SECTION 6

The Galactic Rotation Curves Anomaly

THE ANOMALOUS ACCELERATION IN ALL ROTATING GALAXIES

In general, galaxies are rotating systems, a balance of gravitational attraction $[G \cdot M \cdot m / R^2]$ and centripetal force $[m \cdot V^2 / R]$ maintaining the structure. A curve or plot of such rotational velocity, V, versus path radius, R, is termed a Rotation Curve.

When the central mass is far greater than the orbiting masses the dynamics are such that the orbital velocities are inversely proportional to the square root of the radial distance from the center mass $[V = (G \cdot M / R)^{1/2}]$, as for example in our solar system and as illustrated in Figure 6-1, below. Such rotational dynamics and rotation curves are referred to as Keplerian.

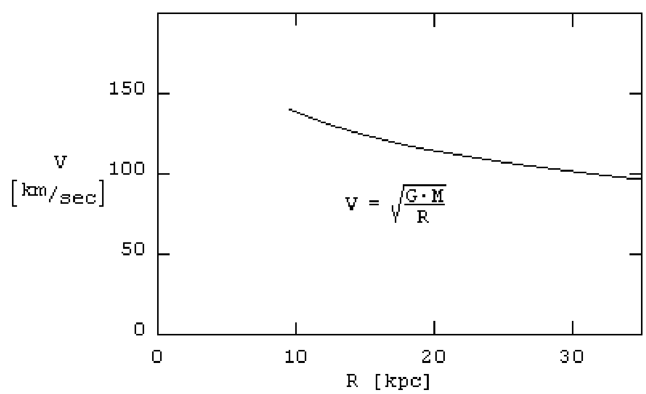

Figure 6-1
A Keplerian Rotation Curve

In the case of a solid sphere of uniform density, ρ, throughout, all parts must move at rotational velocities directly proportional to radius as illustrated in Figure 6-2, below.

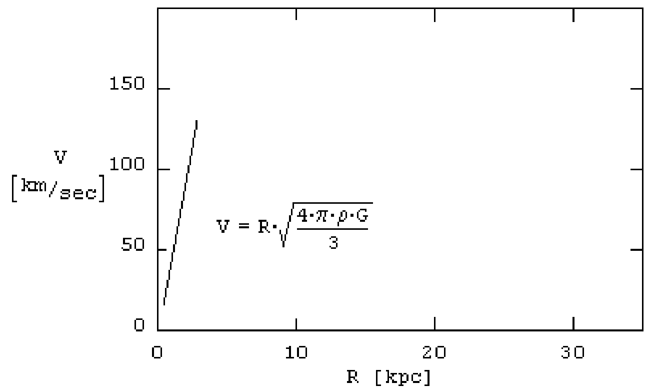

Figure 6-2
The Rotation Curve of a Solid Sphere of Uniform Density

The form of galaxies as we are able to directly observe them is that of a fairly spherical star-dense central core and a transition from that to the much more extensive flat disk of a far smaller density of more widely dispersed stars. The portion of galactic rotation curves that pertains to the dense central core of the galaxy would be expected to exhibit approximately the same velocity-proportional-to-radius form as illustrated for a solid sphere in Figure 6-2, above.

Likewise, the more dispersed flat disk, minor in mass compared to the dense central core, would be expected to exhibit the Keplerian form of Figure 6-1, above. The expected form of galactic rotation curves would be the two combined with a smooth transition between as Figure 6-3, below.

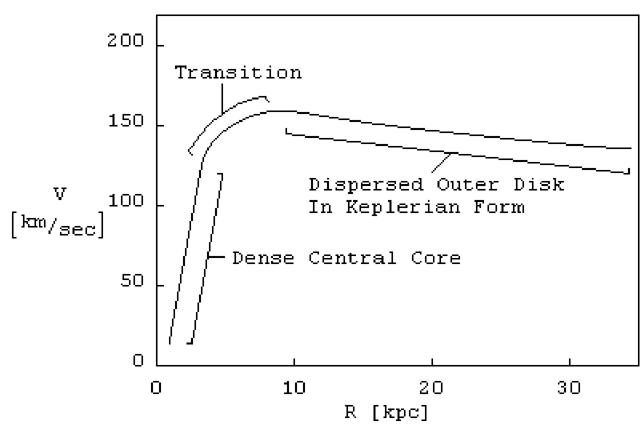

Figure 6-3
The Expected Form of Galactic Rotation Curves

For galaxies that present themselves in an edge view of the thin disk not as their spiral or globular spread in space, it is possible to measure the rotational velocities and obtain a rotation curve. We see one end of the presented flat disk moving toward us relative to the center and the other end moving away. The rotational velocities are measured along the galactic diameter represented by our view of the disk by observing the variations in redshift, those variations being a Doppler effect.

Galactic rotation curves so obtained do not exhibit the expected Keplerian form, an inverse square root of radius, in the region after the transition. Rather, they exhibit a flat form, that is, they there exhibit rotational velocity independent of radius. The overall curve, after the portion pertaining to the dense central core of the galaxy, is a transition to a flat curve in the region corresponding to the spread-out galactic disk as in Figure 6-4, below.

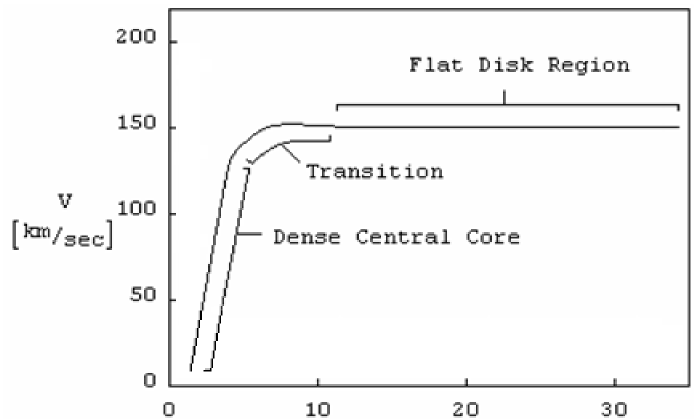

Figure 6-4
A Typical Galactic Rotation Curve as Observed

Because the form of the flat portion of galactic rotation curves lies between the case of a dominant central mass, as in the Keplerian inverse square root of radius form [Figure 6-1], and the case of a uniformly dense mass, with its direct proportion to radius form [Figure 6-2], it has been inferred that matter that we have not observed must be present similarly distributed within the galaxy.

That is, it is inferred that unobservable matter must be distributed in the galaxy in a manner that lies between the matter distribution of a dominant central mass [the Keplerian case] and that of a uniformly dense mass [the direct proportion to radius case] as a halo of "dark matter" which causes the rotation to take the form that the rotation curve exhibits. Thus arose the "dark matter" hypothesis.

No explanation has been offered for why the inferred "dark matter", while performing a gravitational function in the galaxy nevertheless fails to be distributed in the same manner as the "visible matter" in a fairly spherical dense central core with a transition from that to a much more extensive flat disk which has a far smaller density of more widely dispersed stars

What the rotation curves demonstrate is the existence of an acceleration that is not accounted for.

That acceleration can be identified as follows. A constant acceleration, $\Delta a_{Anomalous} = 8.4 \cdot 10^{-8}\ cm/sec^2$, expressed as Δa_A in the figure below, acting alone as a gravitational acceleration maintaining a mass in orbit, would produce a rotation curve of its own as in Figure 6-5, below. That acceleration, a_A, is directed toward the center of the galactic rotation just as is the accelerations of Figures 6-1 and 6-2.

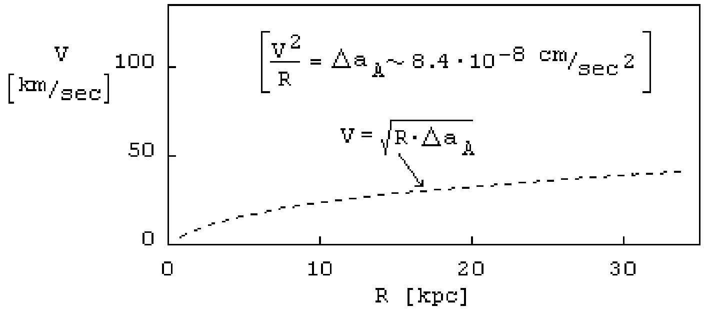

Figure 6-5
The Rotation Curve of $a_{Anomalous}$ Acting Alone

That rotation curve is of the correct form and magnitude to convert a galactic rotation curve exhibiting a Keplerian form [as in Figure 6-1] to a flat one [as in Figure 6-4]. That is, the rotation curve of a_A exhibits ***Velocity*** directly proportional to the square root of ***Radius*** and the Keplerian rotation curve exhibits ***V*** inversely proportional to the square root of ***R***.

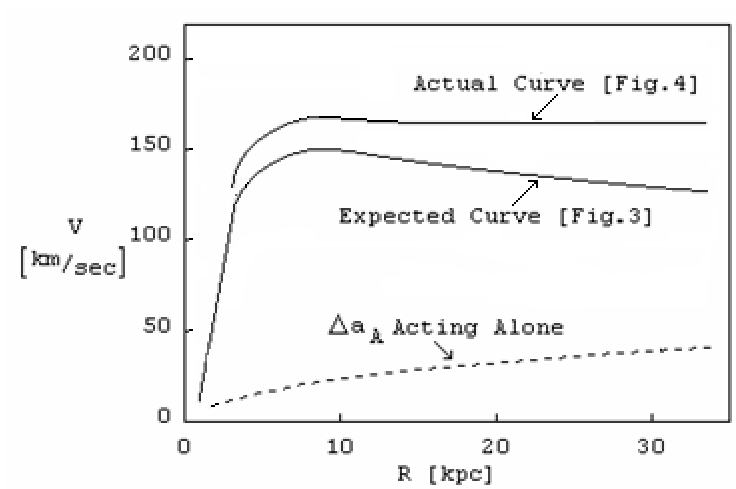

Figure 6-6
The Anomalous Acceleration, $a_{Anomalous}$, Acting Alone
Superimposed on the Expected and Actual Rotation Curves [Figures 6-3 & 6-4]

The two effects tend to cancel and leave a flat rotation curve. With the naturally occurring typical rotation curve modified by the addition of $a_{Anomalous}$ the rotation curve becomes flat, as illustrated in Figure 6-6, above, by superimposing the curves.

The rotation curves do not demonstrate the existence of a specific hypothesized cause such as dark matter; they only demonstrate the presence of a previously unknown acceleration, an acceleration unaccounted for by any known physical effects. It will be shown further below that the Universal Exponential Decay produces such an effect.

The hypothesized "dark matter" as the cause of the rotation curves behavior by supplying an additional gravitation is defective in that the dark matter is required to distribute itself differently than the other galactic matter in order to perform the function for which it was hypothesized.

After about a century of efforts to demonstrate the validity of the dark matter hypothesis by detecting identifiable dark matter, all without any success, an alternative cause of the galactic rotation curves behavior is called for.

This is the first appearance of a small acceleration (in addition to that of natural gravitation), centrally directed and independent of distance causing an anomaly

Next: The Pioneer Anomaly