

EXPONENTIAL EXPANSION OF SPIRAL GALAXIES

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It has been observed that stars revolving in the arms of spiral galaxies are unexplainably moving at substantially the same velocity. Because this phenomenon is contrary to standard gravitational principles of Newton and Einstein, wherein stars more distant from the galactic center should move more slowly... an explanation for the anomalous movement was sought. "Dark matter" seemed to be the only solution available and remains the best guess for the anomalous behavior. It should be noted that dark matter was "invented" to solve the problem, even though there was no hint of its existence prior to the galactic problem. To date, the existence of dark matter remains unproven. "Dark Matter" in our time, appears to be equivalent to "Lumeniferous Ether" which was invented to resolve light speed problems before relativity.

The exponential expansion (XPP) model provides a solution for the movement of stars in a spiral galaxy. It is submitted that the expansion constant (G_E) is a universal constant for the expansion of space by any matter, and it applies to all matter distributions. It is also submitted that the XPP occurs in situations (embodiments) such as the cosmic flow, gravitation, and spiral galactic rotation.

By applying the principles of XPP to the velocities of stars both within the galactic bulge and external to that bulge, the observed star velocities are consistent with the XPP theory. There is no need for dark matter.

Figure 92-1 shows a rough diagram of the relationship between the velocity and radial distance of stars of a spiral galaxy. It is seen that the stars within the bulge increase in speed radially, until a position (a virtual surface), after which the stars unexplainably move at a constant velocity. This suggests that the bulge stars expand in the same manner as the proper (Hubble) universal flow, wherein the expansion factor H (not the H_0 of the universe) is constant because both the mass and volume are increasing exponentially as R^3 .

Galaxies differ from gravitational objects, such as stars and planets, in that the galactic stars have very little interaction. It is proposed that the closely-spaced matter expanding within gravitational masses conflicts, inhibiting the free expansion of the matter until it reaches a "surface". Beyond the surface, no matter exists, so that the radial velocity of the expansion field exponentially decreases. The outer stars of a spiral galaxy, however, produce sufficient mass to affect the spatial expansion external to the bulge so that stars there move at a uniform speed.

The "virtual surface" of the bulge of a spiral galaxy, (where $t = T_0 = 1/H_0$) suggests a boundary between the expanding bulge and the exponential expansion in the arms. The mass of the stars beyond the bulge induces a constant star velocity in this spatial expansion. A comparison of the space beyond the surface of a gravitational object with galactic space beyond the bulge is shown in the diagram 92-1. Because the space surrounding a gravitational object (see "gravity") is essentially devoid of matter, M_0 becomes mathematically constant within the expansion factor H . The "expected" curve for velocity of orbiting stars is shown as decreasing with radius. A horizontal path is observed in actuality.

In all embodiments of the expansion, an instantaneous radial spatial velocity at a position is found by first determining a value for the appropriate expansion factor (H). The gravitational expansion factor (see "gravity") is defined as:

$$H = \sqrt{\frac{G_N M_0}{R_0}}$$

It can be seen that H is a function of the mass density. Multiplying by the position vector, R , defines the velocity. A mass having a velocity equal to the spatial XPXP will orbit.

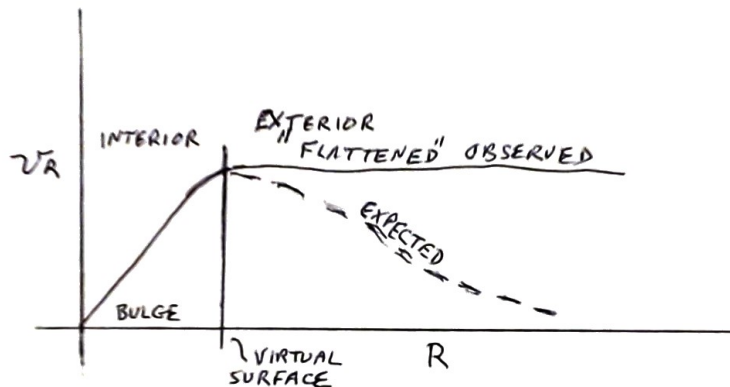
Because the universe experiences a concurrent exponential expansion of both matter and volume, the universal density is a constant H_0 . (a postulate of the XPXP theory). H_0 for the universe is constant, but it will be shown that H for other astronomical situations may not be constant. This produces a different expansion character for embodiments of XPXP.

Some general observations of spiral galaxies:

The stars within the bulge of spiral galaxies expand in a familiar way...the velocities of those stars increase in direct proportion to the volume with respect to the center. This is analogous to the movement of the galaxies in the cosmic Hubble flow, and therefore implies an (unhindered) exponential expansion of both the volume and mass.

It also is notable that stars within galaxies have very little interaction with each other, as compared to the matter within concentrated masses. At the outer limit of the bulge, the radial velocity reaches a maximum and remains constant thereafter. This is termed a “Flattening of the velocity curve”. FIGURE 92- 1. shows a rough drawing of this relationship between radial distance and velocity for stars in a spiral galaxy.

FIGURE 92-1. Spiral galaxy - velocity vs. distance curve



The expansion field created beyond the surface of a concentrated mass describes Newtonian gravitation (see “gravity”), with a decreasing radial velocity and a negative radial acceleration. Figure 92-1. shows an expected λ CDM galactic decreasing radial velocity compared to the “flattening” that is observed. Applying the principles of Newtonian gravitation or general relativity to this situation does not work, unless a dark matter halo is hypothesized.

The velocity of stars within the bulge behave in a manner similar to the galaxies in the Hubble flow, i.e. their radial velocities increase exponentially. A maximum is reached at the “edge” of the bulge. This maximum star velocity can be thought of as being located at a “virtual surface”. But the bulge does not have a well-defined surface, like that of concentrated matter surrounded by space (as in planets and stars). It is suggested that, because stars in galaxies do not substantially interact with other stars, they do not form a true surface. Instead, it suggests that the stars at the boundary and beyond exponentially provide enough matter to offset the exponen-

tial decay of the expansion in this region. The galactic exponential expansion is defined by the local values of the galaxy: H_0 , M_0 , V_0 , T_0 and ρ_0 and (just as in the universe) obey the general equation for a matter-induced volumetric acceleration. External to the bulge, rather than an exponential decay caused by an absence of matter as described in gravitation, the additional matter provided by the stars located in the arms of the spiral galaxy substantially offsets such a decay and produces a constant radial velocity in these arms. This is shown in the mathematics of the situation, when $M = M_0 e^{H_0 t}$ at a position within the arms, affecting the density in H and causing the radial velocity to be constant.

In a manner similar to the XPXP cosmic flow and gravitation, a method very different from conventional λ CDM math explains the flattening of the velocity curve. As in other XPXP situations, the properties of the expansion are determined by the expansion constant G_E and the density at the position. By formulating an H and multiplying it by R , an instantaneous (and positional) radial velocity is determined:

Use G_E and $\rho = M/V$ to formulate an H of the particular situation, where H may be a constant H_0 or variable, depending upon the simultaneous expansion of the matter and volume. Because of the linear increase of the radial velocity and distance of the stars within the galactic bulge, it is proposed that both the matter and the volume are exponentially expanding proportionately to R^3 , just as in the Hubble flow. This implies that, within the bulge, the character of the expansion is analogous to that of the Hubble flow and has a constant H_0 , where:

$$R = R_0 e^{H_0 t} \quad \text{and} \quad H_0(\text{internal}) = \frac{\sqrt{G_E \rho_0}}{3}$$

But, unlike the cosmos, galaxies run out of matter. Rather than forming a surface at R_0 (as in concentrated matter), the stars have freedom of movement, and are not affected by nearby stars. It is assumed that this characteristic of spiral galaxies creates a spatial expansion which produces a constant radial velocity for stars beyond the bulge. The distribution of the matter from the virtual surface (where $M = M_0$, and $V = V_0$) outwardly follows the form $M = M_0 e^{H_0 t}$, which is increasing as t increases. Volume continues to expand exponentially where $V = V_0 e^{3H_0 t}$ in this region.

An exponential distribution of matter (stars) which satisfies $M = M_0 e^{H_0 t}$ is shown in Figure 92- 2. It is accounted for in the cross-sectional shape of spiral galaxies. The tapered shape of the star population suggests the exponential reduction in matter as distance increases.

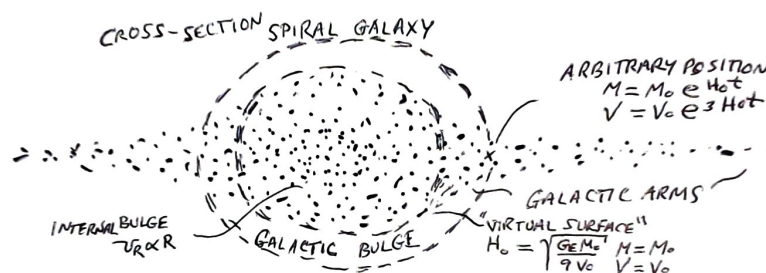


Figure 92-2.

The radial velocity of the expansion of the space beyond the bulge can be determined in

the same manner as in the other forms of XPXP, wherein the H of the expansion is multiplied by R, to provide a radial velocity. The math is shown below; it causes the expansion field in the arms of spiral galaxies to have a constant radial velocity throughout, indicating that all stars have the same velocity. These stars are not accelerated, therefore do not behave as in gravitation. In Figure 92-2, a representative arbitrary position is shown to be at a radial distance for a sphere inside which the matter is included to produce the density, and therefore H. In the space surrounding the bulge, matter (stars) is exponentially added, and it forms the arms and a diminishing disk. For spiral galaxies:

$$M(\text{external}) = M_0 e^{H_0 t} \quad V(\text{external}) = V_0 e^{3H_0 t} \quad R = R_0 e^{H_0 t}$$

$$H(\text{external}) = \sqrt{\frac{G_E M_0 e^{H_0 t}}{9V_0 e^{3H_0 t}}} = \sqrt{\frac{G_E M_0}{9V_0 e^{2H_0 t}}}$$

$$v_R = H \cdot R = \sqrt{\frac{G_E M_0}{9V_0 e^{2H_0 t}}} \cdot R_0 e^{H_0 t} = \sqrt{\frac{G_N M_0}{R_0}}$$

after doing the math. (REM: $G_E = 12\pi G_N$)

Therefore, the product of HxR is: $\sqrt{\frac{G_N M_0}{R_0}}$, and is equal to the Newtonian Orbital Velocity for the virtual surface of the bulge **and beyond**.

The stars at the virtual surface (and beyond) therefore have a common radial velocity, which plots as a flattening of the velocity curve. **No “dark matter” is necessary.**