

# RADIUS OF STABLE GALAXY

According to 'MATTER (Re-examined)'

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*Abstract:* An evolving galactic cloud, depending on its parameters, may attain a stable state for a brief period. Total 3D matter-content, spin speed, and diameter of the spinning galactic cloud determine the duration of the stable period. This article proposes a mutual relation between these factors required for a galactic cloud during its life as a stable galaxy.

*Keywords:* Galaxy, radius of stable galaxy.

Depending on its parameters, it is possible for a galactic cloud to become a stable galaxy for a brief period during its life. As the magnitude of the angular speed or radius of a galactic cloud increases, the inward radial motion of its 3D matter particles (due to gravitational collapse) becomes too low to compensate for their outward displacement due to centrifugal action. The 3D matter-contents of the galactic cloud continue to spread outwards in the planes of its spin. Halo, formed around the spinning galactic cloud, tends to arrest the whole-body linear displacements of the galactic clouds towards any other similar galactic clouds and keep them steady in space without translation to form a stable galaxy and for further inner developments.

## Stable galaxy:

Galactic stability, which is related to the translational motion of one galaxy towards another, is a short-lived phenomenon. Except for a temporary arrest in its translational motion, a galactic cloud never reaches a stable state. However, a galactic cloud that can keep its absolute place in space and has no relative translational motion with respect to similar galactic clouds may be considered a stable galaxy.

A galaxy is a combination of microbodies that continuously move and evolve within. Galaxy, itself, changes its parameters continuously until either the whole of its 3D matter-content is dispersed or reverted into the universal medium, or it condenses into a single macrobody. This is the death and ultimate fate of all galaxies. Smaller galaxies or galactic clouds (before their development into stable galaxies) may approach each other under gravitational attraction to collide and integrate into a single rotating group of macrobodies. Depending on the magnitude and direction of their spin motions, this type of collision may help to form super-galaxies or cause total disintegration of both galaxies.

There are no rigid macrobodies. Macrobodies of high viscosity are usually in a solid state. They tend to maintain their integrity and shape. Near larger macrobodies, fluid macrobodies tend to adopt the shape of their container. In free space, all fluid macrobodies tend to become spherical. Clouds and debris in deep space gather, under mutual gravitational attraction, to form very large macro bodies. They are mainly gaseous, with few solid macrobodies in them. Generally, they can be considered to be of fluid nature.

A fluid macrobody has lower viscosity. Gravitational attractions between 3D matter particles provide adhesion between its constituents. Action by gravitational attraction to reduce its size is the fluid macrobody's gravitational collapse. In the course of their formation, due to uneven gravitational collapse, they acquire spin motion. Outer regions of a fluid macrobody attain greater spin speed about its spin axis compared to inner and polar regions. If the efforts causing gravitational collapse and moulding the fluid macrobody into a sphere are uniform throughout, the fluid macrobody will not gain spin motion at all.

It is quite improbable that the radial motions (due to gravitational collapse) of components of such a large fluid macrobody of diverse contents are uniform in all directions. Uneven radial motions of different components of the fluid macrobody induce its accelerating spin motion. Due to low viscosity, centripetal action (provided by

mutual gravitational attraction between constituent macrobodies) is very low. Hence, during the spin motion, fluid macrobodies in free space (not restricted by a container) spread outwards from the spin axis.

With the help of mutual gravitational attractions between its constituents, a fluid macrobody should continue to rotate at an accelerating angular motion. However, changes in its parameters are bound to affect the fluid macrobody's state of rotary motion. As the spinning-fluid macrobody expands in diameter, 3D matter particles at its equatorial periphery keep moving away from the centre of rotation. If the fluid macrobody has to maintain its original angular acceleration, constituent 3D matter particles near the periphery have to move at a faster linear speed in their circular paths. If no additional work is supplied, this cannot be accomplished. Additional work in association with each 3D matter particle remaining (more or less) steady: their angular speeds with respect to the centre of the fluid macrobody reduce as they move away from the centre of rotation, with a corresponding reduction in the angular speed of the fluid macrobody.

Outward displacements of 3D matter particles continue until sufficient centripetal action can be provided to arrest their outward displacements. As the total 3D matter-content of the fluid macrobody does not change and its radial size increases, centripetal actions on 3D matter particles can only reduce rather than increase. The tendency of expansion acts in direct opposition to the actions of gravitational collapse of the fluid macrobody. Every 3D matter particle tends to move away from the centre of rotation of the fluid macrobody due to angular motion. Centripetal action, provided by the gravitational collapse, tends to move them towards the centre of rotation. The balance between these actions determines the future formation of the fluid macrobody.

Magnitude of 'centripetal force',  $F_c$ , required for a 3D matter particle (situated at the outer periphery) of a spinning fluid macrobody to maintain its linear motion in a circular path;

$$F_c = 4mv \tan \omega \quad \text{Refer equation (5/9) in the book 'MATTER (Re-examined)'} \quad (1)$$

where  $m$  is the rest mass,  $v$  is the instantaneous linear velocity, and  $\omega$  is the angular speed of a 3D matter particle.

This effort is provided mainly by the adhesion due to gravitational attraction between the 3D matter particle and the rest of the spinning-fluid macrobody. By using the inverse square law for the approximate magnitude of gravitational attraction,  $F_g$ ;

$$F_g = \frac{MMG}{R^2} \quad (2)$$

where ' $m$ ' is the rest mass of the 3D matter particle, ' $M$ ' is the rest mass of the rest of the fluid macrobody, ' $G$ ' is the gravitational constant in the 3D spatial system, and ' $R$ ' is the radius of the fluid macrobody, taken as the average distance between the 3D matter particle and the rest of all constituent 3D matter particles of the fluid macrobody.

For a stable radial size of the fluid macrobody, its component 3D matter particles (on average) should move in circular paths. This can be achieved only when the magnitudes of 'centripetal force',  $F_c$ , on them should be as given by equation (1). Hence, a spinning fluid macrobody can maintain its radial size constant only when the gravitational attraction,  $F_g$ , on a 3D matter particle (moving at the periphery of a spinning fluid macrobody) is equal to the required 'centripetal force',  $F_c$ , on it.

$$\text{Hence,} \quad \frac{MmG}{R^2} = 4mv \tan \omega, \quad \frac{MG}{R^2} = 4R \omega \tan \omega, \quad \frac{MG}{4R^3} = \omega \tan \omega, \\ \left(\frac{MG}{4}\right) \frac{1}{R^3} = \omega \tan \omega \quad (3)$$

For critical equilibrium of the radial size of the fluid macrobody in the plane of its spin, equation (3) has to be satisfied. In equation (3),  $\omega$  is the fluid macrobody's spin speed and  $R$  is its radius. For a fluid macrobody, the term  $(MG/4)$  is a constant. Hence, the value of the term  $(\omega \tan \omega)$  is inversely proportional to the cube of its radius.

$$\text{Putting} \quad \omega = \frac{v}{R} \quad \text{in equation (3);} \\ \left(\frac{MG}{4}\right) \frac{1}{R^3} = \frac{v}{R} \tan \omega, \quad \left(\frac{MG}{4}\right) \frac{1}{R^2 v} = \tan \omega \quad (4)$$

Should the magnitude of the angular speed or radius of a galactic cloud become comparatively greater, inward radial motions of the 3D matter particles due to gravitational collapse become too slow to compensate for their

outward displacement due to centrifugal action. The 3D matter-contents of the galactic cloud continue to spread outwards in the planes of its spin. As the linear speeds of 3D matter particles, in their circular paths, approach the linear speed of light, they break down to primary 3D matter particles (bitons). The accumulation of independent bitons around a spinning galactic cloud forms its halo. Interactions between halos of two neighbouring galaxies modify their parameters until both galaxies exert sufficient repulsion against the gravitational attraction between them to maintain the distance between them constant. As long as this stage continues, it may be considered a stable galaxy.

The linear speed of 3D matter particles near the outer periphery of a stable galaxy may be approximated to the linear speed of light,  $c$ .

$$\frac{MG}{4R^2} = \text{Tan } \omega$$

Approximate spin speed of a stable galaxy,  $\omega = \text{Tan}^{-1} \frac{MG}{4R^2 c}$  **(5)**

Gravitational collapse and accelerating spin motion of a fluid macrobody cannot be stopped. Hence, these actions continue to change the parameters of the fluid macrobody. A fluid macrobody, like a newly formed galactic cloud in free space, expands until its angular speed is sufficiently lowered, when the 'centripetal force' is sufficient to maintain the curvature of its periphery. However, such a large fluid macrobody can sustain its stability of radial size only as long as equation (5) is satisfied.

Since a stable galaxy is a spinning-fluid macrobody, its gravitational collapse and acceleration of spin motion continue during and even after a brief period of stability. Its constituents have constant tendencies to spread outward. As the diameter of the galaxy increases further and the linear speeds of primary particles approach the linear speed of light, they breakdown into independent photons and radiate in various directions away from the galaxy. Gradually, the whole galaxy disintegrates and disperses.

Should the magnitude of the angular speed or radius of the galactic cloud (or its central region) become comparatively lesser (or it is not spinning) during its condensation, the outward motion of 3D matter particles becomes too slow to compensate for their inward radial motion due to gravitational collapse. The galactic cloud will shrink at an accelerating pace to form a single, very dense macrobody (black hole), with low spin speed or without spin motion at all. This macrobody has no protection from the gravitational attraction towards other macrobodies in space, as in the case of a stable galaxy.

### Conclusion:

Stable radial size and nature of a very large galactic cloud (formed in free space by the accumulation of intergalactic clouds and debris) are determined by its spin speed during condensation. With low or no spin speed, a galactic cloud condenses to become a 'black hole'. As long as the spin speed of a galactic cloud corresponds to equation (5), it can maintain its stability as an independent static galaxy. Should its spin speed exceed the magnitude given by equation (5), the galactic cloud will gradually disintegrate and lose most of its 3D matter-content into free space.

### Reference:

[1] Nainan K. Varghese, *MATTER (Re-examined)*, <https://www.matterdoc.in>

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