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A Theory for Galaxy Formation: Innovative Model for Evolution of Galaxies as a Function in the Initial Cloud 2π and 4π Geometry and Acceleration

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Abstract

The **Big Bang idea** is referred in the **glorious Quran.** As a matter of fact, there is no single integrated model describing the formation of all type of the galaxies. This work proposes a new theory and equations describing the controlling conditions and parameters of stars and galaxies formation. The derived equation called, Sayed`s galaxy formation formula **(SGFF)**, shows that the formation of the major disk (spiral) and elliptical galaxies is correlated to the 2π and 4π geometry of the initial cloud. Sayed`s temperature (Ts) , pressure (Ps) and radius (Rs) are among the effective parameters of galaxies formation. The mass of galaxy (Sayed`s galaxy mass formula- SGME) was also deduced based on acceleration and expansion and given as a new formula. The formulas were validated and verified by check of the units and comparison with the declared values. The minimum mass ($0.0774M_{\odot}$) for star formation was calculated and found to be fully matched with the reference range; 0.075 – 0.08 solar mass, for 4π geometry. The gas halo mass of the Milky Way was calculated with ~2 % discrepancy. Our previous article; Dark matter-energy to Hydrogen-helium ratio should be considered in galaxy formation mechanism and calculation.

Keywords: Galaxy formation model, 2π and 4π geometry, Sayed`s galaxy formation formula, galaxy mass

I. Introduction

It was assessed that the visible universe contains about two trillion galaxies. Our Milky Way galaxy embraces ~ 200 billion stars. How huge the universe is and **How Great the Creator of the universe is ?**

There are published theories and models tried to explain the galaxy formation. These great efforts of the scientists gave a wide spectrum of knowledge. However, There is no a definitive model of how galaxies form. One of the many problems astrophysicists face in trying to construct a useful model is the need to match observations of galaxies in the current or nearby Universe with those and those in the early Universe with theoretical simulations. Recent work on the role of dark matter in the early Universe has led to the hierarchical or bottom-up model gaining wide acceptance (1) Recent articles found correlation of π with dark energy- dark matter ratio and hydrogen-helium ratio. This is in addition to cosmological constant calculation and Black hole anatomy and others (2-9)

This work aims mainly at introducing a model describing formation of the galaxies at the beginning stages of the universe based on geometry of the gas cloud and other controlling parameters

II. Survey of galaxy formation models and observations

- Recently, the James webb space telescope revealed new images among them the farthest galaxy (Glass z13, of 13.4 billion light years away; dates back to 300 million years after the Big Bang (see fig.1 (10)**.** This image puzzles the astronomers and astrophysics concerning the Big Bang theory.

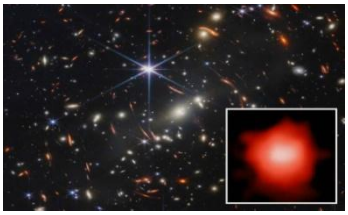

Fig. 1. The Farthest galaxy image (Class z13) by JWST -NASA */CSA/ESA/STScI, (10)*

- Classification scheme of the galaxies as given by E. Hubble is shown in the next fig. 2 **(11)**

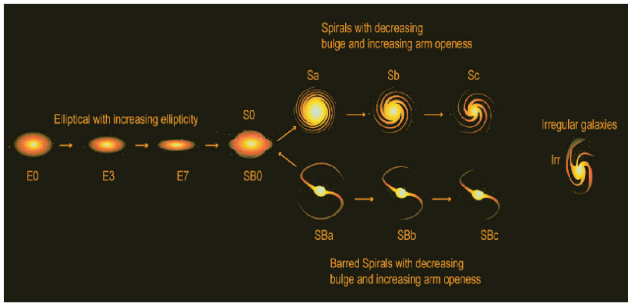

Fig.2. E. Hubble tuning fork diagram of galaxy morphology (11)

- In the absence of direct evidence, astronomers formed two theories: the theory of accretion, in which blobs of stars came together to form galaxies; and the theory of collapse, in which galaxies were formed in the collapse of an enormous gas cloud (12)
- The formation and evolution of galaxies are highly dependent on the dynamics of stars and gas, which is governed by the underlying law of gravity (13)
- The two principal theories relating to galaxy formation and evolution were suggested during the 1960s. The hybrid hierarchical model offers a viable explanation that can be used to have an understanding of how galaxies were formed and evolved (14)
- Merger histories of dark matter halos play an important role in hierarchical theories of galaxy formation. F. Zwicky realized that there must be some “missing mass” in clusters of galaxies (15)
- The barred spiral milky way anatomy can be shown in the following figure no. 3 (16)

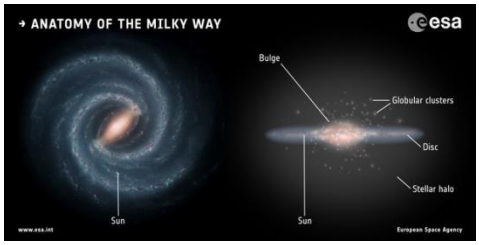

Fig.3. Anatomy of the Milky Way galaxy

- It is now generally accepted that the overall star-formation rate (SFR) of a galaxy is determined by its ability to form dense molecular clouds. The ‘microphysics’ and ‘macrophysics’, the former deals with the formation of individual stars in dense molecular clouds (often called ‘cores’), while the latter deals with the formation and structure of molecular clouds in galaxies (15)
- A few properties of the dynamics of stars in the two general morphological classes of galaxies: disc and elliptical systems. Their different dynamical states (discs supported by rotation; ellipticals supported mostly by random motion) and surface brightness radial gradients (17)
- Remarkably precise observations of the center of our Milky Way Galaxy and other galaxies have revealed that a great many, perhaps most, spiral and large elliptical galaxies are home to one or more supermassive black holes at their centers. The supermassive black holes are the central engines responsible for the exotic and remarkably energetic phenomena (18).

III. Derivation of Sayed`s galaxies formation formulas (SGFF)

Generally, the elliptical galaxies: the gas turns into stars right at the beginning of the collapse of the primordial dense region. While, Spiral galaxies: gas only turns into stars right at the end of the collapse.

This work introduces a model describing the formation of galaxies based on the **geometry** of the gas clouds. The sphere and disc geometry of gas cloud are used in this model to explain the formation of the major spiral and elliptical galaxies. By using James Jeans's mathematical formula for the radius of a spherical gas cloud at which pressure balances gravity (11,19,20,21)

$$\mathbf{R_c = \sqrt{(15K_B\, T / 4\pi\, G\, \rho\, m)}} \quad (1)$$

Where, K_B is the Boltzmann constant (Joule/kelvin), T is the temperature (Kelvin), G is the gravitational constant (N m^2/Kg^2 or $m^3/kg\ s^2$), ρ is the mass density (kg/m^3) and m is the mass of gas particles (Kg).

A) In the case of a spherical geometry

The sphere surface area (A_s) as a function in its radius (r) is given by:

$$\mathbf{A_s = 4\ \pi\ r^2} \quad (2)$$

The pressure (P) is defined as force (F; Newton) per unit area (m^2)

$$P = F/A \quad (3)$$

By substituting equation 2 in 3, one gets

$$P = F/ 4\ \pi\ r^2 \quad (4)$$

$$F = 4\ \pi\ r^2 P \quad (5)$$

The force of gravity (F) between two masses (m) and (M) is inversely proportional to the separating square distance (d^2) as (11).

$$F = G\ (m\ M/d^2) \quad (6)$$

By equating equation 5 and 6, The G can be deduced as follow:

$$G\ (m\ M/d^2) = 4\ \pi\ r^2 P \quad (7)$$

$$G = 4\ \pi\ r^2 P\ d^2 / m\ M \quad (8)$$

By substituting equation 8 in equation 1, one gets

$$R_c = \sqrt{(15K_B\ T\ m\ M/ 4\pi\ (4\ \pi\ r^2 P\ d^2)\ \rho\ m)} \quad (9)$$

Where, the volume (V) can be obtained from mass (m) to density (ρ) ratio as in equation 10;

$$V= mass/\rho \quad (10)$$

Substituting 10 in 9, gets

$$R_c = \sqrt{(15K_B\ T\ V/ 16\pi^2\ r^2 P\ d^2)} \quad (11)$$

Taking into consideration the ideal gas law (11)

$$PV = nRT \quad (12)$$

$$V= nRT/P \quad (13)$$

Where, P is the pressure (Pascal: newton /m^2 and Joule= 1N m), V is the volume, n is number of mole (physicists use the number of particles instead), R is the gas constant (Joule/mole kelvin) and T is the temperature (Kelvin). By substituting equation 13 in 11, one gets:

$$R_c = \sqrt{(15K_B\ T^2\ nR / 16\pi^2\ r^2 P^2\ d^2)} \quad (14)$$

This equation can be rewritten as given in equations 16 and finally equation 17;

$R_c = T/ 4 \pi d P r (\sqrt{(15K_B n R)}$ (15)

$4 \pi r^2 = T/ d P (\sqrt{(15K_B n R)}$ (16)

$4 \pi = T/P d r^2 \sqrt{(15K_B n R)}$ (17)

This formula (eq.17) shows that the **4π geometry** (**π= circumference/diameter)** of the gas cloud with the other parameters is the condition for initiating of the elliptical galaxies formation. The equation number 17 is called **Sayed`s galaxy formation formula (SGFF).** This formula was validated by check the units of its terms as follow:

m^2 = (kelvin / (N/ m^2). m). √ 15 (j /Kelvin) . mole. (j/mole. Kelvin)

The other parameters (Ts , Ps, r^2) which affecting the galaxy formation can be expressed as

$Ps = (T/ 4 \pi d r^2) \sqrt{(15K_B n R)}$ (18)

$Ts = 4 \pi P d r^2 / \sqrt{(15K_B n R)}$ (19)

$R_s^2 = (T/ 4 \pi P d) \sqrt{(15K_B nR)}$ (20)

Where. Ps, Ts and Rs are called **Sayed`s pressure, temperature** and **radius** respectively.

In general, elliptical galaxies are characterized by smooth, elliptical surface brightness distributions, contain little cold gas or dust, and have red photometric colors, characteristic of an old stellar population) 15) .The elliptical galaxies contain a significant amount of dark matter. More detailed estimates of the amount of dark matter in ellipticals show that up to 95% of elliptical galaxies' masses may be made up of dark matter (11)

B) In the case of disc geometry

In spite of the spherical assumption of the gas cloud given by Jeans, the cloud could be deformed to have any other geometry. For the disc geometry, the disc surface area (A_d) and its radius (r) is given by:

$A_d = \pi r^2$ (21)

Using the same abovementioned approach given in item (A), with taking into consideration the equation 21, one gets;

$2 \pi r^2 = T/ P d (\sqrt{(15K_B n R)}$ (22)

$2 \pi = T/P d r^2 \sqrt{(15K_B n R)}$ (23)

This formula (Eq.23) shows that the **2π geometry** of the gas cloud with the other parameters (Ps, Ts, r^2,…) is the condition for formation of disc (Spiral) galaxies. These type of spiral galaxy in which the spiral arms start at the end of a central bar structure rather than the nucleus can be described as sphere (bulge) surrounded by opposite concentric arms of **69 shape** as shown in **(**Fig.4)(15,22)

Fig. 4. The M51 spiral galaxy image (Hubble Heritage (STScI/AURA/NASA) & NASA, ESA, S. (STScI).

Generally, disk galaxies have a far more complex morphology than ellipticals. They typically consist of a thin, rotationally supported disk with spiral arms and often a bar, plus a central bulge component. The

spiral structure is best seen in face-on systems and is defined primarily by young stars, HII regions, molecular gas and dust absorption (15)

C) Derivation of Sayed`s galaxy mass equation (SGME)

C-1. Based on acceleration of the gas cloud

Based on the concept of the universe expansion, the mass can be calculated based on Newton laws and our previous work (11,4):

$G\ mM/r^2 = ma$ (24)

$M = a\ r^2 /G$ (25)

where (**a** in m/s^2) is the acceleration of the cloud. By substituting the value of **r** of equation 20 in equation 25 , one gets mass of disc galaxy

$$\mathbf{M_s = (a/G)(T/2\ \pi\ p\ d)\ .\sqrt{15\ K_B\ n\ R)}} \quad (26)$$

By substituting the value of **r** in equation 21 in equation 25, one gets mass of elliptical galaxy

$$\mathbf{M_s = (a/G)(T/4\ \pi\ p\ d)\ .\sqrt{15\ K_B\ n\ R)}} \quad (27)$$

This formulas are called **Sayed`s galaxy mass formula (SGMF)** based on acceleration of the cloud.

C-2. Based on speed of the cloud

In case of stable circular orbit (r), the centripetal force needs to be balanced and equals the force of gravity. These forces can be expressed as in equation 6 and in the following equation 28 (11,15). A star is born when atoms of light elements are squeezed under enough pressure for their nuclei to undergo fusion. All stars are the result of a balance of forces: the force of gravity compresses atoms in interstellar gas until the fusion reactions begin (23)

$F = mv^2 /r$ (28)

By equating the two forces, the mass (kg) of galaxy can be deduced by **;**

$mv^2/r = G\ mM/r^2$ (29)

In the case of disc (spiral) galaxy, the mass can be given using the velocity v (m/s) as:

$M = r\ v^2 / G$ (30)

While, in the case of elliptical galaxy, the mass is given by

$M = k.\ r\ \langle v^2 \rangle / G$ (31)

Where, k is a constant depends on how elongated the elliptical galaxy is. The v^2 is the velocity dispersion (Root mean squared velocity)

By substituting the value of r of equation 30 in equation 23, one gets the mass of disc galaxy;

$$\mathbf{M_s = (V^2/\ G).\ (15\ K_B\ n\ R\ )\ \sqrt{\ T/2\ \pi\ P\ d\ ).}} \quad (32)$$

This formula is called **Sayed`s galaxy mass formula** based on velocity of the galaxy

By substituting eq. 31 in equation 17, one gets the mass assay formula for elliptical galaxy;

$$\mathbf{M_s = k\ (\langle V^2 \rangle / G).\ (15\ K_B\ n\ R\ )\ \sqrt{\ T/4\ \pi\ P\ d\ ).}} \quad (33)$$

D) Validation of Sayed`s galaxy mass formula (SGMF) based on acceleration

The validation of the formula was carried out by using the following equations (mentioned above):

$M_s = (a/G)(T/4\ \pi\ p\ d)\ .\sqrt{15\ K_B\ n\ R)}$

$M_s = (a/G)(T/2\ \pi\ p\ d)\ .\sqrt{15\ K_B\ n\ R)}$

The parameters considered for calculation are;

Ms is the Sayed`s mass of neutral hydrogen cloud needed to initiate star formation.

a is the acceleration of the cloud = 6.338 $x10^{-8}$ m/s^2 (4).

T is the Temperature of neutral hydrogen gas cloud = 50 K

R is the gas constant = 8.3145 J/mole Kelvin

K_B is the Boltzmann constant = 1.38 x 10^{-23} J/Kelvin

G is gravitational constant = 6.674 x 10^{-11} Nm^2/kg^2 (or $m^3/kg\ s^2$)

Solar mass ($M_\odot$:mass of the Sun)= 1.9884 x 10^{30} Kg

The result of the verified value compared with Jeans and reference values is given in table 1.

Table 1: Comparison of mass calculation using Jeans `s formula and Sayed`s formula

Item	Jeans mass collapse formula (24)	Sayed`s formula M=a/G…..	Reference value (25,26,27)	%diff.
4π geometry	3600$M_\odot$ *The actual value is far below this value*	0.07742 $M_\odot$	0.075-0.08 $M_\odot$	2.67-3.75 %
2π geometry	-----	0.15485 $M_\odot$	No reference	----

It could be concluded that the **4π geometry** is almost identical to the reference value. While, the 2π geometry uses double the minimum solar mass to start nuclear fusion. Below ~ 0.08 M_{sun}, the core never gets hot enough to ignite H fusion (25). The smallest theoretical mass for a star to support nuclear fusion is 0.07 – 0.08 solar mass (26). The minimum mass for hydrogen fusion in a manner that is capable of sustaining a star in equilibrium against gravitational contraction is about 0.075$M_\odot$, with an uncertainty of about 0.002$M_\odot$ (27).

E) Validation of Sayed`s galaxy mass formula (SGMF) based on speed

Verification result of the derived Sayed mass formulas for 4π and 2π geometry is given in table 2.

$M_s = (V^2/ G).\ (15\ K_B\ n\ R\ )\ \sqrt{\ T/4\ \pi\ P\ d\ )}$

$M_s = (V^2/ G).\ (15\ K_B\ n\ R\ )\ \sqrt{\ T/2\ \pi\ P\ d\ )}$

Table 2: Comparison of Sayed`s formula result with the reference range

Item	Reference values (25,26,27)	Sayed`s formula	Diff %
4π geometry	0.075 – 0.08 $M_\odot$	0.07479 $M_\odot$	0.269 - 6.5 %
2π geometry	-----	0.10585	----

It can be shown that the discrepancy percentage between our derived and reference values is in the range of 0.269-6.5% for 4π geometry**.**

F) Application of Sayed`s formula for Milky Way galaxy

In this part, validation of the derived formulas will be carried out for calculation of Milky Way galaxy mass. The Milky Way Galaxy is enclosed within a gaseous “atmosphere” or a gas halo. The following parameters and values of the Milky Way galaxy halo will be considered:

The declared Mass = 0.8 – 1.5 x 10^{12} solar mass.

Mass of the gas halo = 1.39 x 10^{42} kg (28)

Mass of the Dark matter halo = 1.3 x 10^{42} kg (29)

Acceleration of Milky Way towards Andromeda galaxy =4.77x10^{-13} m/s^2

Temperature (gas cloud Halo) = 10x10^{6} Kelvin (30)

Pressure (typical P in clouds of interstellar gas) = 1.38x 10^{-16} N/m2

Number of mole in MW galaxy gas Halo (calculated) = 1.498 x 10^{45}

The result of verification is given in table 3.

Table 3: Validation and verification of Sayed`s galaxy mass formula (SGMF)

	Mass of gas Halo Mass of Milky way (11,28,29) Mass of Dark matter Halo	Calculated Mass by **Sayed`s Fomula**	% discrepancy
2π geometry	1.39 x 10^{42} Kg 0.669 x 10^{12} $M_\odot$ (Range 0.8 – 1.5 x10^{12} $M_\odot$)	1.36 x 10^{42} Kg 0.68 x 10^{12} $M_\odot$	2.158%
4π geometry	----	0.68 x 10^{42} Kg 0.34 x 10^{12} $M_\odot$	----

It can be observed perfect calculated value matched with the most recent published articles. It should be mentioned that the mass of the Milky Way galaxy is correlated to both dark matter and gas halos. The dark energy/ dark matter ratio must be taken into consideration for galaxy mass calculation (2,3,11,15) The total mass of the Milky Way (Barred spiral galaxy) and its mass in stars have found that only about 10%. That means that roughly 90% of the Milky Way's mass might be dark matter! (11)**.** A recent 2019 mass estimate for the Milky Way is 1.29×10^{12} $M_\odot$ (28).

IV. Conclusion

The expanded huge universe is a miracle to be discovered and studied by the talent scientists. This article proposed a theory to be added to the global galaxy formation theories. It can be concluded that the disc (spiral) galaxy formation is controlled by the 2π geometry of the initial cloud at the era of formation. While, the elliptical galaxy is controlled by 4π geometry. This, in addition to the other controlling parameters such as temperature, pressure and radius. The derived equation describing formation of the galaxy is called **Sayed`s galaxy formation formula (SGFF).** Equations for calculation of the cloud and galaxy mass (SGMF) was also derived. Validation of these derived equations was performed. The minimum discrepancy of 0.27% was found between our values and those published references.

Acknowledgement

My Great Creator; The Creator of the universe, please accept my deep thanks, respect and love.

Conflict of interest

The author declares that there is no conflicts of interest with anyone

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Biography

Sayed is the slave of the Great Creator of the universe. He was V.Chairman of Egypt nuclear regulatory authority (ENRRA). He studied for Ph.D. in Germany in the field of delayed neutron assay and activation analysis of fissile and source nuclear materials. He has published and unique theories in the field of black hole anatomy, cosmological constant, unification of the classic , relativity and quantum field theory and dark matter and energy ratio. He participated in national, regional and international training, meeting and conferences in the IAEA, USA, EU states, Russia and Arab States AEA. He worked as nuclear affairs and scientific supervisor in the wonderful UAE.