small galactic clusters to spit out each of the local collection's largest giant elliptical galaxies entrained with Vela's ~13.8 byr old stars, gas, and even older dark matter.

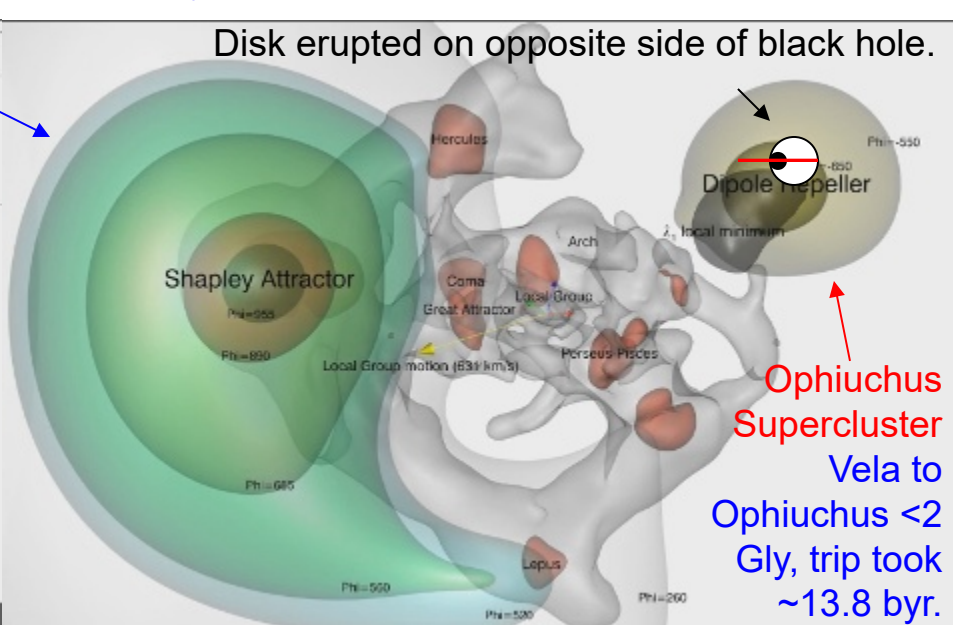
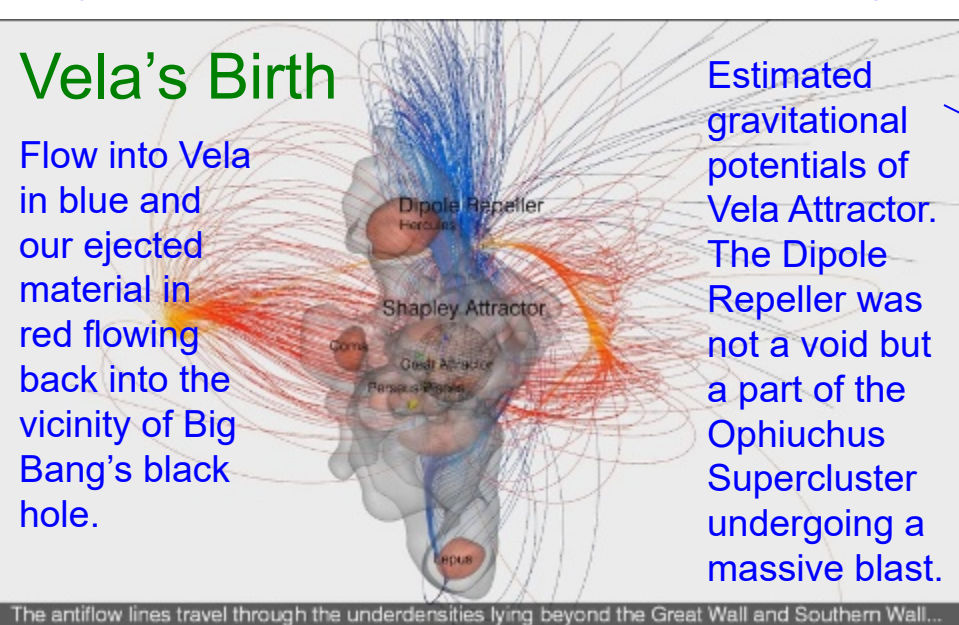


Mass elements travel a typical distance of roughly 1000 km/s along flow lines.

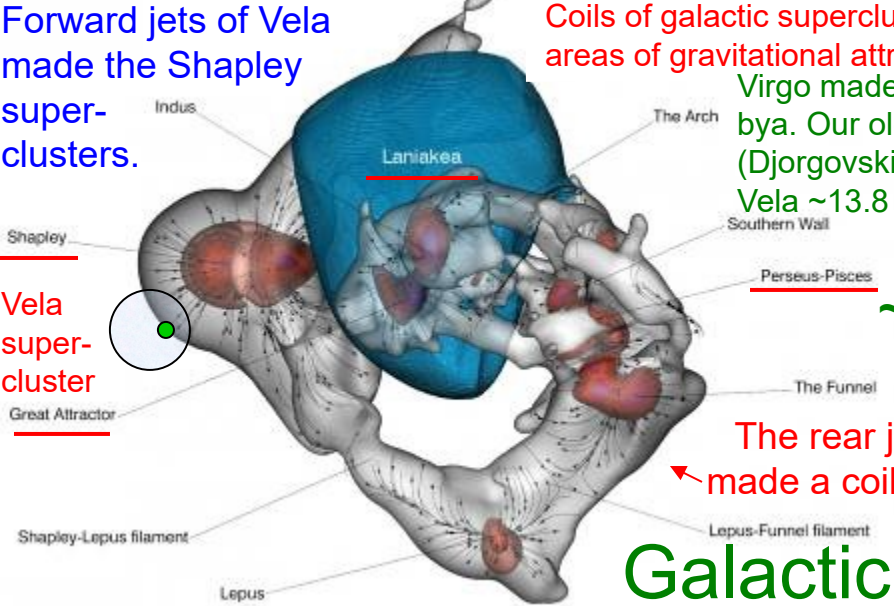
For convenience, the region of the Dipole Repeller is materialized by a sphere...



Vela Supercluster was not yet discovered in 2017 when these figures were made so they call it the Shapley Attractor. The currently called Dipole Repeller is the spot from which galaxies and gas apparently originate to eventually fall into Vela's collection of superclusters. Now thought of as a void with little gravity to hold it's materials that then fall into our higher gravity mostly along a N to S plane while our ejected material falls back to the Dipole Repeller along galactic voids in the E & W directions. The material from just inside the parallel limit of the jet from the Ophiuchus Supercluster is still falling into the Shapley and Vela Superclusters and the collection.



Forward jets of Vela made the Shapley super-clusters.

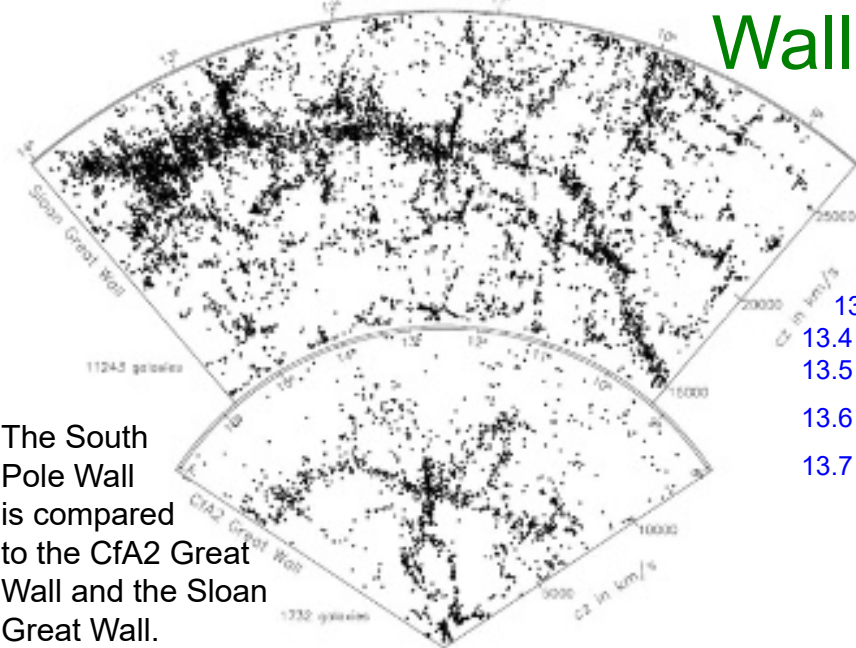


Coils of galactic supercluster walls tie areas of gravitational attraction. Virgo made its stars ~12 – 10 bya. Our oldest globulars (Djorgovski 1) were made in Vela ~13.8 – 12 bya.

Virgo ~12 Byr

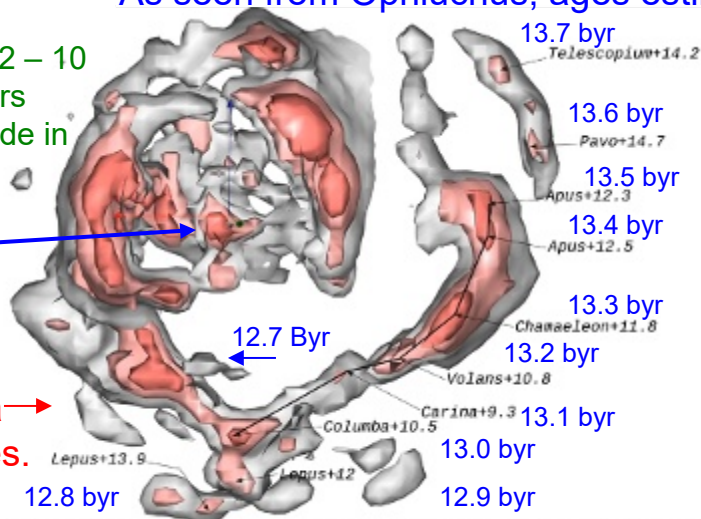
The rear jets of Vela → made a coil of galaxies.

Galactic Walls



The South Pole Wall is compared to the CfA2 Great Wall and the Sloan Great Wall.

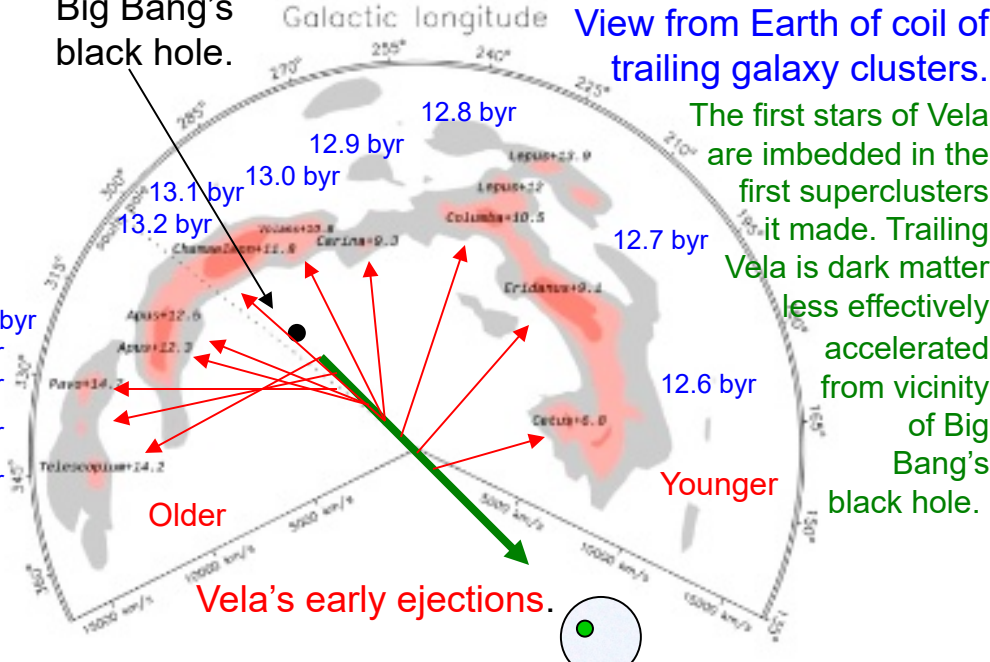
As seen from Ophiuchus, ages estimated.



The wall has its heart in the Chamaeleon sector and connects the Lepus and Apus overdensities spanning an overall ~17,000 km/s or 220 Mpc

Big Bang's black hole.

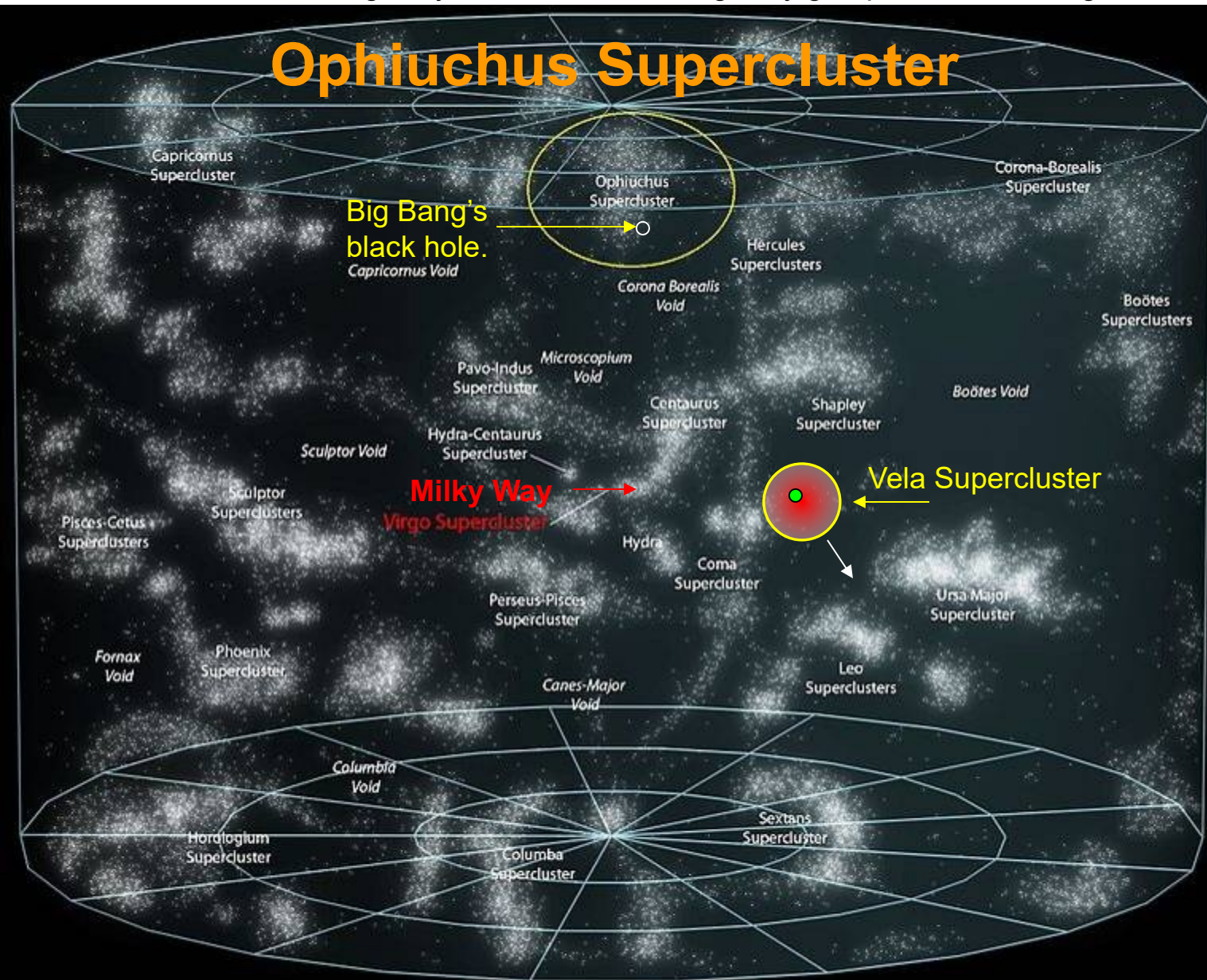
View from Earth of coil of trailing galaxy clusters.



Vela's early ejections.

Vela's jets were not as fast or as powerful as the Big Bang's jets so even though the Shapley jets were forward Vela outpaced it. To the rear the sequence of Vela's cD making jets and the rapid growth of its central black hole is easier to see. We are in the KBC Void or the Local Hole of ~2 Gly diameter, possibly cleared by Big Bang.

Ophiuchus Supercluster is a nearby galaxy supercluster in the constellation Ophiuchus. The supercluster forms the far wall of the Ophiuchus Void; it may also be connected in a filament, with the Pavo-Indus-Telescopium Supercluster and the Hercules Supercluster. This supercluster is centered on the cD cluster Ophiuchus Cluster, and has at least two more galaxy clusters, four more galaxy groups, several field galaxies, as members.



I propose that the source of all Big Bang events is located in the Ophiuchus Supercluster ~390 Mly away and it created the Vela Supercluster in a pulse ~13.8 Bya. Opposite Ophiuchus will be a grouping similar to Vela's Collection also ~13.8 Bya. Massive Vela gravitationally dragged large amounts of dark matter away from Ophiuchus and redistributed the dead stars along with Vela's new stars of <13.8 Byr into each cD galaxy it made. In turn dead stars and Vela's oldest stars are incorporated into the dwarf and spiral galaxies ejected from cD galaxies along with the globular clusters made in each cD galaxy. We are the inheritors of old stars born in bigger, older, and gasser galaxies.

In February 2020, astronomers reported that a 100 million light-year wide cavity in the Ophiuchus Supercluster originated from the ejection of ~270 million solar masses from a nearby supermassive black hole, the largest known explosion in the Universe since the Big Bang. The explosion is about five times greater than the previous record holder, observed in the galaxy cluster MS 0735.6+7421, and hundreds to thousands of times greater than typical clusters. The Ophiuchus galaxy is 390 million light-years away, and the image is 2.8 million light-years across. WISEA J171227.81-232210.7 - a black hole several billion (trillion?) times as massive as our Sun blew the energetic equivalent of a billion super-nova explosions, unleashed in a torrent that probably lasted 100 million years.

I propose to name this the Cardinal Creator for it is the universe's central coordinate. Nadir of dying galaxies that long ago reached their gravitational apex and have returned to the bottom of the gravitational well. The universe's biggest black hole will be discovered here having a small snack of very old dwarf galaxies. Our collection also took a while to make as it took a supercluster of dying galaxies to be consumed by deorbiting into the gargantuan accretion disk. The 2.7⁰ Big Bang radiation was not from a momentary event

Big Bang's black hole.

The death spirals of nearly dead galaxies.

WISEA J171227.81-232210.7

Cardinal Creator

Hole is wide enough for ten Milky Ways.

Mostly hydrogen gas with dark matter later becomes globular clusters.



At 13.8 Gly thin hydrogen gas heated to 6000° reflects what we see as the 2.7° K radiation

Ophiuchus Supercluster
Vela Supercluster

COBE's
microwave
background
radiation map
minus Milky Way's
contributions.

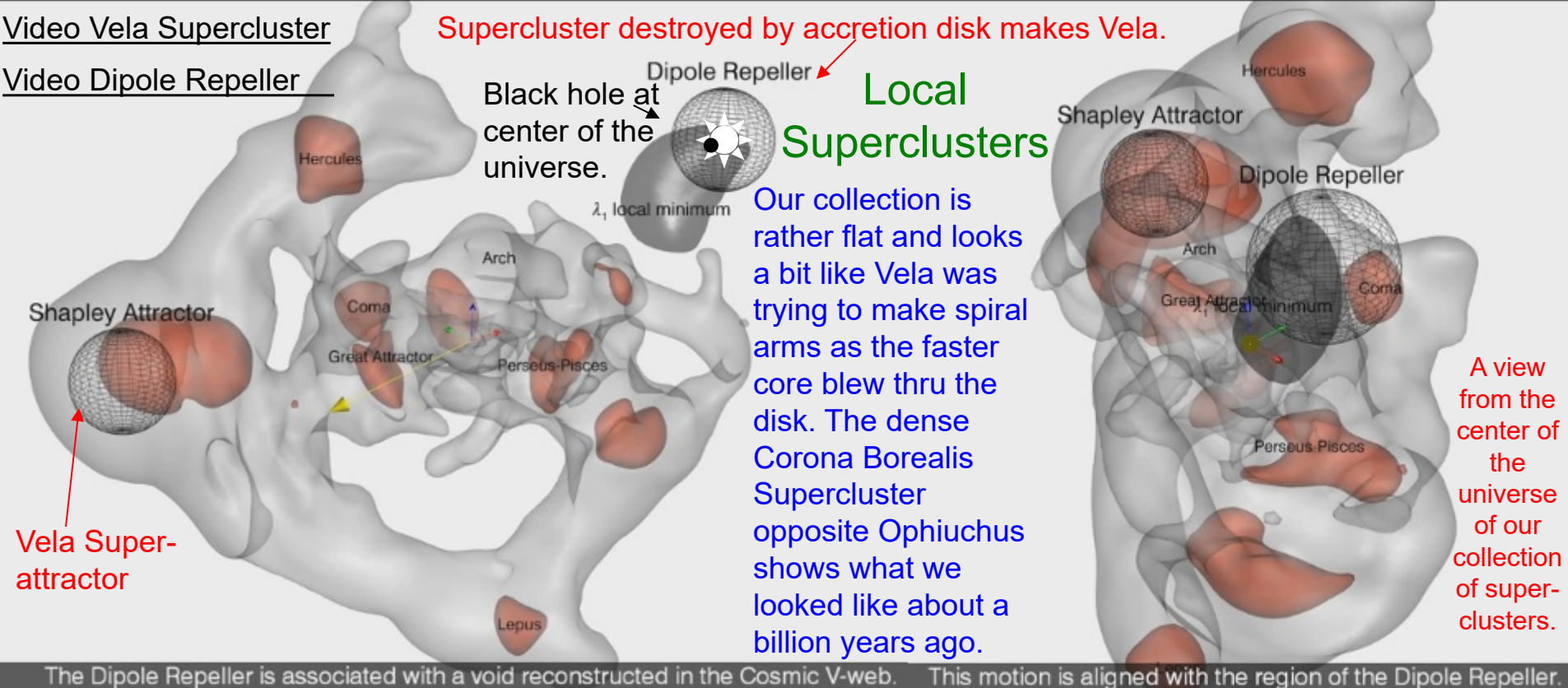
2.7° K
Radiation

The Big Bang Radiation is being reflected off thin hydrogen gas heating it to ~6000° K but redshifting drops this to ~2.7° K. Assumed to be a uniform quick blast, a longer event smoothes the background radiation with thickness and better explains the bell curve around the 2.7° K peak. Previous blasts as big as the one ~13.8 bya would radiate at close to absolute zero and so far have been impossible to detect. The unstudied Ophiuchus Supercluster should have the largest black hole with the largest amount of dark matter from dead galaxies returned to the bottom of the gravitational well. Our Big Bang event was the destruction of a supercluster of dying galaxies. Currently only dwarf galaxies are being consumed so Ophiuchus looks a bit like a normal supercluster. The problem is after 13.8 byr there are ~100 galaxies spiraling into the Cardinal Creator (see previous slide). Even after trillions of years there would still be billions of stars in the nearly dead spirals that would supernova in contact with the accretion disk, trillions of supernova's for an elliptical, and a trillion times that for a supercluster.

Video Vela Supercluster

Video Dipole Repeller

Supercluster destroyed by accretion disk makes Vela.

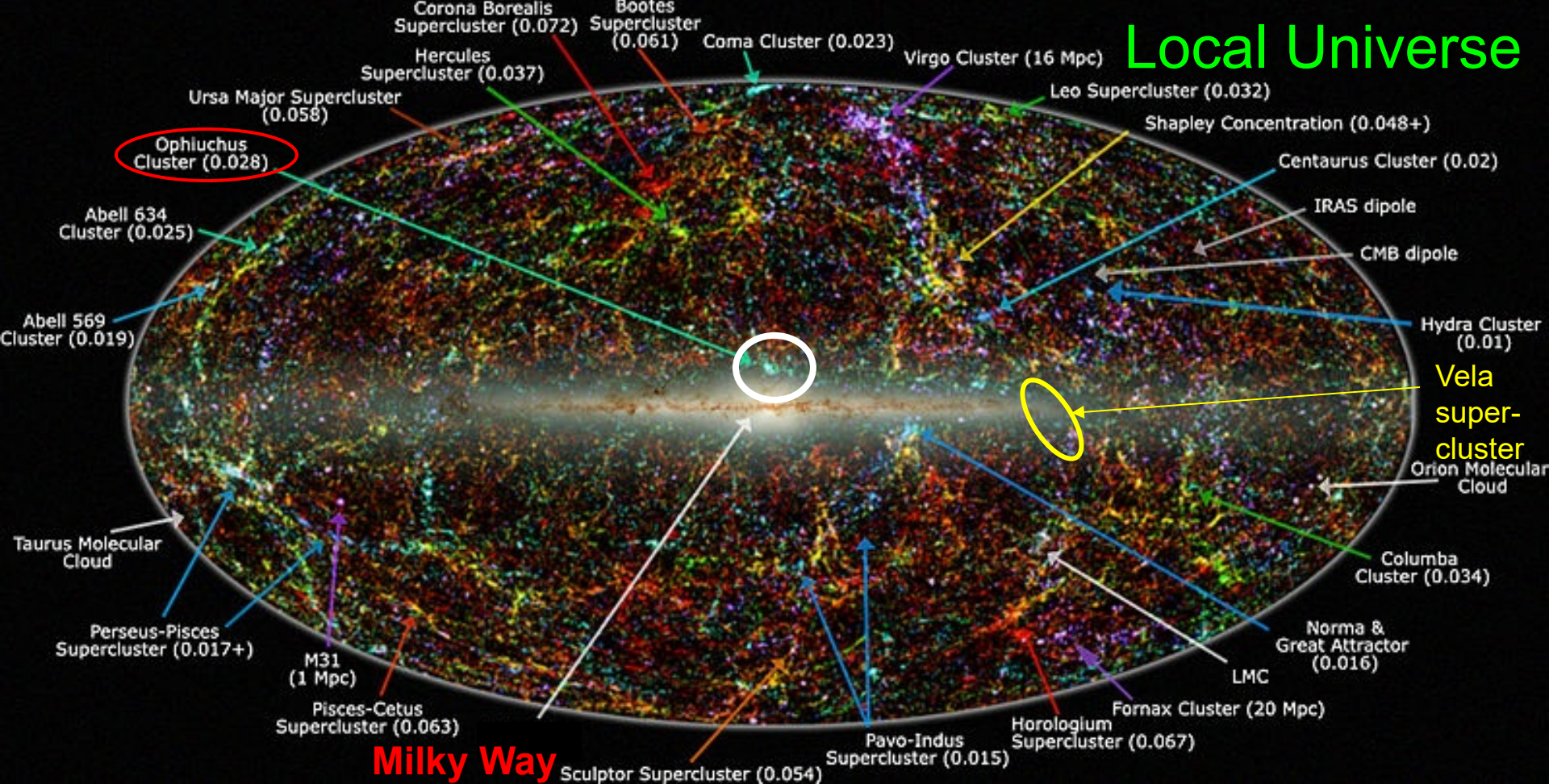


The Milky Way is closer to the center of the universe 390 Mly than the Vela Superattractor ~700 Mly. While the Vela ejection did drag a good chunk of dead stars from the final nadir at Ophiuchus and redistributed dark matter throughout the Vela collection, we are still inside a vast cloud of dark dying galaxies deorbiting into the universe's center. The next Big Bang may have started 100 mya but is only burning at a billion supernovas right now. We are the youngest finished pulse at only ~14 byr but Vela got less than two billion light years away. If it looks like we are the center of the universe it is because we are still too close for comfort. Just like the giant molecular clouds from the center of galaxies makes curving spiral arms, galaxies ejected from cores of superclusters take the form of a giant spiral galaxy. Collections of stars that impact the black hole directly have straight antipodal jets not aligned with the accretion disk plane. The Vela Supercluster is moving too fast to make a surrounding spiraled disk. The Vela collection is the latest addition to vast spiral arms that make a disk made of older collections of superclusters that spiral away from Ophiuchus for tens of billions of light years. Within 2 Gly of Ophiuchus are the massive jets made by the 13.8 bya Big Bang. About 5 to 6 Gly away faster galaxies were made in a more powerful blast from a Big Bang ~50 bya. Distance galaxies' Pop I and II stars are older and more metallic.

Greater walls of galaxies billions of light years long surround us.

Hercules–Corona Borealis Great Wall or the **Great GRB Wall** is the largest known structure in the observable universe, measuring approximately 10 billion light years in length (for perspective, the observable universe is about 93 billion light years in diameter). This massive superstructure is a region of the sky seen in the data set mapping of gamma-ray bursts (GRBs) that has been found to have an unusually higher concentration of similarly distanced GRBs than the expected average distribution. It was discovered in early November 2013 by a team of American and Hungarian astronomers led by István Horváth, Jon Hakkila and Zsolt Bagoly while analyzing data from the Swift Gamma-Ray Burst Mission, together with other data from ground-based telescopes. It is the largest known formation in the universe, exceeding the size of the prior Huge-LQG by about two times. The overdensity lies at the Second, Third and Fourth Galactic Quadrants (NQ2, NQ3 and NQ4) of the sky. Thus, it lies in the Northern Hemisphere, centered on the border of the constellations Draco and Hercules. The entire clustering consists of around 19 GRBs with the redshift ranges between 1.6 and 2.1. Typically, the distribution of GRBs in the universe appears in the sets of less than the 2σ distribution, or with less than two GRBs in the average data of the point-radius system. One possible explanation of this concentration is the Hercules–Corona Borealis Great Wall. The wall has a mean size in excess of 2 billion to 3 billion parsecs (6 to 10 billion light-years). Such a supercluster can explain the significant distribution of GRBs because of its tie to star formation. The Hercules–Corona Borealis Great Wall is now the largest known structure in the observable universe.

The **Giant GRB Ring** is a ring of 9 gamma-ray bursts (GRBs) that may be associated with one of the largest known cosmic structures. It was discovered July 2015 by a team of Hungarian and American astronomers led by L.G. Balazs while analyzing data from different gamma-ray and X-ray telescopes, in particular the Swift Spacecraft. The ring of GRBs lies at a distance of about 2.8 gigaparsecs (9.1 billion light years) from Earth at the redshift between 0.78 and 0.86 and measures about 1.72 gigaparsecs (5.6 billion light years) in diameter, making it one of the largest structures known. Typically, the distribution of GRBs in the universe appears in the sets of less than the 2σ distribution, or with less than two GRBs in the average data of the point-radius system. Thus, such a concentration as this appears extremely unlikely, given accepted theoretical models. Proposals include the existence of a giant supergalactic structure. This would be an extremely huge structure of the universe, with a mean size of about 5.6 billion light years. Such a supercluster can explain the significant distribution of GRBs because of its tie to star formation. If such a structure did exist, it would be one of the largest structures of the observable universe.



There are probably more than 170 billion (1.7×10^{11}) galaxies in the observable universe. Most are 1,000 to 100,000 parsecs in diameter and usually separated by distances on the order of millions of parsecs (or megaparsecs). Intergalactic space (the space between galaxies) is filled with a tenuous gas of an average density less than one atom per cubic meter. The majority of galaxies are organized into a hierarchy of associations known as groups and clusters, which, in turn form larger superclusters. At the largest scale, these associations are generally arranged into sheets and filaments, which are surrounded by immense voids.

Panoramic view of the entire near-infrared sky reveals the distribution of galaxies beyond the Milky Way. The image is derived from the 2MASS Extended Source Catalog (XSC)—more than 1.5 million galaxies, and the Point Source Catalog (PSC)—nearly 0.5 billion Milky Way stars. The galaxies are color coded by 'redshift' obtained from the UGC, CfA, Tully NBGC, LCRS, 2dF, 6dFGS, and SDSS surveys (and from various observations compiled by the NASA Extragalactic Database), or photo-metrically deduced from the K band ($2.2 \mu\text{m}$). Blue/purple are the nearest sources ($z < 0.01$); green are at moderate distances ($0.01 < z < 0.04$) and red are the most distant sources that 2MASS resolves ($0.04 < z < 0.1$). The map is projected with an equal area Aitoff in the Galactic system.

Most bright nearby galaxies of $<2 \text{ Gly}$ are the products of the last Big Bang and thus have parts with similar ages.

The Big Picture

The extent of galaxies made from the last Big Bang event are all within 2 Gly of Ophiuchus.

93 Billion Light Years
28 Billion Parsecs

Central bulge of dying galaxies captured into slowly decaying orbits around Ophiuchus.

The extent of galaxies made from the last Big Bang event are all within 2 Gly of Ophiuchus.

Central bulge of dying galaxies captured into slowly decaying orbits around Ophiuchus.

Expansion is faster at ~6 Gly as that Big Bang blast ~50 bya was stronger.

Jets outside disk plane are straight.
Each galaxy eventually reaches it's
gravitational apex and falls back.

A central bulge of dark ancient galaxies orbits inside the red sphere. Walls of superclusters are arranged like spiral arms of a thick spiral galaxy with Ophiuchus at the center. The Universe's spiraling collections of superclusters also has straight supercluster antipodal jets protruding above and below, filling parts of the polar voids. Dying galaxies would be returning to Ophiuchus to be recycled into new collections of giant elliptical galaxies. To get to us, Ophiuchus begat Vela ~14 bya, which begat Virgo (M87) ~12 bya, which begat the Milky Way (Sagittarius A) ~8 bya, which begat a giant molecular cloud ~5 bya, that initiated the supernova that made our Sun 4.6 bya.

A few distant galaxies are newborn and they are metal rich.



Is this universe young or old?
Is this woman young or old?

At great distances the jet reaches its gravitational apex and dying galaxies begin to fall back to the center of the universe.

Spiral segments of superclusters of galaxies add up to great walls that are arranged like the spiral arms of galaxies within a thick disk.

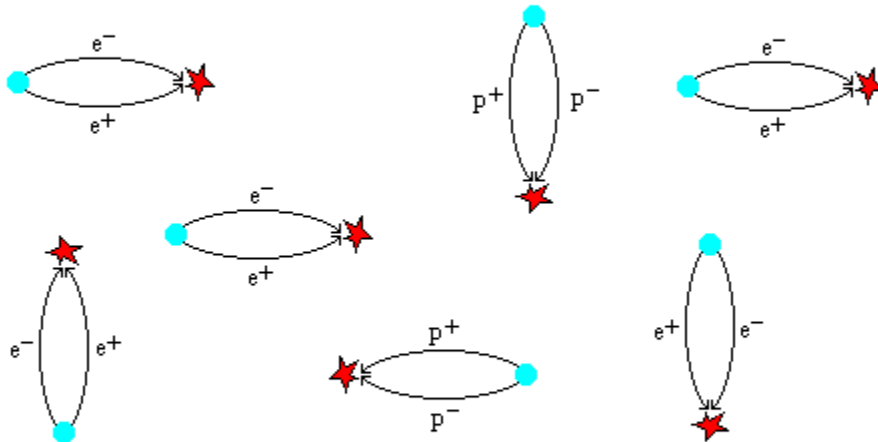
Edge of the observable universe where redshift extinguishes light.



Quantum Vacuum

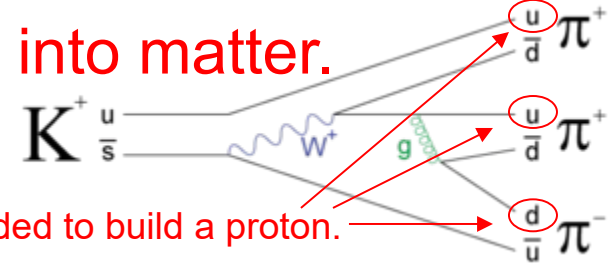
Decay of the quantum vacuum into matter.

the quantum vacuum cannot be perceived or measured directly since it appears to be empty, in fact it is filled with potentiality



within the quantum vacuum, pairs of virtual matter and anti-matter particles are continually created and destroyed, borrowing their mass/energy by the uncertainty principle. They do not exist as observable entities, but their existence is exerted on other particles as a subtle pressure (called the Casimir effect)

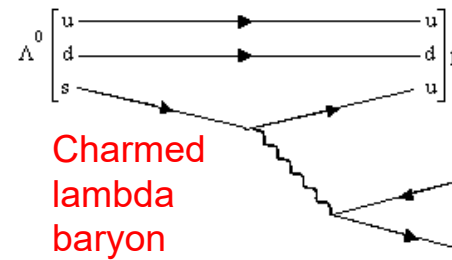
The parts needed to build a proton.



The decay of a kaon (K^+) into three pions ($2 \pi^+$, $1 \pi^-$) is a process that involves both weak and strong interactions.

Weak interactions : The strange antiquark (s) of the kaon transmutes into an up antiquark ($\bar{u}$) by the emission of a W^+ boson; the W^+ boson subsequently decays into a down antiquark ($\bar{d}$) and an up quark (u).

Strong interactions : An up quark (u) emits a gluon (g) which decays into a down quark (d) and a down antiquark ($\bar{d}$).



Charmed lambdas can decay into a proton and pion.

Pion meson

At the quantum scale it has been observed that matter and antimatter pairs are continuously created and destroyed. A charmed lambda might decay into a proton and pion. A random kaon decay might generate the up and down quarks needed to make a proton. Large volumes of empty space can make matter through the decay of the quantum vacuum but when you have all the time in the universe a vacuum will decay into infinitely stable protons and electrons and you get hydrogen. Even a radiation proof box, with the hardest vacuum, sitting at absolute zero, has quantum fluctuations of space that make particle, antiparticle pairs. Even though the odds have been greatly reduced eventually quantum uncertainty creates a particle within the box. Over a very large period of time space will decay into the electrons and protons now seen as stars and galaxies. Much more on the creation of matter from energy is in my quantum physics lecture 'The Electromagnetic Universe'.

Materials from internet, Sky & Telescope, Astronomy and Scientific American for educational & artistic purposes.

Centaurus A harbors one of the nearest active supermassive black holes to Earth, at about 13 million light-years away. Even though this galaxy isn't a quasar, its study helps astronomers understand how jets launch from active black holes and how such structures affect galaxy evolution. © R. VAN DER KUIJ, J. K. STRETT, ET AL. / NASA, HST/STIS

Centaurus A

The Beginning & The End of the Universe is Not In Sight.

Jet's are clearly in
disk plane making
spiral arms.

Centaurus A

These are the opinions of Michael Marron and no one else.

This image of the central parts of Centaurus A reveals the parallelogram-shaped disk of old stars and dust around the center.