UNIVERSALITY OF STRUCTURE FORMATION IN THE UNIVERSE: INFALL AND OUTFLOW REGULATED BY HIERARCHICALLY EMBEDDED SPIRAL

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Abstract

How cosmic structures in different scales, varying by millions of trillions of times in dimensions, are formed by following the same universal principle is presented. The study is based on the analysis of empirical data available at different wavelengths (from radio to x-rays) starting from super-clusters of galaxies to planets in our solar system. The different shapes and activities of cosmic objects, whether they are galaxy clusters, galaxies, star clusters or stars, are given a unified explanation. The universal mechanism of evolution of structures from birth to death involving simultaneous inflow towards the center and outflow from the center, regulated by three armed spiral structures sitting at the heart of all cosmic bodies, is depicted and explained with imageries. The inner spiral, which is the foundation of a hidden order in an apparently chaotic turbulent universe built as a hierarchically embedded self-similar structure, is found to be the most central element in the formation of all cosmic bodies. The three-armed spiral existing in the womb of a larger spiral, which in turn is embedded inside a smaller spiral, which is embedded inside an even smaller spiral and so on in descending scales, constitutes the foundation of the fractal nature of the universe. We show that the universe is very different from the structure formation scenario proposed by the big-bang models. Most of the observed phenomena can be understood by the mechanism driven by turbulence and magnetic field in association with gravity, following a universal mechanism of evolution from birth to death.

1 Introduction

After Copernicus changed the centre of the universe from being our Earth, astronomers believed for a long time that we lived in a universe filled with stars where sun was situated at its centre. The galaxies seen as patches of lights were considered to be nebulae residing inside the starry universe. Only in the late 1920s Hubble discovered that these nebular patches were outside the Milky Way and, in fact, they were separate island universes made of billions of stars. Since then our understanding of the universe had grown rapidly.

In the beginning of the twenty first century we now believe that instead of a universe filled with stars we live inside a sphere filled with millions and millions of galaxies, while each galaxy is made of billions to trillions of stars. The galaxies are seen in amazing varieties that differ in shapes, colors, brightness, stellar activities and emission properties in different wavelengths. Some look redder, some appear bluer, some look like Frisbees, some are spherical, some blow jets that can be detected in radio wavelengths, some are quiescent, some possess nuclei that emit x-rays and blow fierce hot winds from their centers, some bubble with intense activities of formation of young stars, and some look very bizarre. Many of these galaxies are found to be interacting with each other. Most galaxies appear in groups, called galaxy clusters. These clusters too vary in shapes, sizes, compactness, optical luminosity, and emissions in radio and x-rays, for example. Some clusters show ejections from their centers and like galaxies some are observed to be colliding with other clusters. These clusters in turn group together and create even larger structures called superclusters.

The star, like our sun, is insignificantly small in this vast cosmic scene. It is only one of the hundreds of billions of stars in the Milky Way galaxy. These tiny stars too appear in different colors, sizes, and energy output and ejection properties. Some are observed being born while illumining the surrounding clouds with fabulous firework of colors. Some are seen to be blowing out shells of gases and jets. The birth and death of stars create so many amazing varieties of scenes that they can not be described by a single imagery. Many appear surrounded by nebulae consisting of rings, and veils of different colors and shapes. There are so many variations of planetary nebulae that one gets perplexed and mesmerized by this cosmic drama.

The large scale universe is too big for most mortals to conceive. For majority of human beings the sun and the planets orbiting around it are big enough to fulfill their curiosity about the universe. The sun itself is tremendously big compared to Earth, and Earth is enormously large compared to our own size.

The purpose of this paper is to show that even in the tinniest of the tinniest structures in the universe, like the planets in the solar system, there are activities akin to what one may observe in the largest structures in the cosmos spanning billions of light years. In this article we intend to answer the questions: What are universal elements in the structures in the universe, and is there any universal mechanism which may be driving the formation of structures in vastly different scales?

So far the studies of the formation of large scale structures like galaxies, clusters and super-clusters have remained a separate field from the studies of the formation of stars and planets. The attempts to answer the question of the formation of the large scale structures are dominated by models based on big-bang cosmology. According to these models, the structures have risen from an initially homogeneous fireball as results of quantum vacuum fluctuations that occurred 10^{-35} sec after the birth of the universe. These quantum fluctuations got amplified with the expansion of the universe and resulted in matter density fluctuations creating clumps of higher densities. Cosmic structures formed as results of gravitational collapse of the high density peaks. Furthermore, the gravitational collapse proceeded via Dark Matter haloes which constitute 90% of the matter density of the universe.

Until now no one knows what this invisible Dark Matter is. Even as regards normal matter, which constitutes only 10% of the matter in the universe, most of it are not yet accounted for. The gases residing in stars, galaxies and visible large structures can only account for 10% of the total normal matter. The rest is expected to lie in interstellar and intergalactic medium.

These structure formation theories produce quite different scenarios depending on the assumption of the nature of the dark matter and its abundance. The other uncertainties lie in several unknown parameters that are needed to describe the cosmology: Among them the Dark Energy which exceed the Dark Matter by a factor of three or more. Besides that, the most important ingredient for structure formation is the spectrum of the primordial fluctuation. The observation of the fluctuations of Cosmic Microwave Background Radiation by WMAP is supposed to provide that knowledge.

The aim of these theories is to find a viable scenario of the formation of large scale structures that does not conflict with observation. The main line of argument comes from the association of high red-shift objects with objects near to the origin of the creation of the universe. Thus, knowing the progress of time with decreasing red-shift values, these theories seek to explain the observational facts. Accordingly, the earliest galaxies must be found at the highest red-shifts and the galaxies with lower red-shifts must have been formed later. The challenge of these big-bang based theories has been to explain the activities of the galaxies at different red-shifts by studying their star formation rates. Galaxies which have been formed earlier must have formed stars earlier and should not show high star formation rates like in the galaxies which have come into existence much later. However, the major issue has been to explain the occurrence of the elliptical galaxies at high red-shift and spirals at lower red-shifts, as well as to answer the question why one observes numerous irregular small faint blue galaxies at high and intermediate red-shifts.

The models which assume the existence of Cold Dark Matter (CDM) have emerged as the most successful models until now. In Cold Dark Matter theories, larger structures form by merging of smaller units in a hierarchical manner. These theories, known as ΛCDM hierarchical model, describe the formation of the early as well as late ellipticals by merging of spiral galaxies and formation of the spirals by merging of the blue small irregular galaxies observed at high red-shifts.

In this paper we depart completely from this view. In an earlier paper, we have analyzed the WMAP data and concluded that big-bang my not have occurred. Instead of living in an expanding universe, we may be living in a vortex universe where inflow and outflow of gases are meticulously arranged in a hierarchical manner from the largest to the tinniest cosmic scales. These inflow and outflow occurring through the mediation of magnetic fields give rise to the formation of cosmic objects as varied as super-clusters of hundreds of million light years in sizes to the planets that light can cross only in fractions of a second.

Our main departure lies in abandoning the heuristic assumption that gravity is the only force that destines the birth and death of cosmic structures. Instead we believe that the cosmic structures, in all scales, are results of a complex interplay of turbulence, magnetic field and gravity. In our view the universe resembles a spiral vortex possessing a fractal structure. In this whirlpool energy cascades from larger structures to smaller ones, which in turn transfer energies to even smaller turbulences and so on in descending scales. The turbulent motions cause compression of gases and generate filamentary structures where clumps of different densities develop. This turbulence also drives the cosmic dynamo that generates cosmic magnetic field, which pervades the universe in all scales. The force of gravity exerted by the enhanced density peaks is counteracted by the thermal, turbulent and magnetic pressures. The fate of the clouds mostly depends on the turbulent and magnetic environment in which they find themselves. The magnetic field, entangled in the cloud, joins hands with turbulent forces in forming a dense central structure at the deep heart of the cloud. With the passage of time this core evolves and the gravitational force exerted by this central object may become appreciable in the end. When star-like objects at the center are formed, gravity may gain dominance over turbulence and magnetic forces and clear away the surrounding gases partly through gravitational accretion and partly by blowing hot winds from the new born structures.

When the masses of such central objects turn high, following the theory of gravity of Einstein, they are doomed to turn into black holes. These cosmic monsters do not slip any signal to the outside world and grow by feeding on the cosmic objects who may come near. The passing objects are torn apart by the immense gravitational field of the black hole. The debris from the debacle is accumulated as a disc around the black hole from where the monster feeds. The synchrotron radiation generated by the infalling material towards the black hole produce intense x-ray emissions. Strong x-ray observations are considered as signature of the presence of these invisible monsters. The black holes are expected to sprawl everywhere in the universe - especially at the centers of the large scale structures.

Our study indicates that this scenario of black-hole described above could be a fiction. In a previous paper, we have discussed about the existence of a micro-spiral at the heart of the Milky Way galaxy instead of a black hole and found that the x-ray emissions from the galactic center follow a three armed spiral structure. The arms of this 3D spiral twist and turn to form several mouths through which hot plasma pours out from the center.

The existence of micro-spiral in the nucleus appears to be a universal phenomenon in cosmic structure formation. We have found similar 3D spiral structures at the heart of many galaxies of different morphological type and nuclear activities as well as in the hearts of clusters of galaxies, star clusters, stars and even planets.

We shall give visual illustration of the universal elements by giving examples of stars, star clusters, galaxies and galaxy clusters and provide a short explanation of how one my understand these observations without going into details about the dynamics. The possible roles played by turbulence and magnetic fields will be discussed in a forthcoming paper.

So far, the studies regarding the roles of turbulence and magnetic field in large scale structure formation are meager. In the early 1950s Weizsacker and Gamow promoted the ideas that galaxies originate from cosmic turbulence. However they could not explain what was the origin of the turbulence and how the turbulence could withstand decay and dissipation. In the end of 1960s and the beginning of 1970s these questions were resolved by Ozernoi and his group. They could explain how catastrophic decay of turbulence could be avoided in an expanding universe and how large chaotic density fluctuations could be generated after the red-shift era of 1000 (recombination era). However, the cosmic turbulence theory was muted by the observation of the weak temperature fluctuations in the cosmic microwave background radiation (Gibson) which was more than thousand times smaller than what one should expect from fluctuations generated by fully developed turbulence. Newly the questions about the role of turbulence have again surfaced in connection with the observation of the cosmic magnetic field and the formation of stars in supersonic turbulent clouds. After turbulence has been discovered at the core of galaxy clusters the study of turbulence in large scale structure formation has also gained some attention. The turbulence has also surfaced in research of planet formation as an effective way of collecting dust that can coalesce into planetismals leading to the formation of planets. With turbulence the role of magnetic field has also become a major point of interest in resolving the questions of the formation of cosmic structures.

The main purpose of this paper, as mentioned earlier, is to describe universal elements that can be found in the formation of structures in different scales - among them are the fractal characteristic of the structures and the existence of hierarchically embedded spiral at the very heart of cosmic objects. The universal mechanism includes inward streaming of colder gases and outward ejection of hotter winds, proceeding down to the very heart of the centre. The way the spiral arms tighten while becoming more and more compact around the core, as one moves from the outer shells towards the centre is another universal feature in structure formation. As one approaches the center, the two spiral arms moving from the opposite sides, which feed the core with new supply of colder gases, join together and form ring-like structures made of two bow-shaped arches. These rings have four openings through which inflow and outflow occur towards and away from the core. Another element is the bipolar ejection of jets perpendicular to the plane of the strong magnetic field existing in the inner region.

2 Embedded self-similar structures

Structures made of self-similar structures are characteristic of fractal objects. This fractality is evident in molecular clouds in galaxies where stars and star clusters take shape. The clumps in the molecular clouds show self-similarity that extends to sizes differing by many orders of magnitudes. This hierarchy of clumps and filaments spans all observable scales from the sizes of the clusters and galaxies down to the protostellar cores. At each scale the clouds appear highly structured. When each smaller clump is resolved in higher resolution they turn out to be made of similarly structured clumps in even smaller scale. This self-similar build up of clouds continue down to the centre where the clouds form highest density peaks. Studies of galaxy surveys indicate that this fractal arrangement continues up to the sizes of the largest cosmic scale so far observed. However, this observation is in conflict with the big-bang cosmology, which can not explain such inhomogeneous fractal build up of the universe.

We will give some examples of this fractality that exists starting from clusters and galaxies down to the molecular clouds, nebulae and stars. The best examples are often galaxies, molecular clouds and nebulae where the stars take forms. In galaxy clusters one observes this fractal arrangement in the cluster cores because the entire cluster structures are often too large for making observations of the full structure. Observations mostly concentrate around the region of the core. Furthermore, the optical emission from the intergalactic material, that fills the clusters, is very faint to be detected. Most observations of the intergalactic medium are made in x-rays because hot gases blowing from galaxies in the intergalactic space give rise to thermal x-ray emissions. As regards stars, the fractal structures can be observed up to proto-stellar stage before the centrally dense clouds collapse. In the early stage of the formation of the stars, where discs of material still surround the core, this fractal can be seen in shell structures. In the planetary case the fractals are observed in the rings around the planets and in the atmospheres which surround the planetary cores. The fractal is everywhere on Earth from the geological crusts to the clouds and the ionospheres. In fact, we see the greatest manifestation of fractals in the biological world down to the level of the structures of proteins in cells.

The cosmic structures are formed in a way that wherever one picks cosmic material, at whatever large or small dimension, the sample can be resolved into similar structures at smaller scales. We will describe the simplest examples of such fractals where similar small structures are embedded at the womb of the mother structures. The daughter structures, in turn, contain their daughter structure in their wombs and so on in descending scales. This self-similar embedding continues until it reaches the deep heart, where they end up in forming dissipative structures, like stars and galactic nuclei, blowing out material in outer space.

As said before, here we will not discuss theoretical models but concentrate in giving visual description of what may be happening in the universe. Theoretical foundation will be given in separate papers.

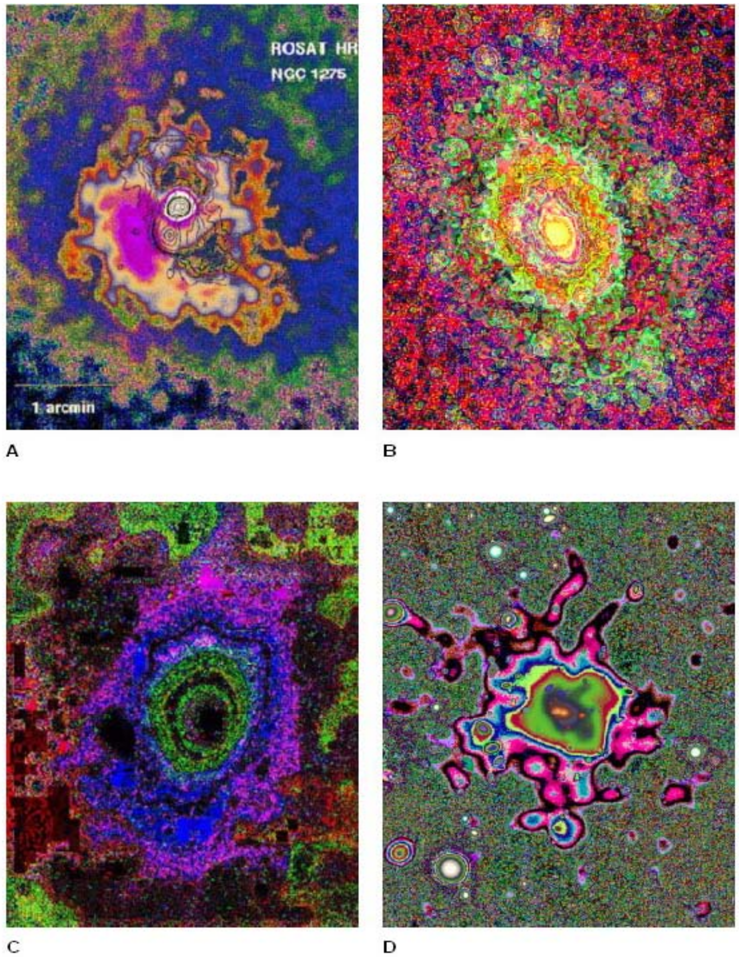


Figure 1: Cores of galaxy clusters at different red-shifts

2.1 Examples of clusters of galaxies

In figure 1 the images A, B, C and D are arranged according to the increasing redshift values of the galaxy clusters. The image A is the core of the Perseus cluster which has a redshift z=.0183. It is one of the most massive galaxy clusters in the nearby universe. The image B corresponds to the galaxy cluster known as Abell 2029. It has redshift z=.0767. The most luminous X-ray cluster RXJ1347-1145 lying at the redshift z=0.45 is shown in image C. The galaxy cluster named RDCS 1252.9-2927 in image D possesses nearly seventy times higher redshift than Perseus cluster and nearly three hundred times larger redshift than the nearest high concentration of galaxies known as Virgo cluster. Virgo cluster is believed to be pulling the Local group of galaxies containing Milky Way and Andromeda galaxy. The Local Group is moving towards Virgo centre. The images shown are mostly based on the measurements of x-ray emissions from the intergalactic hot gases with temperature of tens of millions of degrees. The dimensions of these clusters are of the order of tens of millions of light years ranging up to hundreds of millions light years. The different colors in the pictures show different intensity zones of emissions and thus correspond to iso-density contours of the gases in the clusters. The fractal embedding of self-similar structures in descending scales by different color zones are evident in all of them.

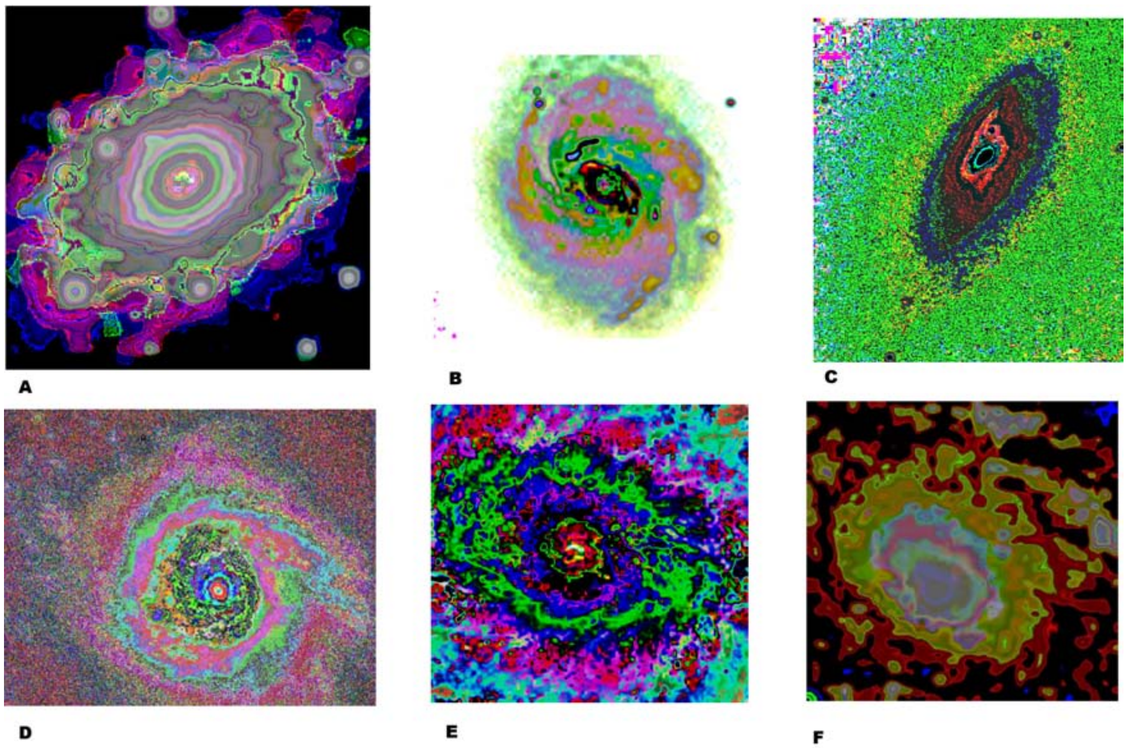


Figure 2: Fractal build up of galaxies and galaxy cores

2.2 Examples of galaxies

Very similar fractals are also seen in galaxies. While in the case of the clusters the images mostly reveal structures in the core regions, in galaxies one can observe the fractal property from the outer regions to the nuclear center. The optical luminosities extend far out from the center which can be detected with sensitive instruments and therefore the structures can be seen in a fuller way.

The galaxies shown in the images in figure 2 vary in distance from 20 million light years to 60 million light years, which is approximately the distance to the Virgo cluster. In distances shorter than Virgo, the galaxies lie in loose groups, like our own local group of galaxies. The galaxies in images A and B lie at nearly the same distance (60 million light years). The image A is a lenticular galaxy M86, which is a type between elliptical and spiral - neither spiral nor elliptical. It lies close to the central elliptical galaxy M87 in the Virgo cluster. Image B is M77, which lies in approximately at the same distance as M86 but in the opposite direction of Virgo. It is a spiral galaxy with star formation activities in the nuclear region and rapid outpouring of gases from its centre. It is classified as Seyfert II galaxy, where the centre resembles a miniature quasar, which strongly emits in radio. It is the nearest and brightest Seyfert II galaxy with active nucleus. The star formation in this galaxy is among the brightest known. These galaxies are believed to be nearly double the size of our Milky Way galaxy and close to the size of our nearest galaxy Andromeda, which is a giant spiral galaxy. In C another Seyfert galaxy, known as M106, is shown. It is approximately three times closer to us than the other two galaxies and lies in Ursa Major. It is known as a peculiar spiral of type Sb containing knots of star formations. The image taken in radio wavelength extends far beyond its optical size. The large star formation in this galaxy is believed to be caused by a close encounter of a second galaxy. NGC 3310 in image D is another spiral galaxy with high rate of star formation. It is known as a starburst galaxy and lies in the same region of Ursa Major as M106. However its distance is more than double of M106 (50 million light years). In the central

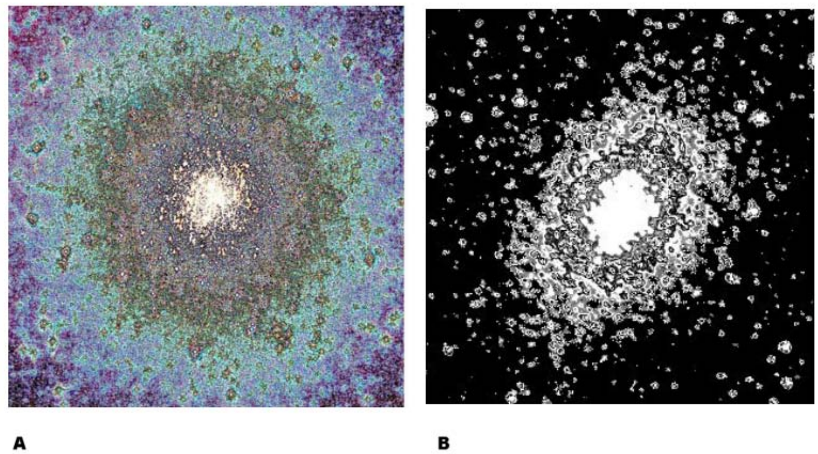


Figure 3: Fractal build up of massive star clusters: A) NGC 2808 star cluster, B) NGC 1978 star cluster in LMC

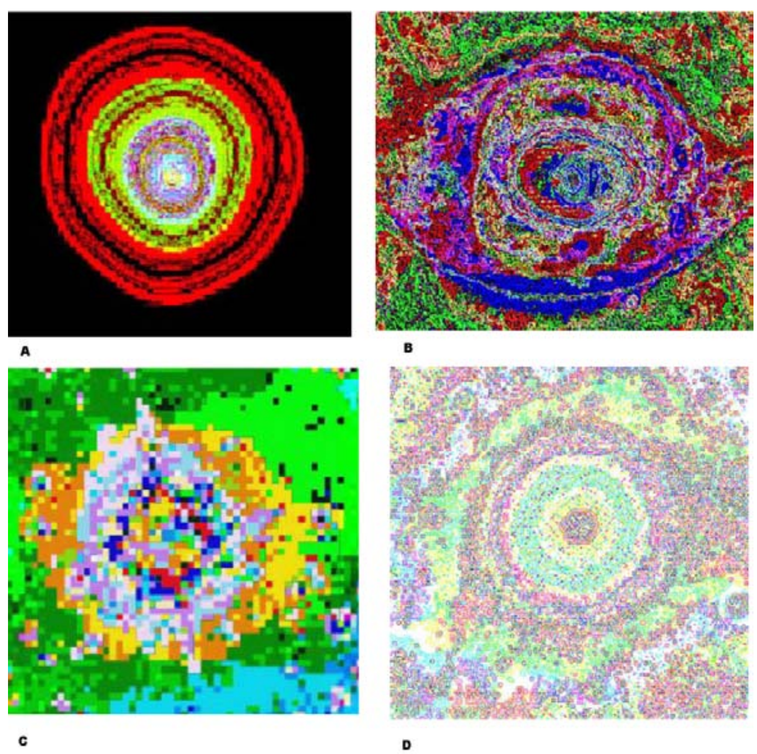
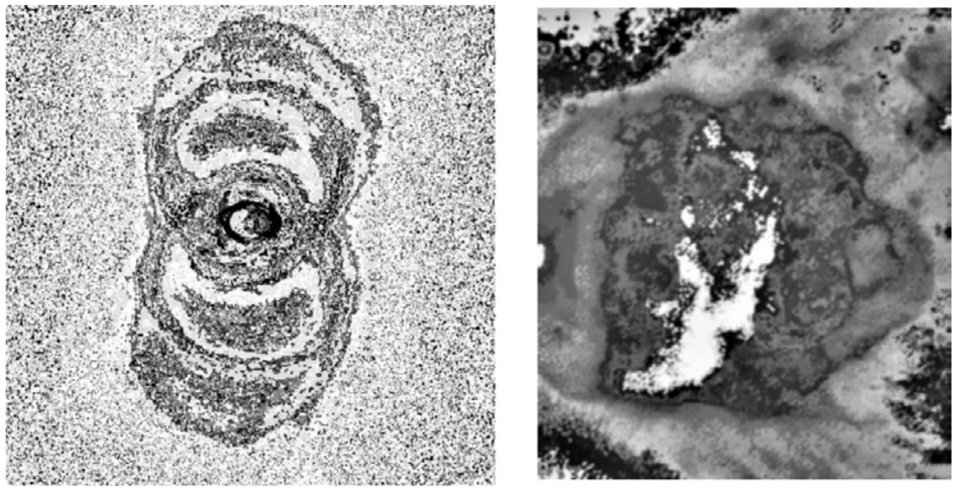


Figure 4: Fractally embedded shells around the old and young stars: A) Red supergiant Betelguese, B) The dying star at the center of the Hourglass nebula MyCn18, C) Central massive young star in the heart of Cocoon nebula,D) Blue young star in Orion.



A B

Figure 5: Ejections of fractally embedded shells from aging stars: A) Expanding shells in Hourglass nebula, B)The expanding shells in Mz3. The dying star is in the middle of the left edge of the image.

region of this galaxy young and old stars are evenly distributed and it is much smaller in size than the Milky Way. The core region of a grand design spiral known as Pinwheel galaxy (M101) is shown in image E. This spiral galaxy is as large as the Andromeda and one of the largest spirals known. However, it is ten times farther away (24 million light years) than Andromeda (2.5 million light years). Several explosions of stars have been observed in this galaxy. In the last image (F in fig.2) the central part of a very common type of galaxy known as flocculent spiral, which does not show well developed spiral arms, is shown. It is approximately 60 million light years away from us. Similar to these examples shown, galaxies of all types - small or big, possessing active or non-active nucleus, showing recent birth of stars, or inhabited by old population of stars - show fractal build up starting from the periphery to the inner core. Thus what happens in large galaxy clusters (scale of hundred million light years) continues in scales which are about thousand times smaller (order of hundred thousand light years).

2.3 Examples of star clusters

The same appears to be the case in scales thousand times even smaller than the size of the galaxies. They are seen in clouds where dense star clusters are formed (see fig.3). The image A is the massive globular cluster NGC 2808 in the Carina spiral arm of our galaxy. The image B is the star cluster NGC 1978 in Large Magellanic cloud. It is an intermediate age massive star cluster. These large stellar clusters can consist of millions of individual stars.

2.4 Examples of nebulae

The sizes of the nebulae inside which individual stars are formed, are similarly tens of thousands of time smaller than the clouds where large star clusters evolve. A few illustrations of the fractals in nebulae are given in figure 4. The image A shows the fractaly embedded shells in the red supergiant star Betelguese in Orion. It is one of the largest star known, whose diameter is more than 1000 times larger than the sun. It is an old star on the verge of decay. In image B the similar shells, arranged inside the others, around a dying star, lying at the center of the Hourglass nebula, is shown. In images C and D fractally embedded shells around very young stars can be seen. Image C shows the shells enveloping the massive young star at the center of the Cocoon nebula, while image D shows shells around a massive blue star in Orion. The formation of stars, embedded within shells lying inside shells, seem to be a generic phenomenon in star formation. While the stars die they expell these shells.

The stars like our sun which has a diameter of only 2 light second is tens of thousand times smaller in size than the nebulae of hot gases (order of thousand AU) which surround such newly born, or dying stars (see fig.5). Stars possess shell structures resembling what one may see at the core of the large scale cosmic ob-

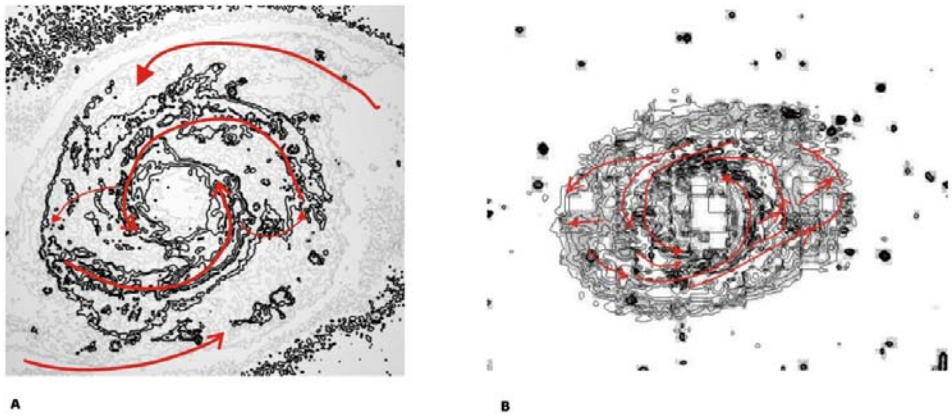


Figure 6: Two spiral arms turning into rings around the core: A)Two armed spiral vortex: Outward ejections return as incoming streams in Whirlpool galaxy M51, B) M77: Formation of rings inside rings by merging of the spiral arms. The rings surround the center where a spiral structure exists.

jects which we shall discuss below. All structures in the universe thus possess similar star-like objects at their hearts only differing in scales.

3 Universal structure at the center of cosmic objects

Presently there exists a consensus that super-massive black-holes harbor at the centers of the large scale cosmic structures. The high-energy activities like intense x-ray and radio emissions from the centers of galaxies and clusters are ascribed to the presence of these black-holes, which collect debris of stars, torn by the strong gravitational fields of the black-holes, in the form of discs (known as accretion discs) around them. The black-holes feed from these accretion discs and grow. The matter swirling from the accretion disc towards the womb of the black-holes generate the high energy x-ray emissions from the centers.

Apart from the intense x-ray and radio-emission, one observes motions of high velocity stars near the center, and expulsion of material from the nuclei of galaxies and clusters. The popular explanations for these activities are based on the existence of black-holes. The ejections are explained as resulting from the strong magnetic field around the black-holes. While the black-hole feeds from the accretion disc some material may get entangled in the magnetic field and are expelled outward in the form of jets.

Here we shall present a totally different story of the activities at the centers. Instead of black hole it is a story related to a universal spiral structure that lies at the heart of all cosmic bodies. This story is universal whether it is the centre of a cluster of galaxy, or a galaxy of any morphological type, or a star cluster, or a star in formation, or a star of any age, or even a planet like Jupiter in our own solar system. We have been able to observe similar mechanism of structure building in all cosmic scales and discovered the mechanism by which this universal phenomenon occurs by simultaneous infall of the material towards the center and ejections from the center.

As said before, the purpose of this paper is not to go deep into the discussion of the dynamics of infall and ejection, where turbulence and magnetic field play central roles, but to describe the universal way the matter streams towards the centre like a two-armed spiral vortex and then evolves towards the centre under the action of magnetic field and gravity. By shredding angular momentum the spiral arms wind inward. This involves outward ejections from the inner part of one spiral arm while the ejected material merge with the streams moving inward in the outer part of the other spiral arm. This infall and ejection continue and form a fractal structure, which creates similar infall and ejection pattern in descending scales. It has similarity with spiral vortex we observe around

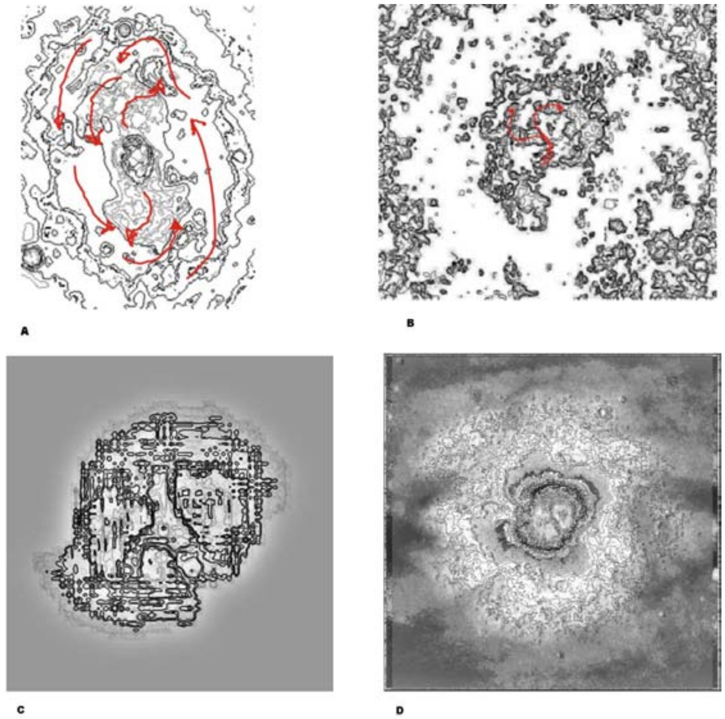


Figure 7: Three-armed spiral inside the rings which envelope the core and the four openings in the rings through which accretion and ejection occur at the same time: A) Inside the rings material pouring out of the center gets trapped and may form a bar like structure which becomes rounder as one approaches the center, B) The structure seen at the center of the massive spiral galaxy Anromeda: Inflow and outflow from the center are regulated by a three-armed spiral sitting at the heart of the galaxy, C) Three armed spiral at the heart of the Whirlpool galaxy, D) Mouths through which the infall and ejection occurs from the center.

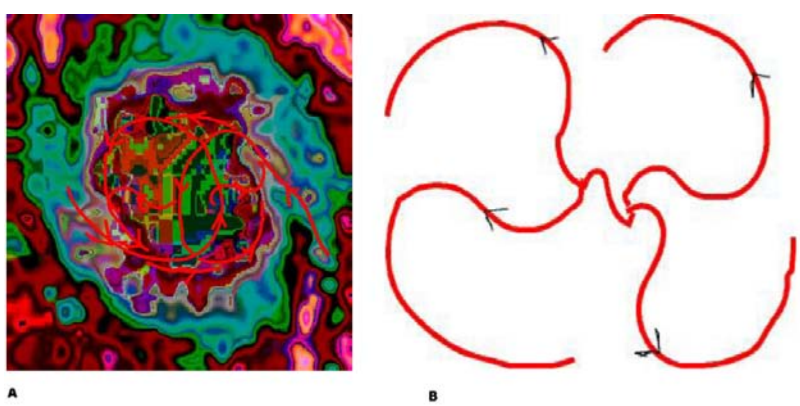


Figure 8: Infall and ejection regulated by a hierarchically embedded spiral at the center: A) The directions of inflow and outflow occurring at the center of a galaxy are indicated by arrows, B) The way the inner spiral regulates inflow and outflow: The ring at the heart of three-armed spiral structure at the center which surrounds a spiral at its heart in turn.

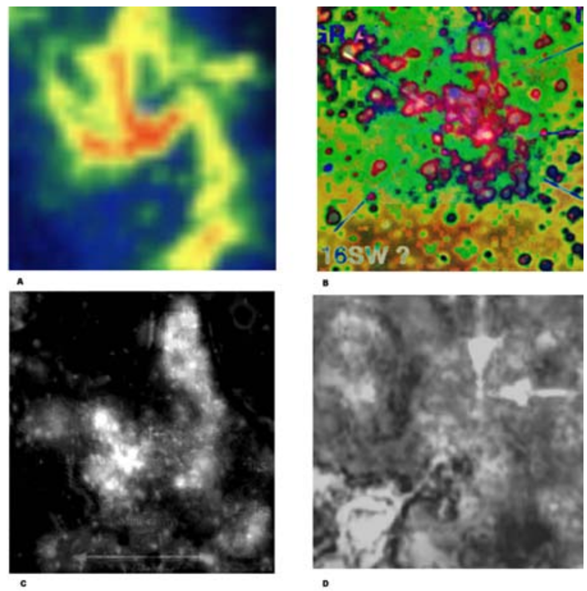


Figure 9: Hierarchically embedded spiral structures in the heart of the Milky Way galactic center: A) Mini spiral in Milky Way center: 10 light years in size, B) The spiral at the heart of the mini-spiral: The image is about 3-light years, C) Double spiral forming ring around the micro-spiral near SgrA* indicated by two arrows: The image size is 2 light-years, D) The micro-spiral at galactic center with helically coiled structures at the bulge from where three arms have emerged. The position of the radio source SgrA* is marked by two arrows.

us on Earth. This two armed spiral vortex continues inward until reaching the core region where the two spiral arms get entangled with each other while forming elliptical or circular rings around the center. These rings appear like rotating discs around the centre, which supply material towards the center as well as pour out material outward from the center. The rings develop four gates through which this infall and outfall take place. The four mouths are paired in two groups which lie nearly perpendicular to each other. Two of these mouths lie in the direction of the bar shapes (in the two opposite ends of the bar) often observed inside the nuclei of galaxies. The other two mouths create bipolar flows perpendicular to the axis of the bar. Inside this ring similar smaller rings may develop and lie as hierarchically stacked shells inside shells. The streams of inflow and outflow are woven together in a very specific universal way in these shells which create a womb inside which the central structure lie secured of the supply of material for its existence and life.

This leads to the formation of a three-armed spiral structure inside the rings in a much smaller scale than the mother spiral. Again the same process continues giving rise to a set of even smaller rings inside the mini-spiral. This in turn generates an even smaller spiral (mini-mini-spiral) inside its core. Thus cosmic structure building follows a universal hierarchical pattern in scales after scales. One may ask where does this process end?

In each descending scale the densities of the structures increase. With it temperatures too rise and magnetic fields become stronger. The dynamics of the universe, which is primarily driven by turbulence at the largest scale, is gradually taken over by the magnetic activities as one approaches the center. The magnetic processes lead to violent ejections and winds from the center. Such winds then decide the conditions around the centre. With increasing density of the structures the gravitational fields become strong and gravity start competing with the magnetic process.

At the densest level we have explored, like the centre of the Perseus supercluster, and our own galactic centre for example, there exist a three armed spiral knot. Unlike the 2D spiral arms, these three arms twist and turn in 3D-space like arms of an octopus spiraling and coiling around strong magnetic sources. These magnetic sources are the mouths through which outpouring occurs from the center. In the centre of the Milky Way the strong magnetic source is one of these mouths and it lies inside one of the three spiral arms that coils it.

The cosmic structures of various shapes, sizes, colors, star formation and nuclear activities are manifestations of different stages of this universal process we have described above. In a structure one may observe several stages of evolution depending on at what scale one makes the measurement and what is the exposure time and the sensitivity of the measuring instruments. For example, in the core of a massive spiral galaxy one may discover structure which is nothing but what one observes in an elliptical galaxy.

In this article we shall restrict ourselves to the question of formation of regular and normal structures and not deal with interacting and colliding systems. We shall also not discuss about the decay and disintegration of cosmic bodies. The question of decay and death of cosmic structures will be discussed in a separate article.

Before giving example of galaxy clusters, galaxies, star clusters, nebulae and stars we shall first present a universal description of the way the structures evolve as one approaches the center from the outer peripheries.

The pictures in figs 6 and 7 illustrate the basic steps that the cosmic structures follow as they evolve towards the core where the densest object is formed. The different orientations of the bow-shaped shells that surround the heart of the nucleus correspond to different morphological appearances of the large structures as a whole. The shells may join to form circular to oval rings and can be symmetrically or asymmetrically placed on two sides of the nuclear mini-spiral.

As said earlier, the three-armed spiral at the heart of the structures regulates the incoming and outgoing flows. All which are poured outward from the center return as inflowing streams by following a specific pattern of inflow and outflow routes governed by the spiral as shown in image A of figure 8. At the center of this nucleus (green and dark green area) one finds the mini spiral as shown in image B of figure 7. At the heart of the mini-spiral one may discover an even smaller spiral structure which harbors another spiral once again. The way rings form around the three-armed spiral embedded at the heart of a larger three-armed spiral is shown in image B of figure 8. The ring surrounds another three-armed spiral at its center in a hierarchical manner.

In the heart, from where the double spiral structure emerges to form a ring, there exists (as in our own galaxy) an even smaller spiral structure. The arms of this micro-spiral, seen in the Milky Way galactic center, coil and create strong centers of magnetic fields. These spots of strong magnetic fields act as the regions of high energy emissions. In our galaxy one of such spots is known as SgrA*, where a black-hole is supposed to exist (we have discussed about the existence of micro-spiral at the center of our galaxy in an earlier paper). Instead of a black-hole we have found a three-armed spiral structure which govern the inflow towards and outflow from the center. The arms of this spiral emerge from a central bulge (image D in figure 9). Everything sinks and everything appears again from the womb of this bulge (it self-creates by feeding on itself). In the Milky Way galactic center we have observed helically moving coiled structures, entangled with each other, filling the womb of the bulge. One may ask what is inside this womb? Though our study does not go further we guess that the fractal hierarchy will continue in even smaller scales leading to even smaller spiral structures from where high energy particles, like in the cosmic rays, are emitted.

As our main aim is to discuss the universality in structure formation, we shall leave this question at this stage. At the very core, where the amount of material ejected is balanced by the amount of material streaming inward, the cosmic objects take shapes as stars, nuclei of galaxies, nuclei of galaxy clusters etc. From these star-like wombs matter blow out along the equatorial plane which then returns through the polar region though magnetic connection. The way the ejected hot material cools and sinks down towards the centre is universal for as small objects as stars to as large structures as galaxy clusters. Similar outpouring from the equatorial plane and accretion towards the pole can also be observed in planets like Jupiter and Saturn in our own solar system.

As said before we shall not delve with the dynamics involving turbulence and magnetic field, which may have caused the formation of these structures. We shall also not discuss to what extent gravity may play any role in building these shapes. We reserve these questions for a separate article.

Instead, we shall point out how the structures bear characteristics of turbulence as regards inflow and outflow occurring in a hierarchical manner in smaller and smaller scales, and reveal the existence of a universal spiral structure at the very heart of all cosmic

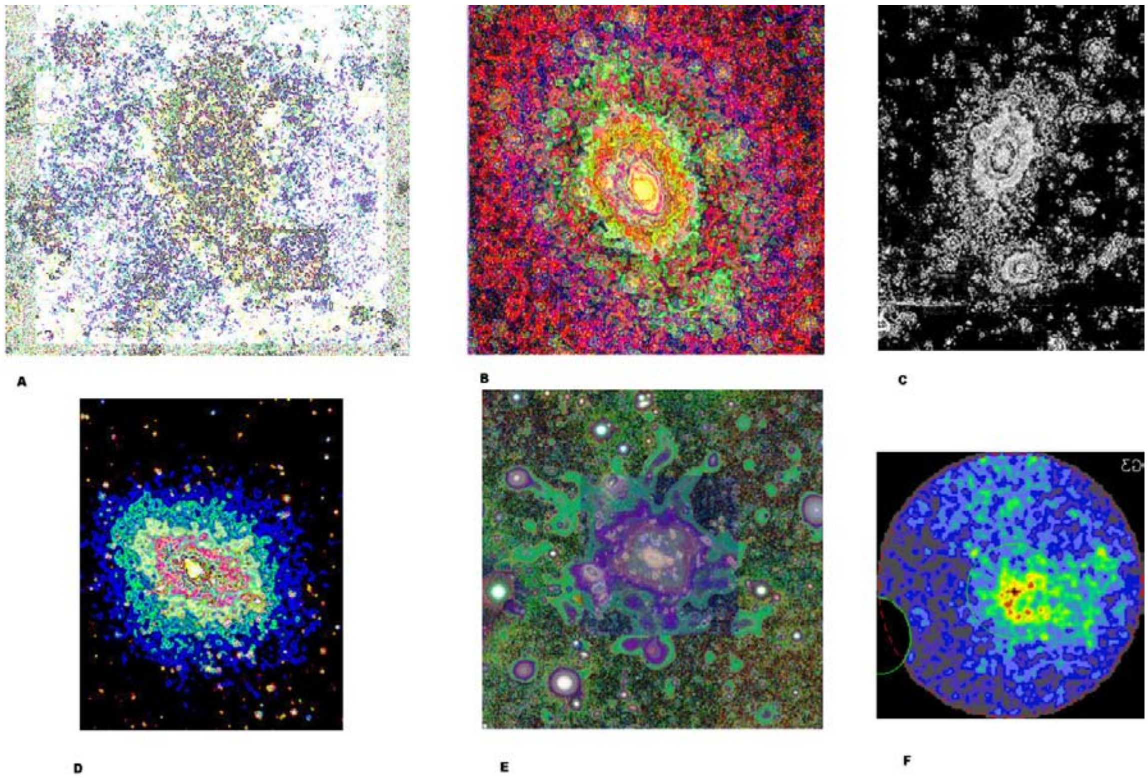


Figure 10: Infalls and ejections in the galaxy clusters at different red-shifts:Very similar to the structures seen in the inner part of spiral galaxies. In images A, B and C the spiral arms around the inner shells are visible. In D the spiral arms have disappeared. E shows a dwarf cluster at high red-shift. In F the inner spiral structure becomes visible. A) CL 1358+62 galaxy cluster core, B) Abell 2029 galaxy cluster core, C) Abell 3558 galaxy cluster core, D) Abell 2018-1132 galaxy cluster core, E)Core of RDC 1252, F) Abell 3556 core.

objects. The discussions of the formation of smaller cosmic bodies by fragmentation and ejection from larger object will be treated separately in another article. We will also not include the cases of collisions and interactions, which may deform the structures causing deviations from the universal manner by which cosmic bodies are formed. We shall keep the discussion of collision and merging of cosmic objects in that article too.

The universality of structure formation is most apparent at the core. This is because the core regions are usually much more luminous in different wavelengths and therefore the structures can be more easily observed than the outer peripheries which are difficult to observe.

3.1 Examples of the centers of galaxy clusters

The examples of the galaxy clusters, which we have given in figures 10 and 11, belong to very different red-shift values: For example, the cluster RDCS 1252 is high-redshift object with z=1.237 while the red-shift value for HCG 62 is nearly hundred times less (z=.0137). Although the redshifts of CL 1358+62 is nearly four times the redshift of Abell 2029 and about seven times the redshift of Abell 3558, the structures are strikingly similar. Not only the universality exists across the different redshift values, the universality is also maintained whether the cluster is a small group like the nearby Compact group of galaxies HCG 62 , or it is one of the largest massive clusters in the sky like Perseus cluster, Abell 3558 (in Shapley superclus-

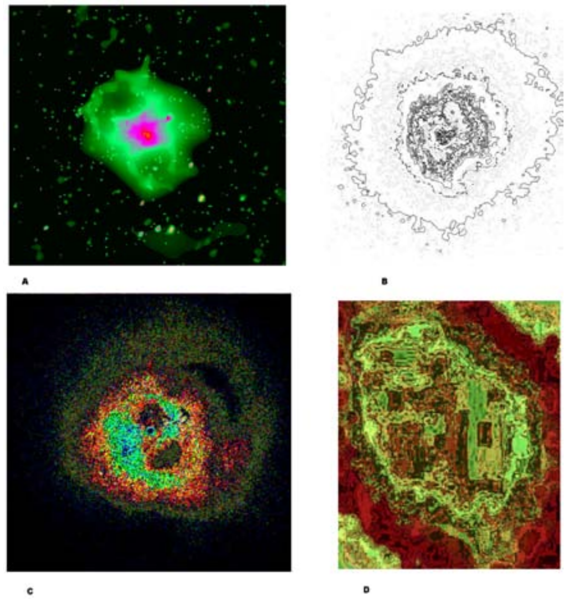


Figure 11: Inner spirals at the hearts of the galaxy clusters: A) Core of HCG 62 galaxy cluster in X-ray, B)Core of Hydra A galaxy cluster, C) Center of Perseus cluster, D) Structure at the heart of Abell 2029 core.

ter), or Abell 2029 (at z=0.08). In the examples in figure 10 we have shown the basic structure that exists at the core. In figure 11 the spirals existing inside the nuclei are shown.

The main features of the structures are ejections from the center and then the ejected material returning back to form the structure at the core. The outward streaming occurs from the deep heart of the nuclear center as well as from the opposite ends of nuclear bar. Inside the nuclear bar rings develop. Inside the rings one finds the 3-armed spiral structure, which regulates the inflow and outflow. As seen in the first few images of galaxy clusters(fig.10), ejections from the center and from two ends of the nuclear bar appear to be generic phenomenon in the formation of galaxy clusters.

The same process repeats inside the galaxies too.

3.2 Examples of galaxies

The best galaxy types to compare with the core of the galaxy clusters are those galaxies which have active nuclei like the Seyfert galaxies and galaxies with high star formation activities at the core.

In all of the above examples in figure 12 there are ejections from the nuclei, while the nuclear centers are surrounded by rings with high star formation rate. They are all nearby galaxies. Among them NGC 2903 is closet to us at around 20 million lyrs away while NGC 1097 is the farthest at a distance of about 45 million light years.

Most of the massive nearby galaxies are spiral galaxies of two categories - normal spiral with dominating spiral arms which encircle the nucleus and barred spiral. The barred kind possesses bar-like elongated structure at the core while the spiral arms emerge from the two ends of the bar structure and are flung outward without encircling the center. The examples of the seyfert galaxies, we have given, belong to the barred type. The nearby region is devoid of any massive elliptical galaxy. The ellipticals are mostly seen in dense cluster environments, where spiral arms of the galaxies are stripped off in encounters with other galaxies. Or they are observed at high redshifts. Based on the calculation of distance by using the cosmological model of big-bang where higher redshift is equivalent to larger

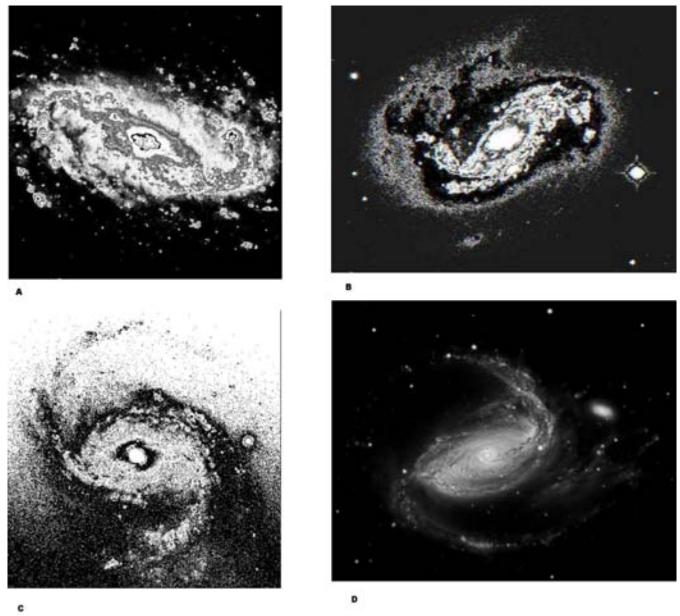


Figure 12: Highly active galaxies with large star formation rates: A)NGC 2903 galaxy with star formation, B) NGC 4051 Seyfert Galaxy, C) NGC 6951: Type II seyfert, D) NGC 1097: Seyfert with concentration of quasars around.

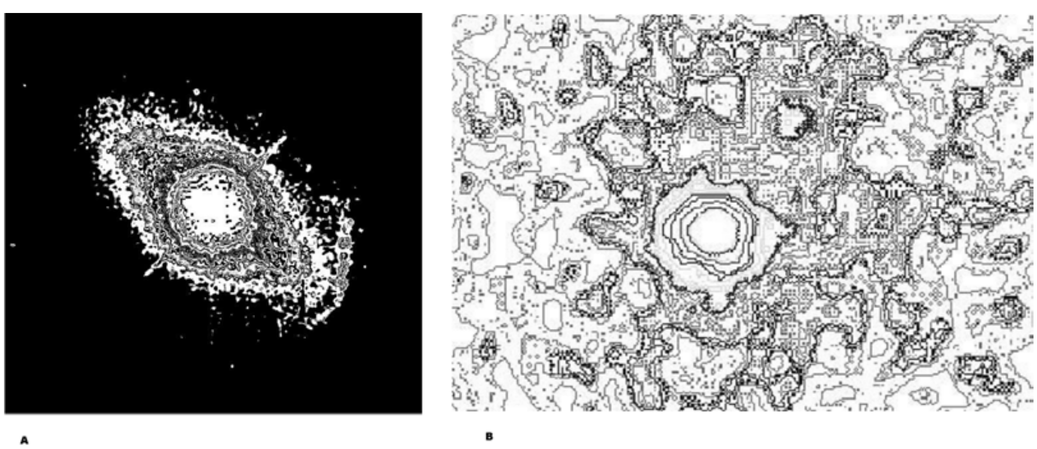


Figure 13: Quasar and Blazar: A) Quasar: QSO 1229+240, B) Blazar: 3C279

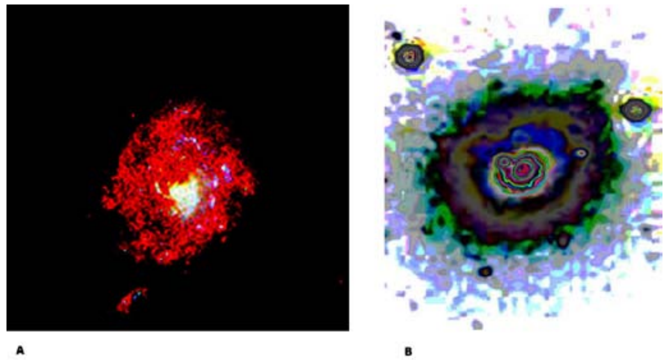


Figure 14: Ejections from the centers of galaxies: A) The nucleus of the highly active seyfert galaxy NGC 1672, B) The nucleus of the massive elliptical galaxy NGC 1275 at the centre of the Perseus cluster.

distance from us, high redshift objects are interpreted as the objects which are formed very early in the creation of the universe. This has led astronomers to conclude that the luminous star like high redshift objects, which are seen in the universe, must be sources of enormous outpouring of energies - many orders of magnitude more luminous than the galaxies we observe around us in the nearby universe. They are called quasars (Quasi Stellar Object). Some of these quasars are observed to have violently variable energy output. They are called Blazars. Furthermore, profusions of small blue galaxies with high star formation rates are observed at high redshift. According to big-bang model they are the primordial building blocks of galaxies which exist in the nearby universe.

In contradiction to this big-bang based explanation of the high red-shift objects we find the quasars, the blazars and the small blue star forming galaxies to be objects ejected from massive nearby galaxies, or galaxies in clusters. As we have said before, we shall refrain from taking up the discussion of ejected objects here and postpone it for our next article. However, also in quasars and blazars we find similar universal elements of structure formation as in galaxy clusters and galaxies.

In quasars and blazars one finds structures that one observes deep inside the nuclei of galaxies (fig.13). Many of them could be smaller objects ejected from the cores of the larger galaxies like Seyfert galaxies, which are animated by high activities at their centers. These nuclear structures in turn are similar to what one may find in the nuclei of galaxy clusters.

We shall continue to discuss these similarities down to the scale of the formation of the star clusters and individual stars too.

3.3 Examples of star clusters

Star clusters appear in many varieties: Some are only made of a few stars while some consist of thousands or millions of stars. The formation of different types of star clusters may follow different routes: One by the process of evolution of hierarchically ordered fractal clumps existing as molecular clouds which constitute the main cloud structures inside galaxies and the other by ejection and fragmentation of smaller objects from larger clouds during the process when the larger units evolve towards more compact structures. Ejections and fragmentation also occur in large cosmic scales like galaxies and clusters of galaxies. We have not discussed these questions for galaxies and galaxy clusters so far.

Here we shall again skip the issue related to ejections and fragmentation and continue our discussion in the same line as we have done so far in this article. The majority of dense star clusters, which we observe, mainly rise from the process of evolution of ejected clouds, which fragment and separate themselves from the main body of the galaxies as they evolve, or dense clusters may form in dense clouds inside the galactic cores. The universality of formation of cosmic structures is quite apparent in these clouds where dense star clusters agglomerate. The best examples are the

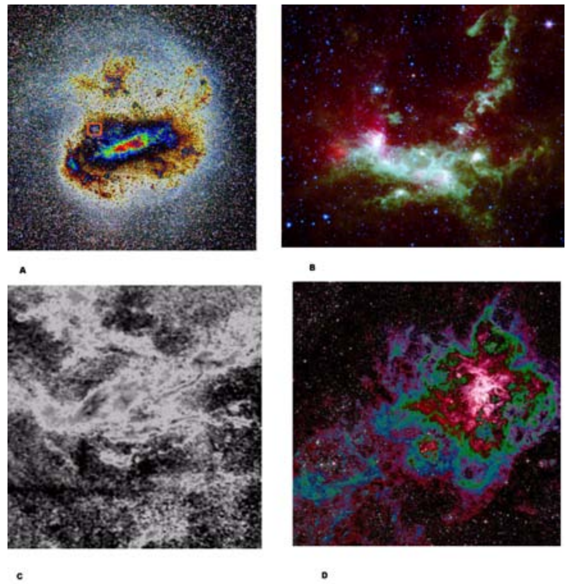


Figure 15: Giant molecular clouds where star clusters form: A) Large Magellanic Cloud (LMC): Tarantulus nebula which harbors one of the largest star clusters is being ejected from LMC center (marked by red rectangle, B) Heinze 206 in Small Magellanic Cloud, C) Taurus molecular cloud- nearest site of major star formation in our galaxy, D) Tarantula nebula in LMC (the area inside red rectangle in image A): Large star cluster named R136 sits at the heart of the nebula.

Small and Large Magellanic clouds which are the nearest star formation regions outside our galaxy. In these clouds one can get a direct view of how star clusters may take shape. In our own galaxy the Taurus molecular cloud and Orion clouds are among the nearest star formation clouds well studied by the Astronomers.

The formations of star clusters involve very similar processes that lead to the central concentration of stars at the galactic center. This involves the existence of a three armed spiral structure encircled by two bow-shaped arms moving from two opposite sides and forming a shell around the central core. As we have said before, violent ejections take place from the center of this three armed spiral. These ejected material, entrapped inside the shells, return back towards the center and feed the structure which is developing at the core. Thus two structures, which are joined together at the center, emerge and create channels that send outflowing materials as inflowing material back to the center. Dense star clusters form in the heart of such structures followed by the formation of three armed spiral (see fig.16).

What one observes in the large scale structures repeats in the star clusters too. Some are open clusters; some are compact clusters showing spiral arms at the centre; some are very dense clusters, like the globular clusters of spherical shapes containing thousands to millions of stars. These globular clusters, which look like balls made of stars, move mostly in the galactic halo and could have resulted from fragmentation and ejections of clouds from the galaxy.

Image A in figure 17 is of R136 in the 30 Doradus region in the Large Magellanic coloud, which lies about 170 000 light years away from our galaxy. 30 Doradus is the most massive star formation region in the Local Group of galaxies. The area of R136 shown is about 50 light years. The center of R136 consists of many huge stars which are more than fifty times more massive than our sun. The image B is one of the most massive star clusters in our galaxy.

The formations and evolutions of dense star clusters are similar to the formations and evolutions of the central parts of galaxies and clusters of galaxies. At the heart of the star clusters a three armed spiral structure appears (see images in fig.18) which regulates the inflow and outflow from the center of the cluster. In fact, one should be able to understand the detailed

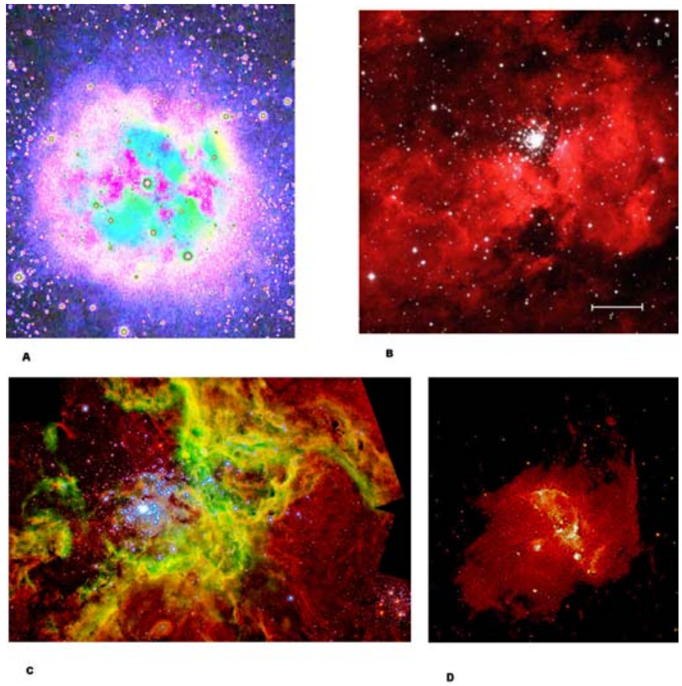


Figure 16: Three armed spiral and formation of dense star clusters at the center of the spiral structure: A) Star cluster embedded inside a three armed spiral in Cocoon nebula, B) Another star cluster inside a spiral, C) Cluster R136 at the heart of Tarantula nebula flanked by the spiral, D) NGC 346 in Small Magellanic Cloud: Cluster at the center of a spiral.

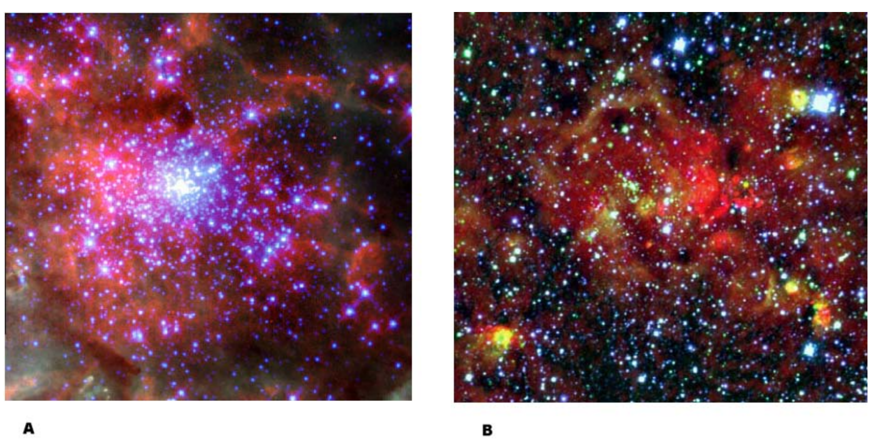


Figure 17: Stellar clusters at the centers of the three armed spiral structures feeding themselves by the material ejected from the centers: A) R136 in LMC: One of the largest star clusters observed,which is embedded inside a structure similar to what one finds within 2 light years inside our galaxy center, B) W49A: One of the most luminous star cluster in our galaxy.

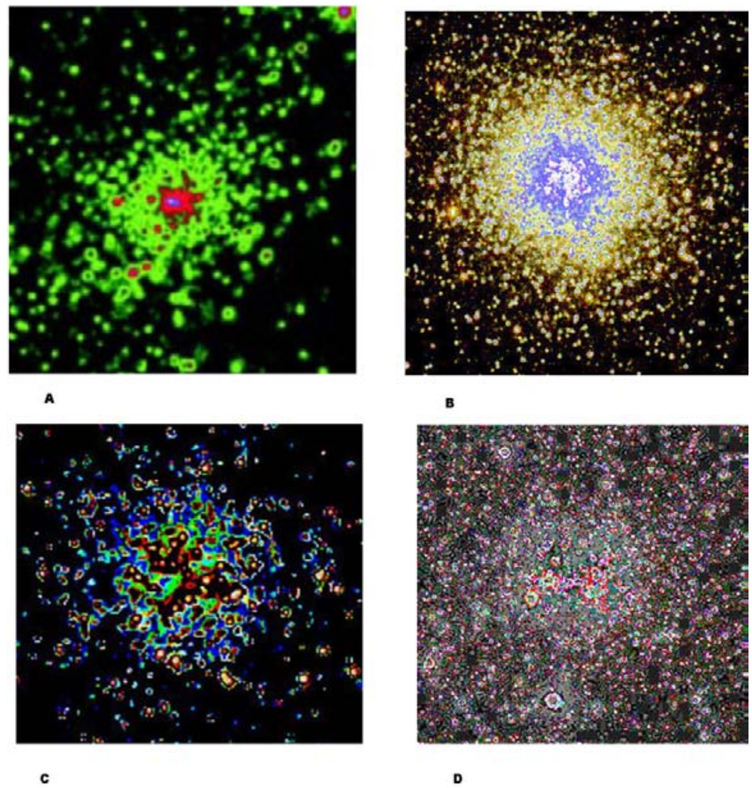


Figure 18: Spiral structures at the hearts of star clusters: A) Star cluster NGC 3603, B) Star cluster 47 TUC in Small Magellanic Cloud, C) M13 star cluster containing the spiral at the center, D) An open star cluster NGC 2194 with the universal spiral appearing again at its heart.

dynamics of the process going on at the centers of large scale cosmic structures by studying the cores of such small structures like the star clusters which are closer to us.

The three armed spiral embedded inside ring, which sits at the heart of a larger three armed spiral embedded inside an even larger ring, which in turn sits at the heart of another spiral appears to be most central mechanism in the formation of cosmic structures in the universe. This fractal nature of the 3-armed spiral is illustrated in image B in figure 19.

This 3-armed spiral is the foundation of a cosmic design which reveals itself in all scales. It is a design inside a design inside another design and so on stacked inside each other in a hierarchical manner. Through this cosmic design the universe reveals its perfect order which embodies the tinniest object inside the largest structure arranged in a fractal manner. We shall discuss about this cosmic design in another article and skip it here. Instead we shall proceed to the discussion of the formation of individual stars.

There are many examples of birth of stars in strongly magnetized clouds where the spiral structure appears. While the shells surrounding the core of the stars expand outwards, as in a supernovae, one may see the presence of this spiral inside the deep heart of stars (see fig.25).

As demonstrated in Fig. 20 star formation involves spirals, similar to all other cosmic structures, which we have discussed so far. The spirals which appear at the heart of the stars are surrounded by shell structures both in young and old stars.

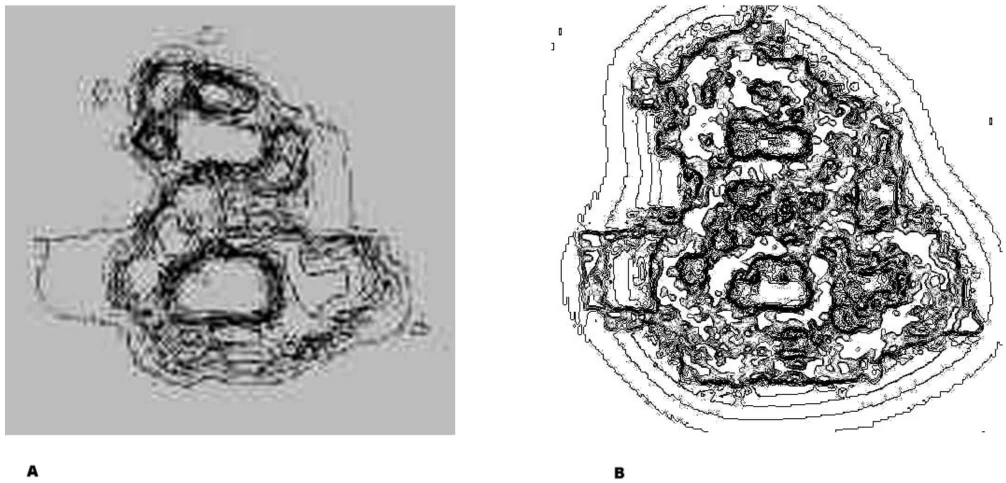


Figure 19: Three armed spiral at the heart of supercluster of galaxies: A) 3D Spiral structure at the heart of NGC 1275 which is the central structure at the core of Perseus supercluster of galaxies, B) More detailed view of the same 3D spiral at the heart of the Perseus supercluster.

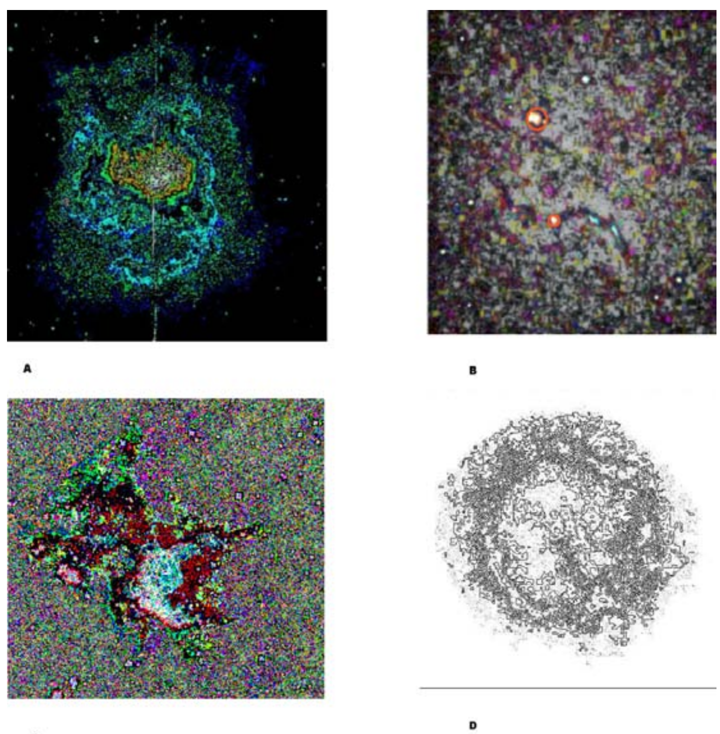


Figure 20: Spirals in the formation of group of stars and massive Wolf-Rayet stars: A)The star formation in L1174: T- Tauri stars are embedded inside the spiral, B) Star formation in dark clouds in L1551 in Taurus: Several T-Tauri stars are embedded inside the spiral form: IRS 5 and T-Tauri stars marked by red circles, C) NGC 2359: Formation of massive Wolf - Rayet star in spiral, D) The expanding outer shells reveal the spiral inside the star in the supernova SN E0102-72.

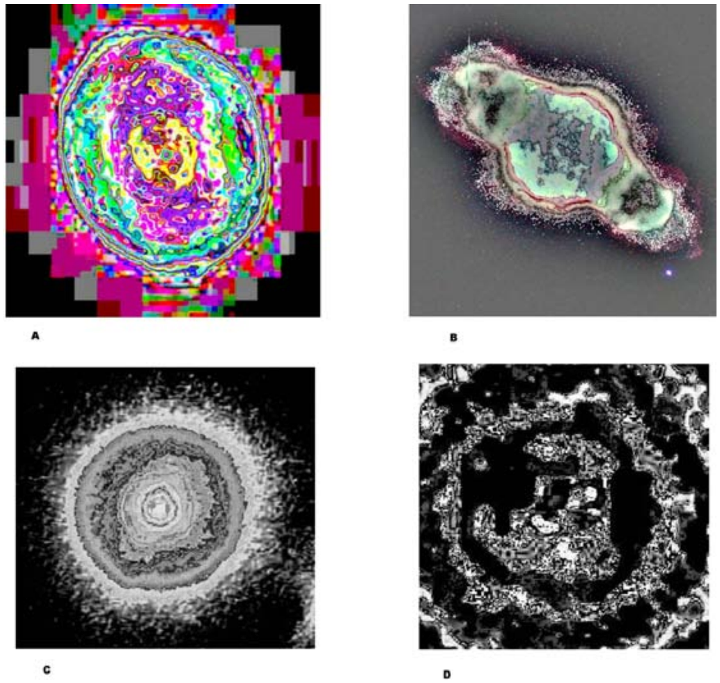


Figure 21: Spiral embedded inside shells in young new born stars as well as old dying stars: A) Dying star - Spirograph nebula IC 418 of 0.3 light year size: The expanding outer shells reveal a hot star at the core, B) NGC 6886: Decaying star reveals the inner spiral at its heart - the shells are splitting apart while ejecting blobs perpendicular to the direction of motions of the expanding shells, C) Structure of T-Tauri star before it turns into a star like our sun, D) The central spiral at the heart of T-Tauri star shown in C.

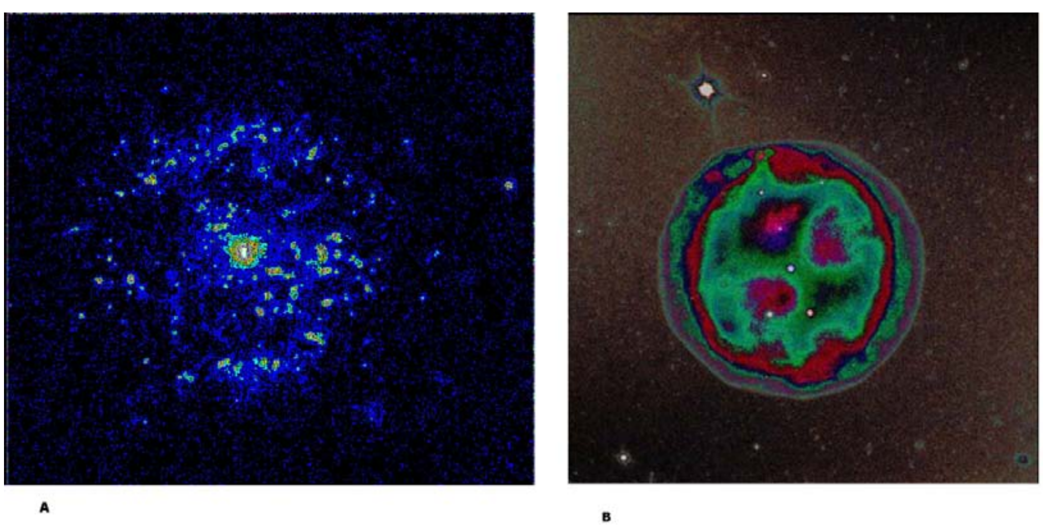


Figure 22: White dwarfs inside nebulous shells:A) Nova T Pyxidis: White dwarf repeating explosions reguarly, B) A white dwarf star at the heart of Owl nebula of 1.5 light year in size.

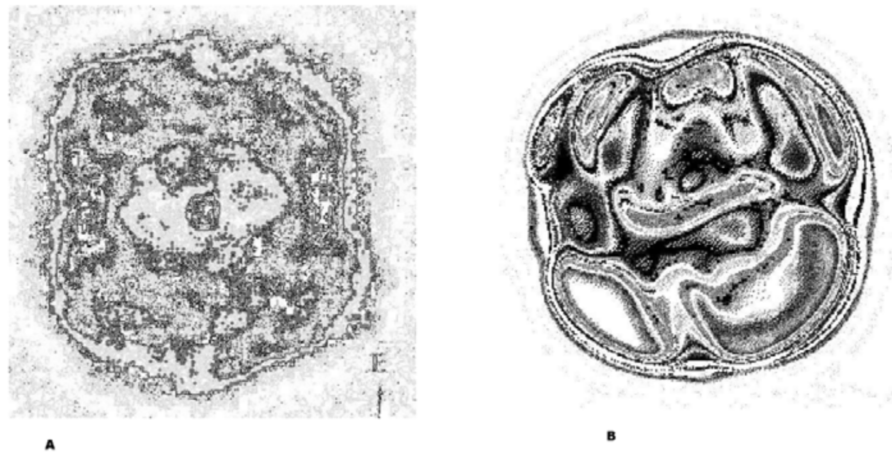


Figure 23: Outer surface of the stars being fed by ejections from the center: A) Planetary nebula M 4-18: The ejections from the center create two lobes, which are joined at the top and the bottom. As the stars will age the top and bottom joints will loosen and the shells will fly away revealing the central structure of the star, B) The structure of long living stars in their more vigorous age: Two halves of the shells that form the outer structure on the surface of the star feed each other by the help of a spiral lying at the center

In image D of figure 21 we show the spiral structure inside the young T-Tauri star, which is also highly variable in luminosity. It lies in Taurus molecular cloud and illumines a gaseous nebula known as Hind's nebula lying in its lower right side (not visible in the image). The image B (fig.21) shows how the shells surrounding the central star split in halves and expand while the knots once holding the two halves together as rings fly away from top and bottom. The image A is on the verge of reaching the stage as seen in B. The images in figure 21 are very similar to the structures that we have seen in the cores of the galaxy clusters and the galaxies. Thus spirals embedded inside shells, as in other cosmic structures can also be seen in stars.

Stars like our own sun evolve from the proto-stars known as T-Tauri stars. These T-Tauri stars harbor a spiral at its core. The spiral helps to transfer hot gases from the center towards the surface of the star where the gases cool and sink back towards the center again in a very similar manner like what happens in the cores of galaxies or clusters of galaxies. Again the main features inside stars comprise of shells surrounded by outer lying similar shells. These shells, like other examples, are comprised of two bow shaped structures joined at two ends. As the star evolves and ages the joints, where two structures are tied together to form rings, loosen and the shells split into two halves and separate. They fly away from opposite sides of the star. However, in every stages of evolution, from formation to decay, in the heart of the star lie a three armed spiral that ejects hot gases towards the surface and accretes cold gases sinking towards the center before sending them back to the surface again (fig.23).

The spirals are abundant in planetary atmospheres. It is observed in the outer ring of Saturn too. Dust streams moving outward from the rings of Saturn and Jupiter, as well as dusts moving from the discs to polar regions are also observed by the spacecrafts sent to study these planets. We find that the structures made of outflowing and inflowing components of dust may exist for these giant planets, which resemble similar dynamics as in larger cosmic structures. From the x-ray data of Jupiter we are able to discover a spiral structure at the heart of Jupiter(fig.26). This spiral appears to be connected with the turbulent structures at the poles of Jupiter. These polar regions of Jupiter are strong x-ray emitters. However, the most remarkable is the structure of Pluto. It is nothing but a frozen 3D-spiral structure (fig.26).

By now we have covered a range of sizes of cosmic objects differing by millions of trillions of times. The universal behavior in structure formation, mediated by spiral, seems to hold in all cosmic scales.

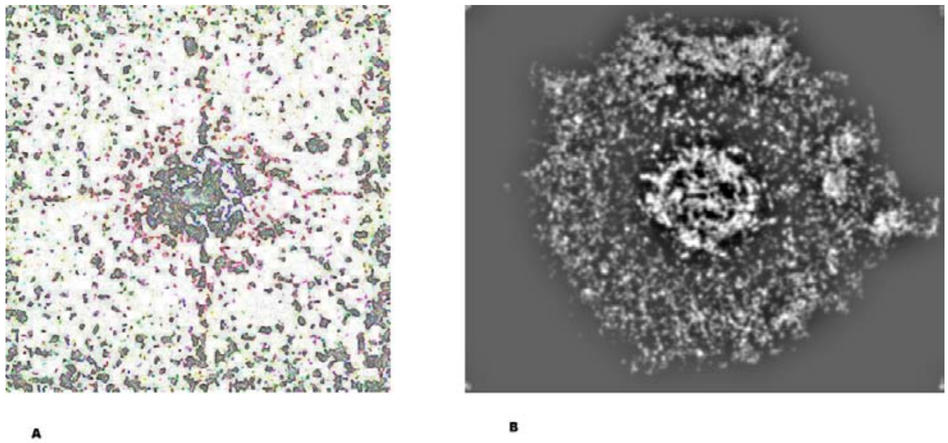


Figure 24: Inner spiral at the heart of the stars: A) The spiral structure at the center of 51 Pegasi, a sun-like star (a little older) about 50 light years away. The evidence of first exoplanet is found around this star, B) GQ Lupi: The central spiral in a very young T-Tauri star where the first direct image of a exoplanet (to the right edge of the picture) has been made. It is 400 light years away.

4 Summary and conclusion

In contradiction to the standard approach, where big-bang based theory is used in understanding the observed data of cosmic structures, our approach has been to build an understanding of formation of cosmic structures by analyzing the observed data in different wavelengths without being motivated by any particular theory. Then we try to find a theoretical ground to explain the observed phenomena.

We have based our analysis on the observational data available at different wavelengths (from radio to x-rays). Special techniques of extracting deeper information from the digital data are used to extract information from images that are not visible through the usual image processing methods used by different observational groups. Most of the images in the paper obtained by using special techniques from the available data are shown in false colors.

Our study indicates that there exists a universal method of building structures in the universe starting from the largest structure observed to the tinniest cosmic structures like planets which are millions of trillions times smaller in scale. The main foundation of this universality lies in the formation of spirals in hierarchically descending scales and the mechanism of inflow and outflow regulated by this spiral structure.

All structures are formed by the mechanism of ejection from the center and infall towards the center. These structures, formed as fractals, are made of similar clumps of smaller sizes resembling the large structures in hierarchically descending scales. The clusters of galaxies are made of clumps of galaxies, galaxies are clumps of star forming units where star clusters appear, star clusters are clumps of stars, and stars are formed from smaller clumps of molecular clouds. Similar mechanism of ejection and infall proceed in a hierarchical manner in smaller and smaller scales. This mechanism of channeling outflowing hot gases from the center back towards the centre is driven by a universal spiral structure which lies at the heart of all cosmic bodies.

This universal three armed spiral, sitting at the heart of structures, ejects material outward. The ejected material gets confined within the inward flowing material and these interactions lead to the formation of shells around the core. These shells form by two spiral arms coming close together, and fusing into one structure as elliptical or circular ring. Depending on how dense and massive the structure is, the number of shells may increase and they are stacked up inside each other in a hierarchical manner as rings surrounded by rings. In these rings four open regions develop in the form of two pairs of mouths lying nearly perpendicular to each other, through which communications between the structure inside the core, and

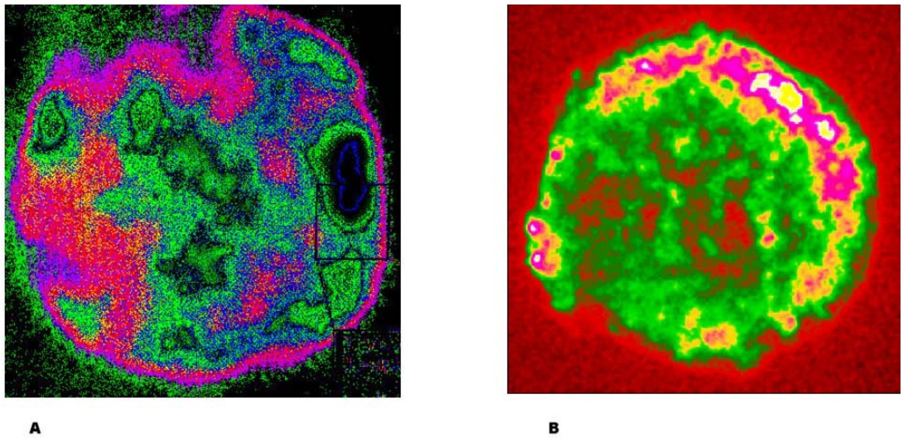


Figure 25: Spirals at the heart of the Type I supernovae seen in exploding stars: A)Image of supernova NG272.2-3.2A: Exploding star reveals in x-rays the three-armed spiral, B) Tycho supernova in Cassiopea which was visible to naked eyes for more than 16 months from November 1572 to March 1574. The three-armed spiral at the center is visible in x-rays.

Figure 26: Spiral in planets: A) Spiral at the heart of Jupiter seen in x-ray data. The strong x-ray emissions from poles are related to the central spiral, B) Pluto is not a sphere but a frozen 3D spiral knot structure made of ice, C) Dust streams flowing outward from the ring plane of Saturn bend back from the equator to the poles in the similar way as gas flows in other cosmic structures. There is an inflow and outflow of dust around Saturn which cover a region several times larger than the diameter of the ring.

structure which lies at the periphery occur. These mouths let matter stream towards the core and leak out from the core. As one moves outward from the core, two spiral arms which surround the structure become more and more distinct and look different from being parts of the rings. Similarly, when one moves in the other direction and approaches the center one observes more intense ejections from the opening mouths. The ejections from the centre join the spiral arms moving inward and thus carry feedback from small to large scales in forming integrated cosmic structure.

Depending on how massive the structure is, the spiral arms may be tightly or loosely wound around the central core. Cosmic structures are never born alone. They are accompanied by groups of similar objects embedded inside a larger unit. However, in the process of formation some structures may be ejected outside the group and appear in more isolated places. There are constant interactions among the structures that surround each other. These interactions may sometimes change the usual evolution of structures by deforming the core and/or striping materials from the spiral arms.

As the structures evolve, which means as the structures grow towards more massive cores, surrounded by more and more massive rings, the spiral arms feeding the core dwindle. In such evolved structures spiral arms become faint and weak while the inner shells become more strong and dominant. In the other direction, in the early stage of evolution, the core does not show such rings and, instead, is surrounded by more distinct spiral arms. In proto stage when the structures start to take their births, the spiral arms as well as the core remain diffused. When the amount of material streaming in and streaming out from the core approaches near equality the structures emerging inside the core becomes stable. Before this phase is attained when more matter stream into the core than what are expelled outward it generates the process of growth by forming newer structures at the core in higher rate. At this stage the structures show intense nuclear activities. After that phase when the outward supply gets less and less and inward activities increase leading to more vigorous ejections, the structures may become unstable and core start to disintegrate. In the end such evolved cores may burst open and undergo decay by ejecting jets.

This universal process of evolution, that brings the structures through the phases of growth and decay, cause different appearances of the structures which we observe in the universe in different scales. However, the universality of structure formation is more clearly revealed in the phase when the core becomes dominating. The main features of universal structure, as seen at the core, is the formation of hierarchically embedded shells surrounding a three armed spiral structure. In the womb of this spiral there exist even smaller spiral around which the masses agglomerates at the center. At the heart of the smaller spiral an even smaller ring, which holds an even smaller spiral at its heart repeats in smaller and smaller scales. This fractally embedded spiral is the foundation of all structures in the universe.

The other main feature related to structure formation is the ejection of smaller bodies from the lager structures as they evolve. The way the ejected clumps form cosmic structures like dwarf galaxy clusters, dwarf galaxies, and dwarf stars and planets, are not discussed in this paper. They will be discussed in our next article.

In contrast to the big-bang based models which assume gravity as the sole player in the formation of large scale structures, the present analysis, instead, indicates that turbulence and magnetic fields could be the major players in the formation of structures in the universe. Though the dynamics of turbulence and magnetic field is mentioned in this article, no detailed study is presented here. They will be discussed in a separate article later.

The main conclusion of this article is that the universal way the cosmic structures form by following a fractal hierarchy is not compatible with the big-bang based models of structure formation: ΛCDM model envisages formation of elliptical galaxies in the early stage of creation of the universe. These early types of galaxies form very quickly and then do not evolve any more for many billions of years. In these models the late type ellipticals are explained as the results of merging of spiral galaxies, while the spiral galaxies themselves are believed to have formed by merging of small "building block" star forming galaxies observed at high red-shifts. Instead of that, we conclude that the universe builds structures - however small or large - in the same universal manner where spiral structure built in a hierarchical fractal manner, lies at the heart of all. The same universal mechanism operates at high and low red-shift objects. Many of the high red-shift objects are bodies ejected from larger structures at lower red-shifts. The morphologies of the ejected objects depend on the time of ejection during the evolution of large structures from where they are ejected. The ejections from the core tend to form denser and more compact spherical objects, while the ejections from outside the core create more irregular shapes.

According to this view point, by studying stars one can learn more about the formation of galaxies and clusters of galaxies and similarly by studying galaxies and clusters of galaxies one can gain knowledge about the formation of stars. As the large universe images itself in the same way in the tinniest structures, one should be able to understand the universe by studying small structure which we observe nearby.

References

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