# New quantum gravity theory

# and

# rotation curve of galaxies

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**Introduction -**

The rotation curve of galaxy is a graph of the rotational velocity of stars, gas and other bodies orbiting around the center of galaxy and their radial distance from the centre of galaxy. The orbital speeds of stars, gas and other bodies contained in the galaxy do not obey the rules found in the other orbital systems. Stars are orbiting around their galaxy's centre at equal or increasing speed over a large range of distances. In contrast, the orbital velocities of planets in solar system and moons orbiting around the planets decrease with distance. The galaxy rotation problem is the discrepancy between observed galaxy rotation curve and theoretical prediction based on the observed luminous or baryonic material or bodies. When mass profiles of galaxies are calculated from the distribution of stars and mass- to- light ratios in stellar disk, they do not match with the masses derived from the observed rotation curve and law of gravity. None of the existing theories including Newtonian gravity and general relativity can explain the Galaxy rotation curve correctly. The rotation curve of galaxies will be explained by using new quantum gravity developed by me.

**Types of rotation curves of galaxies-**

In many galaxies the rotation curve has a particular complicated shape. The shape of this curve distorted at many locations depending on the internal structure of the galaxy. Still we can group the different rotation curves into some particular types taking into consideration their common features. In most cases the form of the curve may be assigned to one of the following major four types.

1) Type I - In this type of curve the, the orbital velocity V(R) of stars and other bodies increases monotonically from the centre of galaxy to the outer edges of galaxy. Typical examples of such galaxies are M 33, NGC 701and NGC 3495.

2) Type II- The rotation curve increases in the central part and reaches a certain value. After this point the curve remains nearly flat at larger distances from centre of galaxy. The orbital velocity V(R) remains constant to within 10 to 15 % forming a plateau.[2] Typical examples of such types are NGC 753, 801, 3672.

3) Type III - The rotation curve increases in central part and reaches a certain value. After reaching a certain value, the orbital velocity V(R) begins to decrease towards the outer edges of the galaxy. Typical examples are M 51, M81, and NGC 4244.

4) Type IV - The rotation curve does not have any monotonic velocity profile and complex shape does not belongs to any of the preceding three types. As the distance from the centre of galaxy increases the the curve most often drops somewhat and then rises again or remains nearly constant or flat.

All these different types of rotation curve can be explained with the help of my new quantum gravity theory. We will discuss each type of rotation curve individually.

**Factors affecting rotation curve -**

Four factors affecting the rotation curve are

1) Structure of the galaxy (Disk, spiral)

2) Companion galaxies

3) Mass density distribution in the galaxy

According to quantum gravity theory, at very large distances the force of gravity is more than Newtonian gravity. The quantum gravitational force increases as the distance from the centre of galaxy increases. The total gravitational force on an orbiting star or body is the quantum gravitational force due to parent galaxy and companion galaxy. The quantum gravitational force due to companion galaxies acts in opposite direction to that of main or parent galaxy. The force exerted by main or parent galaxy is attractive and force exerted by companion galaxies is repulsive.

Ft = Fm - Fc

Ft = Total quantum gravitational force on star or body

Fm = quantum gravitational force on star or body due to main or parent galaxy

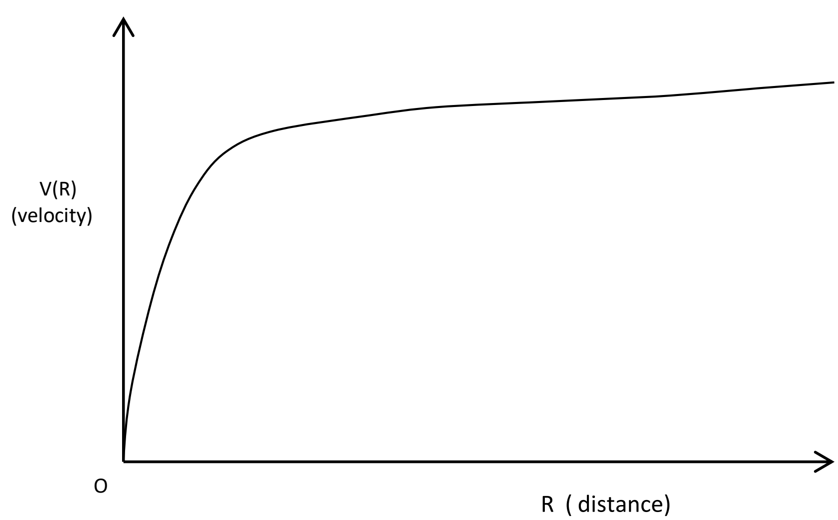
Fc = Quantum gravitational force on star or body due to companion galaxies.

Inside the stellar disk the quantum gravitational force increases as the distance from the centre of galaxy increases. The orbital velocity of star or body V(R) also increases. At a very large .distances outside the stellar disk the quantum gravitational force Fm increases as the radial distance r increases. The orbital velocity V(R) of stars or bodies also increases. The rotation curve monotonically increases. As the radial distance increases the distance from the companion galaxies decreases. The repulsive quantum gravitational force of companion galaxy Fc keeps on increasing. The total gravitational force on stars or bodies Ft keeps on decreasing. The orbital velocity V(R) of the stars and bodies also keeps on decreasing.

**Effect of quantum gravity -**

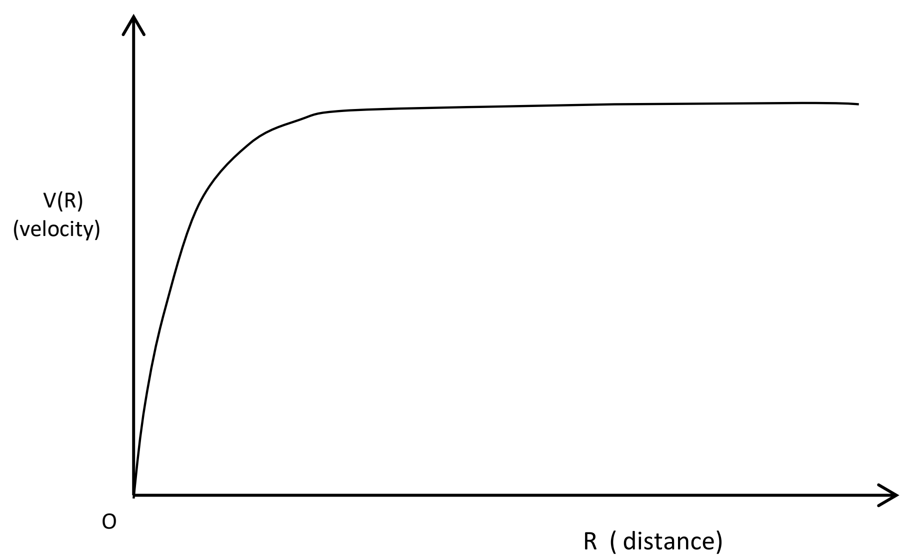
The different types of the rotation curve will be explained on the basis of analysis done in previous section.

1)Type I - In this type of curve the , the orbital velocity V(R) of stars and other bodies increases monotonically from the centre of galaxy to the outer edges of galaxy. These rotation curves are similar to rotation curve as shown in the figure given below. It has been observed that such type of galaxies do not have any companion galaxies in the vicinity of distances $d < 10\ D_o$. $D_o$ is the de vaucoulers angular diameter of the larger galaxy.



The companion galaxies are located at distances more than $10D_o$. Since the satellite or companion galaxies are located at very large distances their quantum gravitational force is very much small. Therefore their effect on orbital velocity V(R) is negligible. Typical examples of such galaxies are M 33, NGC 701and NGC 3495.

2) Type II- In this type of rotation curve the , the orbital velocity V(R) of stars and other bodies increases in the central part and reaches a certain value at the outer edges of stellar disk of galaxy. Then the rotation curve remains nearly flat. These rotation curves are similar to rotation curve as shown in the figure given below.




It has been observed that such type of galaxies do not have any companion galaxies in the vicinity of distances less than $d = 10D_o$. The companion galaxies are located at distances more than $10D_o$. Since the satellite or companion galaxies are located at large distances their quantum gravitational force is small. Therefore their effect on orbital velocity is small but significant..The rotation curve increases in central part and reaches a certain value. After this point the total quantum gravitational force Ft keeps decreasing very slowly. Due to this effect of slow reduction in total gravitation force Ft, the orbital velocity V(R) remains nearly constant.

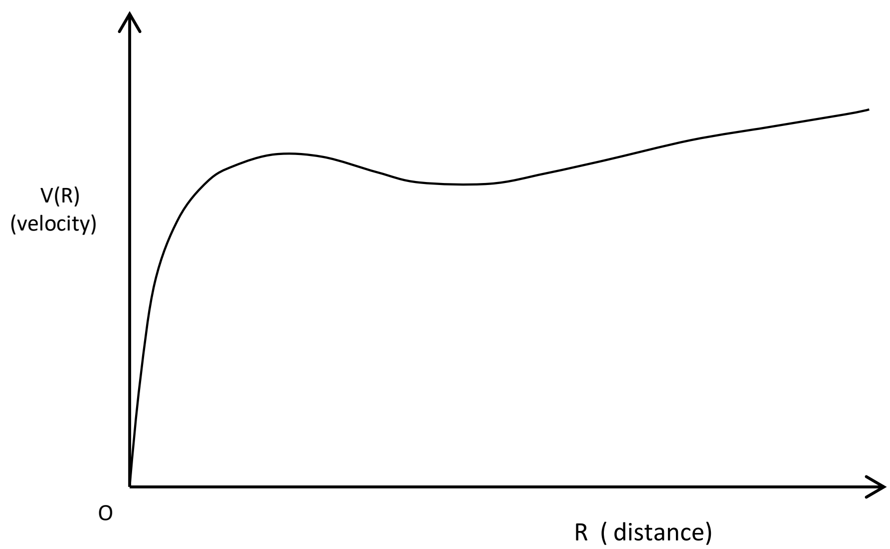
But at very long distances from the centre of galaxy the quantum gravitational force of companion galaxies increases more rapidly in comparison to attractive quantum gravitational force Fm of main galaxy. Therefore the orbital velocity keeps on decreasing slowly. Typical examples are NGC 753, 801, 3672.

3) Type III - The orbital velocity increases in the central part of galaxy and reaches a certain value at the outer edges. After reaching a certain value, the orbital velocity V(R) begins to decrease towards the outer edges of the galaxy. These rotation curves are similar to rotation curve as shown in the figure given below.

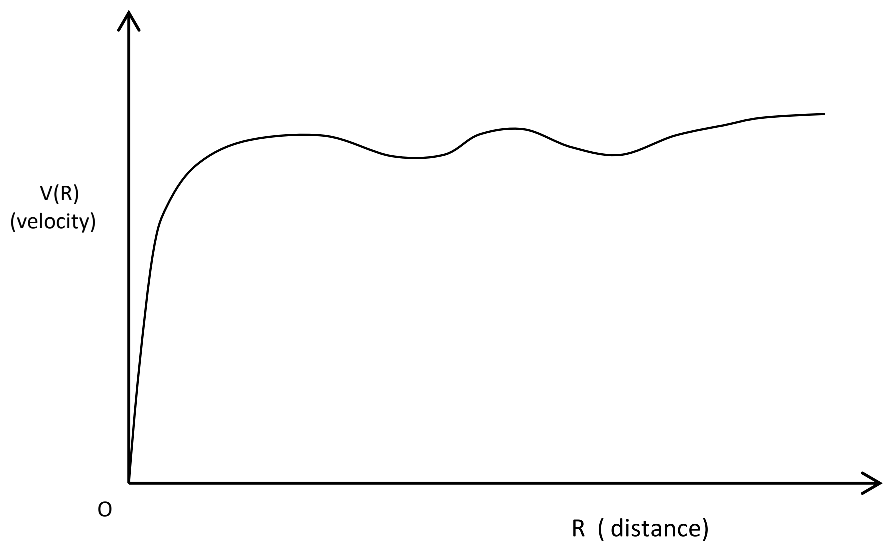

The rotation curve of this type are found in about 20 % of all galaxies .It has been observed that such type of galaxies have close companion galaxies in the vicinity of distances $d < 10D_o$. This result is now confirmed by more extensive material.[2] The companion galaxies are located at distances less than $10D_o$. Since the satellite or companion galaxies are located at shorter distances, their quantum gravitational force Fc is large. Therefore their effect on orbital velocity is large and significant. The rotation curve increases in the central part of galaxy and then reaches a certain value. After this point the total quantum gravitational force Ft keeps decreasing rapidly. Due to the effect of rapid reduction in total gravitational force, the orbital velocity V(R) keeps on decreasing rapidly.

4)Type IV-  As discussed earlier, the rotation curve of this type  does  not have any monotonic velocity profile and complex shape does not belongs to any of the preceding three types. As the distance from the centre of galaxy increases the the curve most often drops somewhat and then rises again or remains nearly constant or flat.

According to new quantum gravity theory such type of curves must be found in galaxies having spiral arms and spheroidal galaxies. In case of spheroidal galaxy the orbital velocity will increase in the stellar sphere right from the centre of galaxy and will reach certain vale at the outer edge of the spheroid provided that the mass density is uniform. After this point the rotational velocity will decrease in the certain region. Then the orbital velocity V(R) will keep increasing again. The orbital velocity V(R) will keep increasing as the radial distance r increases. The rotation curves of such galaxies are as shown in the figure given below.



In case of spiral galaxies the stars or bodies located in between two arms are acted upon by quantum gravitational force of internal mass of galaxy and external arm. The total quantum gravitational force on star or body is reduced. Therefore the orbital velocity decreases in this region and increases again when approaching the external arm. It has been observed there are small troughs at some regular interval on rotation curve. These intervals depend upon number of spiral arms. The rotation curves of such galaxies are as shown in the figure given below.




References-

1) Galaxy rotation curve - Wikipedia

2) The rotation curve of normal galaxies- A. V. Zasov and G. A. Kyazumov