EXPONENTIAL EXPANSION OF SPIRAL GALAXIES

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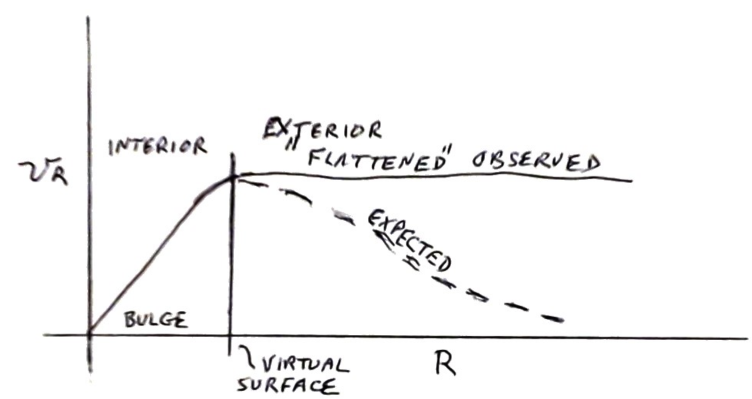
It has been observed that stars revolving in the arms of spiral galaxies are unexpectedly moving at substantially the same velocity. Because this phenomenon is contrary to standard gravitational principles of Newton and Einstein, wherein stars more distant from the galactic center should move more slowly... 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. To date, the existence of dark matter remains unproven.

Exponential expansion provides a path to a better understanding. It is submitted that G_E is a universal constant for the expansion of any matter, and therefore applies to all situations. It is also submitted that the XPXP occurs in several forms, such as the cosmic flow, gravitation, and galaxies. As a rule, the instantaneous radial velocity for a position may be found by finding a value for H, then multiplying by the position vector, R. Ho for the universe is constant, but H for other astronomical situations may not be constant, and may produce a different expansion character.

Some general observations of spiral galaxies: The stars within the bulge of spiral galaxies move in a familiar way...the velocities of the stars increase in direct proportion to the distance from 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 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 <u>expected</u> λCDM 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 add enough matter to offset the exponential decay of the expansion in this region. The galactic exponential expansion is defined by the local values of the galaxy: Ho, Mo,Vo, To and ρo 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 offsets such a decay and produces a constant radial velocity in these arms. This is shown in the mathematics of the situation, when M= Mo e^Hot 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 λCDM math will explain 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 radial velocity is determined:

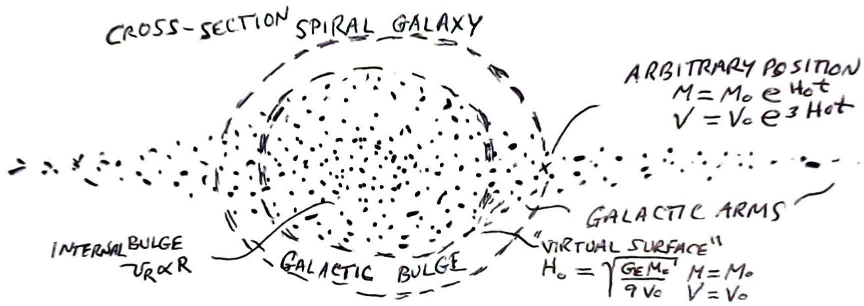
Use G_E and ρ =M/V to formulate an H of the particular situation, where H may be a constant Ho or variable, depending upon the concurrent expansion of the matter and volume. Because of the linear increase of the radial velocity and distance of the stars within the galactic bulge, it is assumed that both the matter and the volume are 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 Ho, where:

$$\boldsymbol{R} = \boldsymbol{R}_0 \, e^{H_0 t} \quad \textit{and} \qquad \boldsymbol{Ho}\,(\textbf{internal}) = \frac{\sqrt{G_E\, \rho_0}}{3}$$

But, unlike the cosmos, galaxies run out of matter. Rather than forming a surface at Ro (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=Mo, and V=Vo) outwardly follows the form M=Mo e^Hot, which is increasing, but at a lower rate as t increases. Volume continues to expand exponentially where V= Voe^3Hot in this region.

An exponential distribution of matter (stars) which satisfies M=Mo e^Hot 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 forms arms and a diminishing disk. For spiral galaxies:

$$\boldsymbol{M}\,(\textbf{external}) = \boldsymbol{M}_0\,\boldsymbol{e}^{H_0 t} \qquad \boldsymbol{V}\,(\textbf{external}) = \boldsymbol{V}_0\,\boldsymbol{e}^{3H_0 t} \qquad \boldsymbol{R} = \boldsymbol{R}_0\,\boldsymbol{e}^{H_0 t}$$

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

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

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

The product of HxR is: $\sqrt{\frac{G_N M_0}{R_0}}$, which is equal to the Newtonian Orbital Velocity for the virtual surface of the bulge <u>and beyond</u>.

The stars at the virtual surface and beyond therefore have a common radial velocity, which plots as a flattening of the velocity curve. **<u>No "dark matter" is necessary for this result</u>**.