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Evaluation of the Fourth-Degree Polynomial Correlation Between Rotational Angular Velocity of Eighty-Four Spiral Barred Galaxies with Radius

AIYOHUYIN, O. E.[1], EKWUBIRI, E. C.[2]
[1,2]*University of Benin, Benin-City.*

Abstract- The Spiral-Barred galaxy is a spiral galaxy with a central bar-shaped structure composed of stars. Bars are found in about two-thirds of all spiral galaxies in the local universe. They generally affect the motions of stars and interstellar gas within spiral galaxies and can also affect spiral arms. Python, Visual Studio, and Math Lab are the software used to study eighty-four spiral-barred galaxies. Data for this computation of rotational angular velocity were sourced from the Internet and the National Aeronautics and Space Administration (NASA). These parameter values were used with the equations of rotational angular velocity for estimation. A program was written with Python for the computation of rotational angular velocity, and the results were tabulated alongside data sourced from the Internet with their units. Some of the results for rotational angular velocity generated for eighty-four spiral barred galaxies are Whirlpool/NGC 5194 (4.77E+128 Km/s), Pinwheel/NGC 5457 (4.09E+130 Km/s), Phantom/NGC 628 (1.82E+122 Km/s), Malin I (4.01E+137 Km/s), Messier 98/NGC 4192 (9.57E+128 Km/s), and Messier 109 (6.43E+130 Km/s). It was discovered that the grouped spiral-barred galaxies were atypical of each other since they behaved differently. The 4th-degree galaxies of the same group acted more profoundly in a topsy-turvy manner, since the increased value in the rotational angular velocity increases in the radius and decreases at a certain stage within the radius-increasing range, it picks up again and finally decreases with an increased radius. The 3rd and 4th-degree polynomials of spiral barred galaxies of the same group B act in opposite modus. Eighty–four spiral-barred galaxies were classified into four groups namely: A, B, C, and D, and it was reviewed that all the groups show different characteristics through their plot alignments, which indicates that spiral-barred galaxies are peculiar to each other, which could be as a result of their different angular momentum.

Index Terms- Spiral Barred Galaxies, Galaxies, Radius, Rotational Angular Velocity.

I. INTRODUCTION

According to Roberts-Borsani et al. (2023), a galaxy is a system made up of stars, stellar remnants, dust, interstellar gas, and dark matter that are all bound together by gravity. From the Greek word "galaxies," which means "milky," the word "galaxy" is derived, and the Milky Way galaxy is the one that surrounds our solar system. Galaxies are believed to have 100 million stars, ranging from dwarf galaxies with fewer than 100 million stars to the largest galaxies classified as "supergiant" with 100 trillion stars surrounding their galaxy's mass centers. In a normal galaxy, stars and nebulae make up very small percentages of the overall mass, while dark matter makes up the majority of the material. Supermassive black holes abound in the centers of galaxies (O'Callaghan, 2022). Astronomical galaxy labels categorize them as irregular, spiral, or elliptical based on their apparent shape. Supermassive black holes are thought to be located in the center of many galaxies. The black hole at the Milky Way's heart, Sagittarius A*, is four million times more massive than the sun. The observable universe is thought to include between 200 billion (2H10^{11}) and 2 trillion galaxies. The majority of these galaxies have sizes of up to 1,000 to 100,000 parsecs (3,000 to 300,000 light years), and are separated by millions of parsecs or megaparsecs. With a diameter of at least 152,000 light-years, the Andromeda galaxy is the closest major companion of the Milky Way galaxy. In contrast, the Milky Way galaxy is at least 26,800 parsecs (87,400 light years) in diameter. The intergalactic space medium is a gas that exists between galaxies and has a usual density of less than one atom per cubic meter. The primary structures created by gravitational organization among the universe's galaxy mass are galaxy groups, clusters, and superclusters. The Milky Way is part of the local

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group of the Andromeda galaxy (Lauer *et al.,* 2021). The group is a member of the Virgo Superclusters. These links are typically arranged into sheets and filaments surrounded by massive gaps in the universe's large-scale structure. The Superclusters of galaxies include the Virgo Superclusters and the Local Group. When galaxies were initially seen using telescopes, they were referred to as spiral nebulae. In the 18th and 19th centuries, most astronomers classified them as unresolved star clusters or anagalactic nebulae, and although they were thought to be part of the Milky Way, their exact composition and structure were still unclear. A few neighboring bright galaxies, such as the Andromeda galaxy, were clarified using larger telescopes and were found to be massive star clusters. However, the actual distances of the objects were far beyond the Milky Way based solely on their apparent faintness and sheer amount of stars (Bedregal *et al.,* 2006). As a result, they were often referred to as "island cosmoses," a term that soon became obsolete since "cosmos" meant the entirety of existence. Or they were just identified as galaxies.

Plate 1: NGC 4414 (Wikipedia, 2024).

II. MORPHOLOGICAL AND TYPES OF GALAXIES

According to the categorization system used by the Hubble Space Telescope, an Elliptical Galaxy is represented by an E, a Spiral Galaxy by an S, and a Barred Spiral Galaxy by an SB. This study includes two additional forms, Lenticels and Interacting Galaxies, in addition to the four primary classifications of Ellipticals, Spirals, Peculiar, and Irregular galaxies (Horváth *et al.,* 2015).

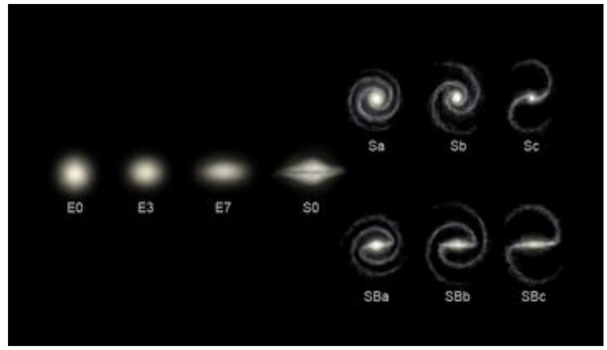

Plate 2: Explanation of galaxy forms based on appearance (Wikipedia, 2024).

Additionally, the Hubble Sequence provides additional information regarding galaxy types according to their shapes. Important features of galaxies, like the rate of star generation in starburst galaxies and activity in the centers of active galaxies, may be overlooked by the Hubble Sequence since it only examines the optical morphological type (contour). Supermassive black holes are believed to exist in a large proportion of galaxies (Horváth *et al.,* 2014).

2.1.0 Ellipticals

The Hubble classification method uses ellipticity, which ranges from E0 (nearly spherical) to E7 (extremely elongated), to rank ellipse galaxies. Regardless of the viewing angle, these galaxies seem elliptical due to their ellipsoidal outlines. Their appearance lacks structure, and they frequently contain small amounts of interstellar material. As a result, these galaxies have fewer open clusters and a slower rate of new star formation. Instead, they naturally orbit a shared center of gravity that controls previous star evolutions. The stars have a good number of dense components since star formation ceases after the initial explosion. They mimic the much smaller globular clusters in this way. The cD galaxy and the Shell galaxy are two well-known elliptical galaxy forms that are covered in this thesis (Robertson, *et al.,* 2023).

2.1.1 cD Elliptical Galaxy

The cD elliptical galaxy has an isophotal width of almost 800,000 light-years due to gravitational lensing. The cD galaxies, first described by Thomas A. Mathews and associates in 1964, are the biggest galaxies. They are a significantly larger subtype of the enormous elliptical galaxies that make up the more widespread D class of galaxies. Supergiant elliptical galaxies are currently the biggest and brightest galaxies known to exist. A vast, faint star halo that extends over megaparsecs envelops the oval core of these galaxies. Their surface lighting profile decreases more slowly with radius or distance from their cores than their less noticeable counterparts (Jarrett, 2012).

Plate 3: Galaxy cluster Abell 1413 controlled by cD elliptical galaxy (Wikipedia, 2024).

The most commonly accepted explanation for the genesis of these cD galaxies is that they are the result of mergers between fainter galaxies either inside dense clusters or outside of randomly over-density clusters, however, this is still an active area of research. Fossil groups or fossil clusters are formed by a variety of mechanisms, where a huge, relatively solitary supergiant elliptical star sits in the center of the cluster and is encircled by a massive X-ray cloud formed by multiple galactic collisions. Observations of clusters such as the Perseus and, more recently, the Phoenix clusters confirm another older idea that proposes the phenomena of cooling flow, in which heated gases in the clusters break down towards their centers as they cool, creating stars in the process (Keel, 2006).

2.1.2 Shell Elliptical Galaxy

A shell galaxy is an elliptical galaxy with stars grouped in concentric shells inside its halo. Ten percent of elliptical galaxies have a shell-like structure that is never seen in spiral galaxies (Keel, 2000). It is thought that when a larger galaxy swallows up a smaller companion galaxy, these systems perform better. Similar to ripples on water, the two galaxy centers start to oscillate around a central point as they get closer to one another. This oscillation creates gravitational waves, which ultimately form star shells. For example, the galaxy NGC 3923 includes more than 20 shells (Howell & Harvey, 2022).

Plate 4: NGC 3923 Elliptical Shell galaxy (Hubble photograph) (Wikipedia, 2024).

III. SPIRALS GALAXY

The global rotation curve notion confirms that most of the material in spiral galaxies is housed in a roughly spherical halo of dark matter that extends beyond the visible component. Because of this, spiral galaxies have a pinwheel-like appearance, even though their stars and other visible components are often on a horizontal plane. Spiral galaxies are composed of an older star bulge in the center and a rotating disk of stars and interstellar material. It makes sense for the arms of the bulge to expand outward. The type S classification for spiral galaxies uses a letter (a, b, or c) to indicate the tightness of the spiral arms and the mass of the midway bulge. Regardless of whether a galaxy is barred or ringed, it will always appear to be spiral (Knapen *et al.,* 2002).

Plate 5: Spiral galaxy (Wikipedia, 2024).

Plate 6: Spiral barred galaxy (Wikipedia, 2024).

Sa galaxies have closely packed, barely discernible arms and a comparatively big center region. According to Kormendy and Ralf (2012), a Sc galaxy is an exposed galaxy with a tiny core region and identifiable arms. The weakly differentiated spiral arms of a flocculent spiral galaxy are distinguished from those of a grand plan spiral galaxy, which have well-defined spiral arms. Since some spiral galaxies are narrow and compact, while others contain large bulges, it is believed that the rotating speed of a galaxy is related to the homogeneity of the disc. Spiral galaxies have spiral arms that roughly resemble logarithmic spirals; this structure can be described theoretically as the result of an uneven rotation of a mass of stars. As with stars, the spiral arms have a constant angular velocity as they orbit the center. The "density waves" or areas with high material densities are thought to be the spiral arms. The gravitational attraction of the amplified density as stars move through an arm affects the space velocity of each cosmic system. When the stars leave the other side of the arm, the velocity goes back to normal. When a lot of traffic is moving along a highway, this causes a "wave" of slowdowns. They are observable because of the great density of the arms, which leads to star formation and produces a lot of brilliant, young stars (Fabian & Lasenby, 2019).

3.1.0 Whirlpool Galaxy

On the plate below, NGC 5195 (M51b) is the smaller object in the upper right-hand section (Skibba, 2023). With a Seyfert 2 active galactic core, the Whirlpool Galaxy is an interacting spiral galaxy that is also known as Messier 51a (M51a) or NGC 5194 (Adams &Laughlin, 2006). Spiral-barred galaxies were initially identified in this galaxy, which is located in the constellation Canes Venatici. Its diameter is 23.58 kiloparsecs (76,900ly) and its distance is 7.22 megaparsecs (23.5 million light-years). Binoculars can be used to view the galaxy and its companion, NGC 5195, making it easy for amateur astronomers to observe the stars. Professional astronomers have studied the Whirlpool Galaxy and its companion with NGC 5195 extensively in order to get an understanding of galaxy structure, especially that related to the spiral arms, and galaxy interactions. One of the most well-known and closely interacting systems is its pair with NGC 5195, which makes it a popular topic for galaxy interaction models (Robertson, *et al.,* 2023).

Plate 7: Whirlpool Galaxy (M51a) (NASA/ESA) (Wikipedia 2024)

3.1.1 Discovery and Visual Appearance of Whirlpool Galaxy

The whirlpool galaxy has a spiral structure, according to William Parsons, who employed a 72-inch (1.8-meter) reflecting telescope at Birr Castle Irland. The first is the "nebula," which is known to have only one spiral arm (Atkinson, 2022). The discovery of Cepheid variables in some of these spiral nebulae by Edwin Hubble, which demonstrated that they were so distant that they had to be completely distinct galaxies, led to the recognition of these "spiral nebulae" as galaxies. Charles Messier discovered the Whirlpool Galaxy on October 13, 1773, while looking for items that could mislead comet hunters. Later on, Messier's collection of astronomical objects included it under the catalog number M51. This interaction between the Whirlpool galaxy and its companion galaxy was clearly shown by the introduction of radio astronomy and later radio imaging of M51 (Chamba, 2020). The pair of galaxies may occasionally be referred to as M51; in this instance, the individual galaxies may be called M51a (NGC 5194) and M51b (NGC 5195).

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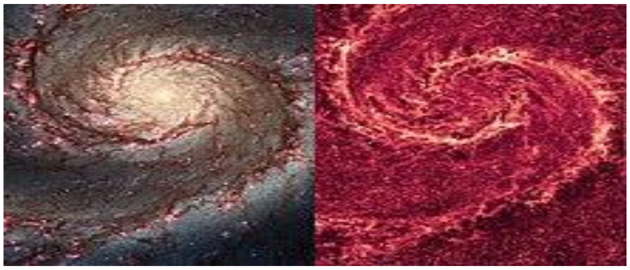

Plate 8: Whirlpool Galaxy in visible light (left) and infrared light (right) (Wikipedia 2024)

The easiest way to locate M51 deep within the constellation Cane Venatici is to locate the Big Dipper's easternmost star, Alkaid, and then travel 3.5° southwest (Cornejo, 2020). It reaches a high altitude throughout this hemisphere, making it an accessible object from early November through the end of May. After that, observation is more coincidental in modest latitudes with the risen sun (due to the Sun approaching and receding from its right ascension, specifically figuring in Gemini, just to the north). Its declination is rounded at +47°, for observers above the 43rd parallel north, making it circumpolar (never setting). Modern amateur telescopes can resolve M51 in detail, and it can be seen using binoculars under dark sky conditions. With a 100 mm telescope, the fundamental shapes of M51 (which are just 5x6') and its companion can be observed. With a modest eyepiece and a 150 mm telescope, it is possible to detect the intrinsic spiral structure of M51 under the black sky. M51 can be seen to be attached to M51b, and the different spiral bands are visible with HII areas when using larger (>300 mm) telescopes in dark-sky circumstances. Its actual structure can only be determined by looking at images, as is typical with galaxies; long exposures show a sizable nebula that extends beyond the apparent circular form (Cornejo, 2021). With the help of the high-speed detector, the so-called image-photon-counting-system (IPCS), which was created in collaboration between the CNRS Laboratoire d'Astronomie Spatiald (L.A.S.-CNRS) and the Observatoire de Haute Provence (O.H.P.), and the exceptionally good visibility provided by the Canada-France-Hawaii-Telescope (C.F.H.T.) 3.60m Cassegrain focus on the summit of Mauna Kea in Hawaii, the Whirlpool Galaxy's triple component was discovered in 1984. The information box above displays the 11,477 × 7,965 pixel composite image of M51 that was created in January 2005 by the Hubble Heritage Project using Hubble's ACS instrument. The picture displays details of some of the structures inside the spiral arms of the galaxy as well as highlights them (Koptelova & Hwang, 2022).

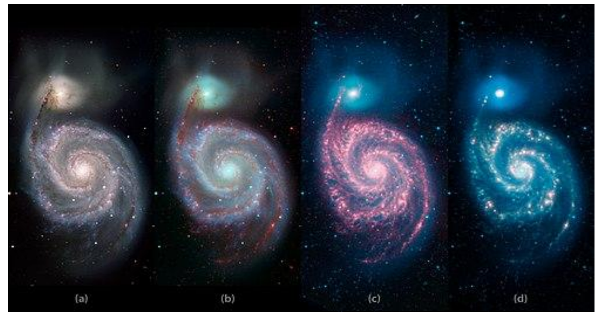

Plate 9: Whirlpool galaxy observed in various light of a) 0.4 µm and 0.7 µm; b) visible-blue/green and IR-red; c) 3.6 µm, 4.5 µm, and 8 µm; d) 24 µm (Wikipedia 2024).

3.1.2 Properties and Spiral Structure of Whirlpool Galaxy

According to the Third Reference Catalogue of Shinning Systems' 1991 estimation, which used the D25 isophote at the B band, the Whirlpool World is between 23 and 31 million lightyears away from Soil. The Whirlpool Systems span 2358 kiloparsecs or 76900 lightyears. The Smooth Way measure is nearly 88 in the entire universe. According to estimates, its mass is 160 billion sun-oriented masses, or roughly 103 times that of the Smooth Way World (Ober, 2023).

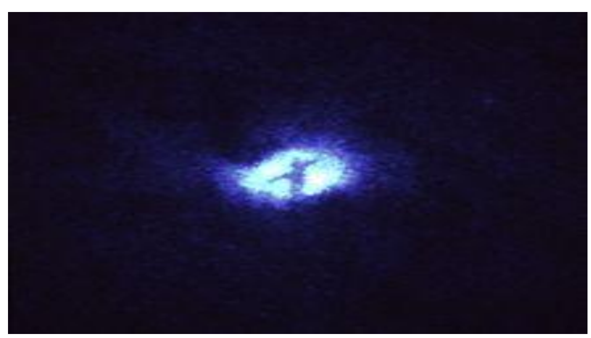

Plate 10: Hubble image showing a knot of dust encircling the black hole at the center of M51 (Wikipedia 2024).

At the center of the spiral is a black hole that was formerly thought to be encircled by a ring of dust but

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is now thought to be partially obscured by dust. From the active galactic nucleus, two ionization cones radiate outward. The two conspicuous spiral arms of the Whirlpool Galaxy wind in a clockwise direction. One arm greatly departs from a steady angle. The close interaction between the Whirlpool Galaxy and its companion galaxy, NGC 5195, which may have passed through the main disk of M51 between 500 and 600 million years ago, is thought to be the cause of the galaxy's prominent spiral structure. According to this theory, NGC 5195 approached the observer from behind M51 and crossed the disk again as recently as 50–100 million years ago, arriving at its current location just behind M51 (Robertson et al., 2023).

IV. METHODOLOGY

Using information from the National Aeronautics and Space Administration (NASA) (NASA 2019) and the internet, the rotational angular velocity and other parameters were computed. The results for rotational angular velocity, specific angular momentum, and angular momentum were determined using other parameters. The letters in equation (16) correspond to spiral-barred galaxy parameters. Python was used to create a program for calculating the rotational angular velocity of spiral-barred galaxies because their parameters are too big to be computed using a plain calculator. Here is an example of a Python program:

```
#1
#WHIRLPOOL GALAXY or MESSIER 51A or NGC 5194

#Estimation of the rotational velocity of a barred galaxy

g = 6.674*10**-11   #gravitational constant in meters cube per kilogram per secs square

c = 3.0*10**8       #speed of light in meters per secs

j = 1.7*10**26       #specific angular momentum of the galaxy in meters square per secs

m = 3.18*10**41     #mass of galaxy in kilogram

r = 3.6*10**20      #radius of a galaxy in meters

v = (3*g*m*j**2/c**2*r**3)**1/2        #rotational velocity in meters per secs

print(v)

 #2

#PINWHEEL GALAXY or MESSIER 101 or NGC 5457 GALAXY

#Estimation of the rotational velocity of a barred galaxy

g = 6.674*10**-11   #gravitational constant in meters cube per kilogram per secs square

c = 3.0*10**8       #speed of light in meters per secs

j = 1.9*10**26       #specific angular momentum in meters square per secs

m = 1.99*10**42     #mass of galaxy in kilograms

r = 8.0*10**20      #radius of galaxy in meters

v = (3*g*m*j**2/c**2*r**3)**1/2        #rotational velocity in meters per secs

print(v)
```

Using the MATLAB predictive modal, the computed values were tabulated and utilized to forecast the behavior of eighty-four (84) barred galaxies. To help reduce the risks associated with overpopulation, the population impact of the United States of America was predicted using the MATLAB predictive model known as the prediction of the United States population. An illustration of MATLAB syntax for forecasting and linking rotating angular velocity, mass, and radius is provided below:

```
% Radius

R = []';

% Rotational Angular Velocity

Rav = []';

% Plot

plot(R,Rav,'bo');

axis([9.2e-13 2e1 9.8e-8 2e4]);
```

```
title('Correlation between Rotational Angular Velocity and Radius');

ylabel('Rotational Angular Velocity');

xlabel('Radius');

p

n = length(t);

s = (t-8.5)/8.5;

A = zeros(n);

A(:,end) = 1;

for j = n-1:-1:1, A(:,j) = s.*A(:,j+1); end

c = A(:,n-3:n)\p

v = (9.2e-13:2e1)';

x = (v-8.5)/8.5;

w = (1.5e1-8.5)/8.5;

y = polyval(c,x);

z = polyval(c,w);

hold on

plot(v,y,'k-');

plot(1.5e1,z,'ks');

text(1.5e1,z+15,num2str(z));

hold off

c = A(:,n-4:n)\p;

y = polyval(c,x);

z = polyval(c,w);

hold on

plot(v,y,'k-');

plot(1.5e1,z,'ks');

text(1.5e1,z-15,num2str(z));

hold off

cla

plot(R,Rav,'bo'); hold on; axis([9.2e-13 2e1 9.8e-8 2e4]);

colors = hsv(8); labels = {'data'};

for d = 1:8

[Q,R] = qr(A(:,n-d:n));

R = R(1:d+1,:); Q = Q(:,1:d+1);

c = R\(Q'*p); % Same as c = A(:,n-d:n)\p;

y = polyval(c,x);

z = polyval(c,11);

plot(v,y,'color',colors(d,:));

labels{end+1} = ['degree = ' int2str(d)];

end

legend(labels,2)
```

The plots generated using MATLAB syntax as shown will be used in the discussion of this work.

V. RESULTS AND DISCUSSION

The upshots presented here were generated with the predictive model of “MATLAB”. The number of data plotted is for 84 spiral barred galaxies extracted and analyzed. These spiral barred galaxies were grouped into A, B, C, and D for best fit using the software. The grouping was based on the connection sandwiched between the rotational angular velocity and radius of the spiral-barred galaxy. The plots will be explained according to graphic appearance, which is the interpretation of the data as it represents the rotational angular velocity and radius of spiral barred galaxies.

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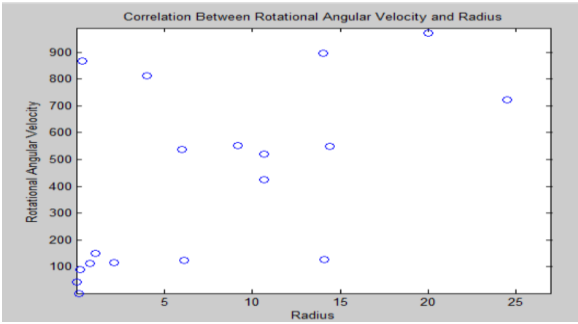

Fig. 1: Plot of Rotational Angular Velocity against Radius of Group A Spiral Barred Galaxies.

The spatial distribution of the plot point indicates the axis of rotation occupancies of the spiral-barred galaxies in the universe. The chosen scale gives the impression that the spiral-barred galaxies are densely packed together. As the size increases, the barred galaxies will appear to be more widely separated within the plot range. Galaxies that appear to be close to one another are those with masses or velocities that are somewhat similar based on the latitude and altitude of the earth. Interactions between galaxies are impacted by both mass and radius because angular momentum is dependent on both; the greater the radius, the higher the angular momentum of the barred galaxies. Because of this, if two or more barred galaxies are close to one another, it could mean that the larger mass is attracting the smaller mass to itself due to its higher angular momentum. They will eventually merge or form a cluster when they come together in space.

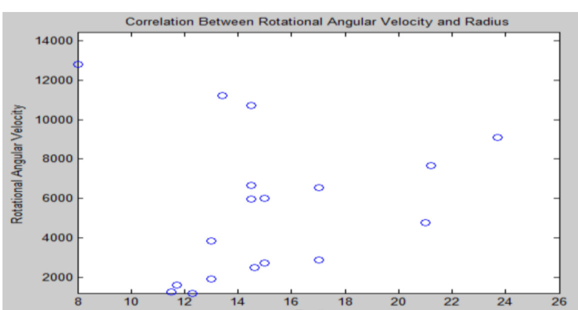

Fig. 2: Plot of Rotational Angular Velocity against Radius of Group B Spiral Bared Galaxies.

The scale that was employed is what gives the impression that the barred galaxies are closely packed together, even though in real space the axis of the site cycle is not a function of the distance between each spiral barred galaxy as seen in the graph. They appear to be near one other because of the model's alteration of their grouping, which is based on their rotating angular velocity and radius. Due to the small difference between their rotational angular velocity and radius, these barred galaxies appear to be close to one another in the universe, however this is not the case. Farther away from the clusters in the plot are the barred galaxies with remarkable rotating angular velocity and radius compared to the barred galaxies under consideration. While the linear velocity is directly related to both the radius and the angular velocity, the rotational angular velocity and radius of galaxies are not because the rotational angular velocity of a barred galaxy is inversely proportional to the radius and directly proportional to the linear velocity. A brief investigation indicates that the rotating angular velocity of spiral barred galaxies is due to its linear velocity. The product of radius and angular velocity is exactly proportional to linear velocity. The inverse adjustment between the rotating rotational velocity and the radius of the barred galaxies is thus depicted in the plot mentioned above.

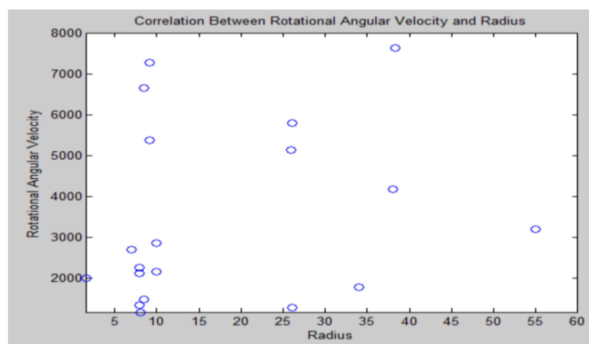

Fig. 3: Plot of Rotational Angular Velocity against Radius of Group C Spiral Bared Galaxies.

Since the rotational angular velocity of almost all spiral barred galaxies is not precisely proportional to their radius, the interest in one galaxy is independent of the other. The plot concludes that spiral-barred galaxies, which have risen in radius and rotational angular velocity, continue to occupy their space location in the absence of gravitational effect.

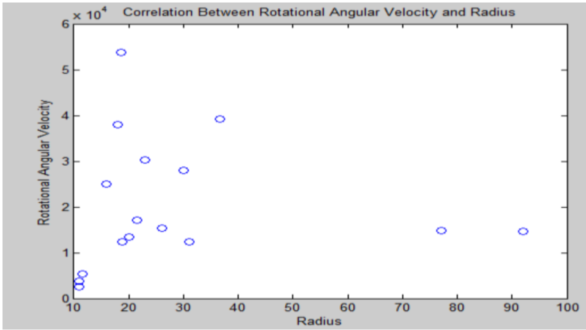

Fig. 4: Plot of Rotational Angular Velocity against Radius of Group D Spiral Bared Galaxies.

A galaxy's rotational location changes as the universe expands, which may have an impact on galaxy mergers or collisions. According to Hubble's law, galaxies go farther apart as the universe expands. Galaxy mergers can occur when two or more galaxies collide. These are the most violent interactions between galaxies. Only when galaxies collide or merge can they expand, and according to Hubble's law, galaxies grow farther apart as they disperse over the universe. Galaxy mergers may occur from collisions between two or more galaxies. Galaxy mergers are the most violent galactic encounters. Both the gravitational cooperation between gas and dust and the resistance between them have a substantial effect on the galaxies in the issue. While the velocity of spiral-barred galaxies tends to remain constant, their radius rises linearly with increasing mass. If not, there are slow changes in the gravitational interactions between their nearby galaxies. Angular momentum is proportional to the square of radius when mass, galaxy form, and angular velocity are held constant. Therefore, the increased radius of spiral-barred galaxies has a considerable effect on their angular momentum. Rotating angular velocity, on the other hand, is not directly proportional to the radii of galaxies; hence, angular speed varies linearly rather than fluctuating as a galaxy's radius changes. A circular path's tangential velocity increases with increasing radius and drops with decreasing radius.

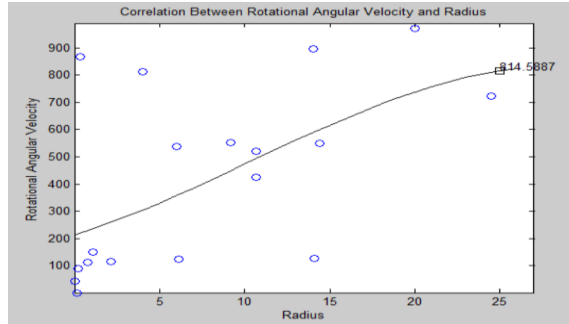

Fig. 5: Plot of 3rd–degree Polynomial of Rotational Angular Velocity against Radius of Group A Spiral Bared Galaxies

The spiral barred galaxies in Figure 5 above behaved similarly at the third-degree polynomial of group A due to the reformist growth in rotating rotational velocity and radius, resulting in a uniform increase in the plot. At some point in their existence, spiral-barred galaxies have a propensity to exhibit peculiar behavior, which could be the reason behind their collisions or mergers to form larger galaxies with unique properties. The radius of a revolving galaxy does not decrease with increasing speed. A rotating object's radius remains constant as long as no external forces are causing it to alter. A rotating object's radius and rotational speed are two independent properties. As can be deduced from the plot, a body rotating on an axis at a given radius remains constant until an external force act upon it; nonetheless, increasing angular velocity rises significantly with radius. This assumption is valid for the set of barred galaxies studied since different barred galaxies have different properties. The galaxy rotational angular velocity problem is the main difference between theoretical predictions and observed galaxy rotational angular curves. We can therefore conclude that the rotating angular velocity of barred galaxies is independent of the galaxy's radius since other factors must be considered.

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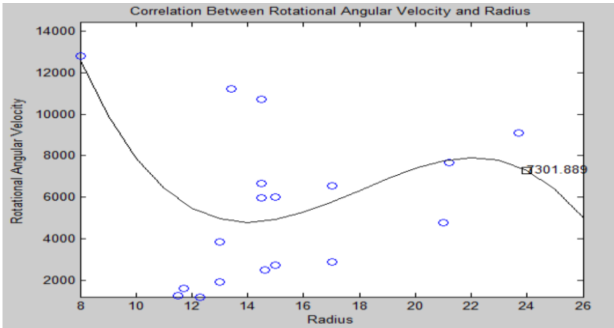

Fig. 6: Plot of 3rd–degree Polynomial of Rotational Angular Velocity against Radius of Group B Spiral Bared Galaxies

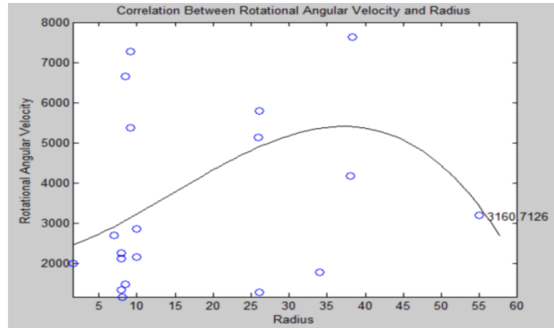

Fig. 7: Plot of 3rd–degree Polynomial of Rotational Angular Velocity against Radius of Group C Spiral Bared Galaxies

A third-degree polynomial of group B spiral barred galaxies showed a sinusoidal wave-like pattern in Figure 6, indicating their distinctiveness compared to group A spiral barred galaxies. The map made it clear how galaxies in the same group differed from one another according to the categorization made as a consequence of this investigation. The larger alteration of the rotational angular velocity and radius is meant to determine the destiny of the barred galaxies in the event of such a catastrophe. Furthermore, the rotating angular velocity and radius did not decrease because this kind of research was not designed for the predictive MATLAB model. The purpose of this increase is to make the graphs more comprehensible and to see how it affects the sample results. The formula (υ = r ω), which asserts that linear velocity is directly proportional to the product of angular velocity and radius, can be used to solve the problem if we assume that angular velocity (ω) is constant and independent of radius (r). Nonetheless, growing radius (r) will raise linear velocity (v), as linear velocity and radius (v & r) are precisely related. Then, to expand the radius (r), energy would have to be injected into the system. Therefore, the relationship between radius and linear velocity remains unchanged by rotational angular motion alone. Because the estimated rotating angular velocity and radius of the barred galaxies under study do not rise or decrease consecutively, their plots are dispersed throughout the plot display region. In the cosmos, barred galaxies are classified according to various features, such as the barred galaxies under study, because they lack a remarkable arrangement inside their orbital region.

The impulsiveness of the group C spiral is depicted by the mountain-like plot in Figure 7. Galaxies that are barred while considering the third-degree polynomial. At the midway point, rotational angular velocity dropped with respect to radius after initially increasing with respect to radius. These unusual characteristics made it evident that spiral-barred galaxies are not all the same. Such asymmetric features demonstrated the differences between spiral-barred galaxies. As shown by the equation (j = J/M), specific angular momentum is a crucial factor in galaxy evolution and is precisely proportional to the angular momentum per unit mass. It also has a lot to do with how visible and dark matter interact. Additionally, the angular momentum is precisely proportional to the galaxy's overall mass and particular angular momentum, which can be written as J = jM. The most remarkable large-scale feature of spiral galaxies are these bars, which result from non-local angular momentum transmission in galaxies. When stars from the exponential disk are rearranged into an energetically beneficial bar, the angular momentum is redistributed throughout the galaxy, resulting in the bar feature. By employing v = rw in the formulation of L = rmv, one can represent the angular momentum of an object moving in a circle in terms of the angular velocity (w). When v is substituted, L = mr2w is obtained. We may conclude that the high angular momentum of the barred galaxies under investigation is the reason for the dramatic experience in the plot by applying this formula to the influence on the plot sample.

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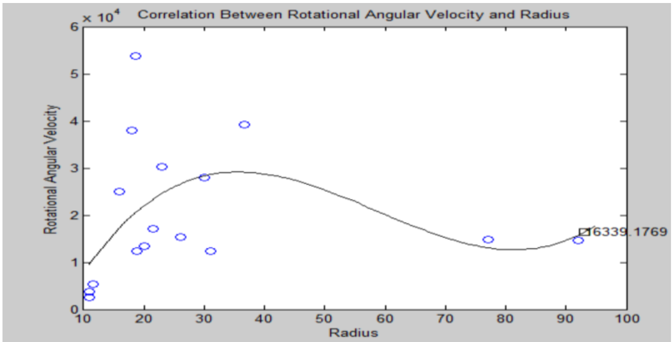

Fig 8: Plot of 3rd–degree Polynomial of Rotational Angular Velocity against Radius of Group D Spiral Bared Galaxies.

Although the crest and trough of the wave features were displayed in the opposite direction, the plot of group D spiral barred galaxies in Figure 8 approximated the sinusoidal wave-like appearance of group B spiral barred galaxies. The mountain-like picture resumed its upward trajectory and terminated along the horizontal plane in Figure 8. There are extremely few behavioral similarities amongst spiral barred galaxies, both individually and collectively, and they act significantly differently inside the third-degree polynomial. This could suggest that the activity of barred galaxies is governed by unidentified mechanisms, including gravitational interactions. Figure 8 implies that the progressive increase in the rotational angular velocity of barred galaxies may be the result of a correlation between the angular momentum and the rotational angular velocity, since there is no direct relationship between the radius and the angular momentum unless the rotational moment of inertia is considered.

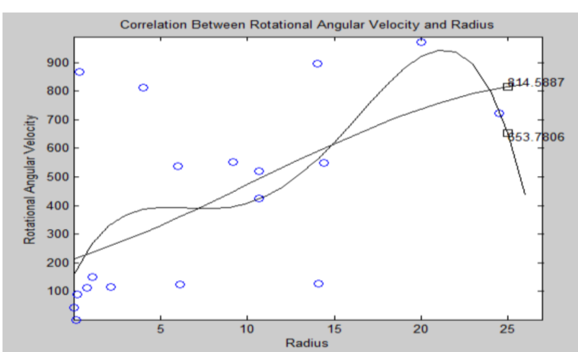

Fig. 9: Plot of 3rd and 4th degree Polynomial of Rotational Angular Velocity against Radius of Group A Spiral Bared Galaxies.

The fourth-degree polynomial in Figure 9 resembled a sinusoidal wave array and a mountain. It implies that galaxies in the same group act more fundamentally in a topsy-turvy manner at the fourth degree, as opposed to the third-degree polynomial. The graphic shows that the relationship between the rotating angular velocity and radius of spiral-barred galaxies is independent of each other. The increased rotational angular velocity value in the fourth-degree polynomial plot increases with radius, decreases at a certain point in the radius-growing range, and then increases again and decreases with a larger radius. This fourth-degree polynomial of spiral-barred galaxies illustrates the earlier observation that the rotating angular velocity of some of these galaxies is independent of their radius. The arc length of a galaxy is the angle turned on the circumference, which is the distance traveled along a particular direction within the axis of rotation. The radius of a galaxy is the distance between its center and its circumference. The rotating angular velocity is therefore a function of the arc length concerning time. Even as the revolving rotational velocity increases, spiral-barred galaxies frequently show dormancy inside the radius. This could be one of the reasons why larger spiral-barred galaxies continue to circle at a specific angular speed compared to smaller spiral-barred galaxies when no external forces are present. This influence led to a weak or nonexistent correlation between the spinning angular velocity and radius.

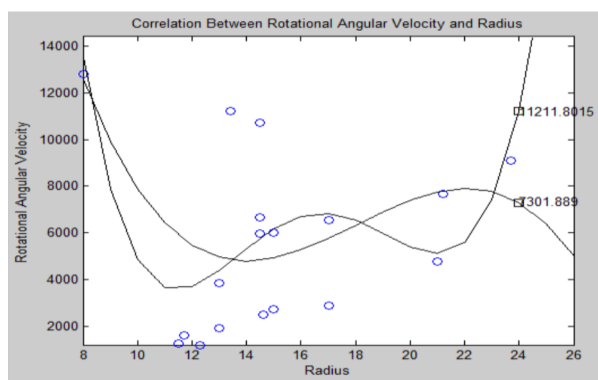

Fig. 10: Plot of 3rd and 4th degree Polynomial of Rotational Angular Velocity against Radius of Group B Spiral Bared Galaxies.

Though the third and fourth-degree polynomials of galaxies in the same group B function in opposite modes, Figure 10 illustrates the fourth degree of group B spiral barred galaxies. This indicates that group B spiral barred galaxies undergo a significant alteration when their rotating angular velocity increases with radius. Comparing the rotational angular velocity of group B's spiral-barred galaxies with their radius reveals inconsistent behavior.

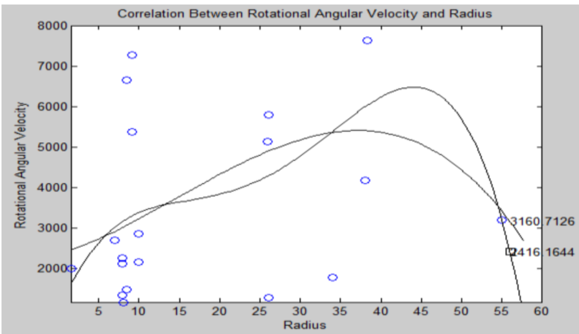

Fig. 11: Plot of 3rd and 4th degree Polynomial of Rotational Angular Velocity against Radius of Group C Spiral Bared Galaxies.

As seen in Figure 11 above, a group C spiral barred galaxy's fourth-degree polynomial showed a mountain-like appearance that was comparable to a third-degree polynomial observed experimentally. An increase in radius within the fourth-degree polynomial resulted in an increase in rotating angular velocity. The rotational angular velocity began to decrease as the radius increased, and there was another little increase at the peak height. This demonstrates how unusual spiral-barred galaxies are.

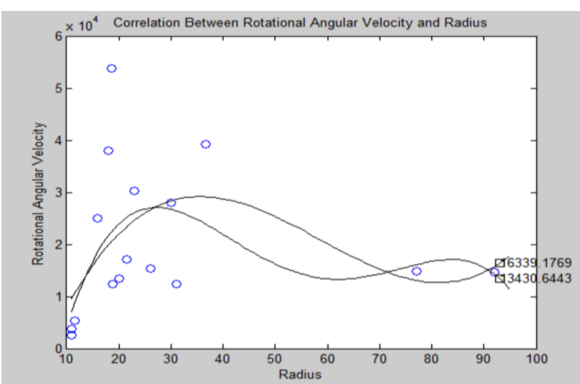

Fig. 12: Plot of 3rd and 4th degree Polynomial of Rotational Angular Velocity against Radius of Group D Spiral Bared Galaxies.

The chart of third- and fourth-degree polynomials is shown in Figure 12 as well. Though nearly opposite to their line of plot, the fourth-degree polynomial graph is comparable to the third-degree one. This suggests that clustered spiral barred galaxies show distinct features at various oscillation velocities with radius. An experimental rise in both will result in unusual chaos in spiral-barred galaxies, even if the correlation between their rotating angular velocity and radius is independent of one another. The distinctiveness of unfluctuating and clustered spiral-barred galaxies is similar, albeit this is exclusive to the kind of spiral-barred galaxy. As a result of the gravitational capabilities of barred galaxies and their interactions with other galaxies, the angular momentum of barred galaxies is the driving factor that dictates what occurs within the gas and stars contained in the spiral barred galaxies." An object's precession frequency will drop if its radius is increased because this will indirectly increase its angular momentum. The most straightforward way to explain angular momentum is to look at an object with mass (m) moving in a circle with radius (r) and tangential velocity (v). The formula for its angular momentum (L) is $L = mrv$. One can estimate the radius using the formula $r = L/mv$. For a spiral barred galaxy, this means that the radius is inversely proportional to the product of mass and velocity and directly proportional to the angular momentum.

VI. SUMMARY

Making the argument that spiral-barred galaxies are different from one another is thought-provoking. Local groups of galaxies differ in their features but are unique in their orbital states and structures. There are similarities between spiral-barred galaxies and other galaxies in terms of angular momentum, dark matter, gravitational attraction, and gravitational interactions. The gravitational pull is the force of attraction between galaxies with large angular momentum and those with low angular momentum. Similarly, the gravitational interactions are between the internal and exterior gravitational forces that exist between galaxies. There is a direct or indirect gravitational pull between galaxies as a result of the dark matter force of gravity holding them in their axis of orbit. Spiral-barred galaxies' internal interactions between the force of rotating gases and stars are the source of their angular momentum. It is common for galaxies with large or robust angular momentum to pose a threat to those with weaker or lower angular momentum. While galaxies with nearly or the same angular momentum combine, swishing and fraternization occur in the two scenarios described. Galaxies with scrawnier angular momentum are sucked up by galaxies with robust angular momentum. Other factors, such as the gravitational forces and angular momentum present in barred galaxies, determine their correlations with angular velocities and the radius of spiral barred galaxies, while the rotational angular velocities of barred galaxies have little to no effect on the latter.

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