A Common Cause of Three Independent Anomalies

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Abstract: - The 1933 indication by galactic rotation curves of “Dark Matter”, the 1998 Pioneer Anomaly, and the 2008 Flybys Anomaly all indicate that they are the result of a common cause, an unaccounted-for acceleration that is: quite small, centrally directed in the system exhibiting each phenomenon, non-gravitational, distance independent, and of a common magnitude. The newly encountered “Dark Flow Anomaly” may be another instance of the same phenomenon.

Key-Words: - Galactic Rotation Curves, Dark Matter, Pioneer Anomaly, Flybys Anomaly, Dark Flow Anomaly

1 The Pioneer Anomaly

The Pioneer Anomaly is a small acceleration of 8.7·10⁻⁸ cm/sec², centrally directed [toward the Sun], constant, distance independent, and of unknown cause. Its evidence is abundant tracking data that have been reviewed and re-reviewed so that the effect is highly validated.

Since its original reporting in 1998 sources of systematic error external to the spacecraft [e.g. solar wind/radiation], internal to the spacecraft [e.g. gas leakage], and in the computational system [e.g. model accuracy/consistency] have all been examined. All are either too small, not applicable, and/or act in the wrong direction to account for the phenomenon. Suggestions for error have come from a number of other sources in addition to the research team.

2 Rotating Galaxies

Rotating galaxies are a balance of gravitational attraction \[\frac{G \cdot M \cdot m}{R^2}\] and centripetal force \[m \cdot \frac{V^2}{R}\]. A plot of rotational velocity, \(V\), versus path radius, \(R\), is termed a Rotation Curve.

When the central mass is far greater than the orbiting masses the orbital velocities are inversely proportional to the square root of the radial distance from the center mass \[\sqrt{\frac{G \cdot M}{R}}\], as in our solar system and are referred to as Keplerian.

For a solid sphere of uniform density all parts move with \(V\) directly proportional to \(R\).

The form of galaxies is a fairly spherical star-dense central core with a transition to an extensive flat disk of far smaller density of more dispersed stars. The portion of galactic rotation curves pertaining to the dense core is expected to approximate the velocity-proportional-to-radius form of a solid sphere.

The dispersed flat disk should exhibit the Keplerian form. The expected form of galactic rotation curves is the two combined with a transition between them.

Figure 1 - Expected Galactic Rotation Curves

For galaxies seen in an edge view of the flat disk we can measure the rotational velocities for a rotation curve. One end of the disk moves toward us relative to the center and the other end moves away. The rotational velocities are measured along the diameter from the redshift variations, a Doppler effect.

Such galactic rotation curves do not exhibit the Keplerian form. They are flat with rotational velocity independent of radius. The overall curve, has the dense central core and a transition to a flat curve in the region corresponding to the spread-out galactic disk as in Figure 2.

Figure 2 - Galactic Rotation Curves as Observed
From that, it was inferred that unseen matter in the galaxy is distributed in a manner between the dense central core case and the dispersed Keplerian outer disk case, as a halo of "dark matter".

No explanation has been offered for why the “dark matter”, while performing a gravitational function in the galaxy like the “visible matter” is not distributed the same as the “visible matter”, a fairly spherical dense central core with a transition to a much more extensive flat disk of far smaller density.

But, what the rotation curves actually demonstrate is not the existence of dark matter; they only demonstrate the existence of an acceleration that is not accounted for. That acceleration is as follows.

An acceleration of \( \Delta a_{\text{Anomalous}} = 8.7 \cdot 10^{-8} \text{cm/sec}^2 \), constant, acting alone, centrally directed as a gravitational acceleration maintaining a mass in orbit [yes, the same Pioneer acceleration], would have a rotation curve as in Figure 3.

\[
\frac{V^2}{R} = \Delta a_A \sim 8.7 \cdot 10^{-8} \text{ cm/sec}^2
\]

Figure 3 - The Rotation Curve of \( \Delta a_{\text{Anomalous}} \) Alone

That is the correct form and magnitude to convert a galactic rotation curve of Keplerian form to a flat one. That is, the \( \Delta a_{\text{Anomalous}} \) rotation curve exhibits \( V \) directly proportional to the square root of \( R \) and the Keplerian rotation curve exhibits \( V \) inversely proportional to the square root of \( R \). The two effects cancel to a flat rotation curve. With the naturally occurring typical rotation curve modified by the addition of \( \Delta a_{\text{Anomalous}} \) the rotation curve becomes flat, as illustrated in Figure 4.

Figure 4 - The Anomalous Acceleration \( \Delta a_{\text{Anomalous}} \) Acting Alone Superimposed on the Expected and Actual Rotation Curves [Figures 1 & 2]

The only difference between the Pioneer anomalous acceleration and that of galactic rotation curves is the center toward which it is directed, which is the dominant factor in the mechanics of the motion involved, the Sun for the Pioneer spacecraft and the galactic center for galactic rotation curves.

3 The Flybys Anomaly

In 2008 anomalous behavior in spacecraft flybys of Earth was reported: unaccounted for changes in spacecraft speed, both increases and decreases, for six different type spacecraft in Earth flybys from 1990 to 2005. These anomalous changes were a function of the incoming and outgoing geocentric latitudes of the asymptotic spacecraft velocity vectors and, further, a latitude symmetric flyby does not exhibit the anomalous speed change.

The same anomalous acceleration \( \Delta a_{\text{Anomalous}} \) involved in galactic rotation curves and the Pioneer Anomaly accounts for the highly varied occurrences of the flyby anomaly: a small acceleration of \( 8.7 \cdot 10^{-8} \text{ cm/sec}^2 \) [in addition to that of natural gravitation], constant, independent of distance, and now directed toward the center of the Earth, the dominant factor in the mechanics of Earth flybys.

First we consider a simple Earth flyby, the pass being all at zero latitude, Figure 5. For the vectors \( A \) is the full anomalous acceleration, \( C \) is its component parallel to the direction of motion of the spacecraft, and \( \theta \) is the angle between their directions of action.

Figure 5 - A Zero Latitude Pass

At a great distance out the spacecraft motion is toward the Earth’s center. The centrally directed acceleration component parallel to the spacecraft motion, \( C \), is large and increases the spacecraft speed. Nearer to Earth that parallel component decreases becoming zero at the closest approach. From that point on it acts in the opposite direction on the
spacecraft, decreasing its speed. Ultimately the anomalous acceleration and deceleration become equal and cancel.

Of the full anomalous acceleration, \( A \), its component, \( C \), parallel to the path of the flyby is
\[
(1) \quad C = A \cdot \cos[\theta]
\]
For flyby paths not at zero latitude, \( \lambda \), the effective value of \( A \) is \( A(\lambda) \), as
\[
(2) \quad A = A \cdot \cos[\lambda]
\]
and
\[
(3) \quad C = A \cdot \cos[\theta] = A \cdot \cos[\lambda] \cdot \cos[\theta]
\]
The gross effect of latitude has three cases: decreasing latitude, increasing latitude, and latitude symmetrical. Figure 6 presents the first case.

![Figure 6 - A Pass at Decreasing Latitude](image)

The first half, i.e. the acceleration half, of the flight path is at high latitude where the latitude effect greatly reduces the parallel component magnitude. But the second half, the deceleration half, of the flight path is at a low latitude where the latitude effect reduces the parallel component magnitude much less. The net effect is a relatively small acceleration followed by a greater deceleration for a net decrease in spacecraft speed.

The actions and net effect are just the opposite for the case of the flyby at increasing latitude, and for a latitude symmetric flyby the acceleration and deceleration halves offset each other.

Depending on the specific path of the flyby the spacecraft may experience an overall net anomalous acceleration or a net anomalous deceleration, those in various amounts depending on the specific encounter and the latitudes involved, and zero net modification if the path is perfectly latitude symmetrical.

The same anomalous acceleration that appears in the Pioneer Anomaly and that replaces the never yet detected “dark matter” in accounting for the form of galactic rotation curves here accounts for the full range of the Flyby Anomaly with the anomalous acceleration here again directed at the center of the dominant factor in the mechanics of the motion involved, for Earth flybys the center of the Earth.

4 A General Anomalous Acceleration Throughout the Universe

Thus there are small, centrally directed, distance independent, non-gravitational, same, anomalous accelerations appearing as a near Earth effect [the Flybys Anomaly], a Solar effect [the Pioneer Anomaly], and a galactic effect [galactic rotation curves]. It can be expected from that that the same effect appears relative to every planet [and every planet’s moons], every sun [star], every galaxy and galaxy group – universe wide.

What could produce such a phenomenon? What could cause there to be a universe wide occurrence of such same unaccounted-for accelerations? Taken together, planet relative, star relative, galaxy relative ... collectively they can only be a shrinking of the universe, a systematic contraction, a gradual reduction in the length component of every length dimension in the universe, a general universe decay.

In material reality such decays are exponential. There are myriad examples of such, e.g. radioactive decay, the decay of electrical transients in circuits involving inductance and capacitance, the decay of motion transients in mechanical systems involving mass and spring, the amplitude decay in a rung bell or a plucked string, etc. It is not unreasonable that a universe that began with an explosive “bang” follow that with a gradual exponential decay.

Such a decay was predicted and analyzed in 1998 in The Origin and Its Meaning, Section 21 [5]. It is an exponential decay of the length dimensional aspect of all quantities in the universe. It involves the fundamental constants (\( c \), \( q \), \( G \), \( h \), etc.) and decay of any of those must be dimensionally consistent with the decay of the others.
The dimension that is decaying is length, the \( \mathbf{L} \) in the dimensions of, for example: \( h, [\mathbf{M} \cdot \mathbf{L}^2 / \mathbf{T}] \); \( c, [\mathbf{L} / \mathbf{T}] \); and \( G, [\mathbf{L}^3 / \mathbf{M} \cdot \mathbf{T}^2] \). The time constant of the decay is about \( \tau = 3.57532 \times 10^{17} \text{ sec} \approx 11.3373 \times 10^9 \text{ years} \).

Objections that such an effect would conflict with the highly accurate planetary ephemeris are a mistaken interpretation of the situation. Consider a planet in circular orbit around a sun as in Figure 7.

![Figure 7](image)

The relationship governing the motion is, of course, equation (4).

\[
\frac{\text{Centripetal Acceleration}}{\text{Gravitational Attraction}} = \frac{v^2 / R}{G \cdot M / R^2}
\]

Now, let the length dimensional aspect of all quantities decay, become smaller with time. That is, let all lengths, \([\mathbf{L}]\), decrease by being multiplied by the decay function, \( D(t) \), per equation (5).

\[
D(t) \equiv \epsilon^{-t / \tau}
\]

Then the quantities of equation (4) all change as:

\[
R(t) = R(t=0) \cdot \epsilon^{-t / \tau}
\]

\[
G(t) = G(t=0) \cdot \left( \epsilon^{-t / \tau} \right)^3
\]

\[
R \cdot \omega^2 = R(t=0) \cdot \omega^2 \cdot \epsilon^{-t / \tau}
\]

\[
\frac{V^2}{R} = \frac{\left( V(t=0) \cdot \epsilon^{-t / \tau} \right)^2}{R(t=0) \cdot \epsilon^{-t / \tau}}
\]

etc.

Furthermore, we observers, using our standard ruler, length \( L \) of Figure 7, would not detect the decay because our standard length would be decaying at the same rate.

The point of this obvious mathematics / physics exercise is that a universal decay of the length aspect of all material reality would not conflict with the planetary ephemeris and would not even be detectable at all except in unusual circumstances such as the Pioneer and Flyby anomalies and the evidence of galactic rotation curves. Nor would it interfere with the relative values of the fundamental constants and their interactions in physical laws.

Likewise, Einstein’s principle of “invariance”, that the laws of physics and the constants in those laws must be the same everywhere in the universe, remains intact in the universal decay because everything is decaying in the same manner with the same decay constant, having begun at the same instant, the beginning of the universe.

Returning to the orbiting body of Figure 7, reproduced as Figure 8 below with its annotations slightly modified, the development of the anomalous acceleration is very direct.

![Figure 8](image)

The Newtonian gravitation component of the centripetal acceleration is only sufficient to maintain the orbit, to keep \( R \) constant, to prevent its increasing as it would if the orbiting mass were released and departed tangentially. For the orbiting body, \( m \), to gradually approach the central mass, \( M \), that is for \( R \) to decrease, additional inward acceleration is required.

That inward acceleration is the anomalous acceleration appearing as a near Earth effect [the Flybys Anomaly], a Solar effect [the Pioneer Anomaly], and a galactic effect [galactic rotation curves]. It is an unavoidable concomitant effect of the contraction of the length dimension \([\mathbf{L}]\) of \( R \) in the above example and of the shrinking, the gradual reduction in the length component, of every physical quantity in the universe.

### 5 The Universal Decay

Details on the universal contraction, or decay – its cause, origin and characteristics are too lengthy for
this report and are provided in full in reference [5].

The Universal Decay causes the speed of light now to be a smaller, decayed value relative to light speed earlier. Thus in general the speed of light is \( c(t) = c_0 \cdot e^{-t/\tau} \). \([c_0 \text{ is the original speed of light at the instant of the } \text{"Big Bang" and } \tau \text{ is time since the } \text{"Big Bang"}].\) The speed of light is now decaying from its present value as we know it, \( c \) or \( c_{\text{now}} \), as \( c(t) = c_{\text{now}} \cdot e^{-t/\tau}. \) Therefore the rate of change of the speed of light now is as follows.

\[
\frac{d[c(t)]}{dt} = - \frac{c_{\text{now}}}{\tau} = - \frac{2.99792 \cdot 10^{10}}{3.57532 \cdot 10^{17}} \\
= -8.38504 \cdot 10^{-8} \text{ cm/s}^2
\]

compared to the Pioneer Anomaly value

\[
= -(8.74 \pm 1.33) \cdot 10^{-8} \text{ cm/s}^2
\]

That rate of change of the speed of light is due to the rate of change of its length dimensional aspect and, therefore, is the at present rate of change of all length dimensional aspects. It is the rate of the universal contraction, the un-accounted for centrally directed acceleration demonstrated in galactic rotation curves, the Flybys Anomaly and the Dark Flow Anomaly.

Because the decay time constant is so large the at-present rate appears to us to be constant. Because everything including our instrumentation, our measurement standards, our atoms and ourselves are all experiencing the same decay, the decay is unnoticeable to us and is generally undetectable by us except for unusual circumstances such as the anomalies presented above.

6  Validating the Universal Decay

Because the speed of light is decaying, light emitted long ago is faster than our present contemporary light, which causes the ancient light to appear to us to have a longer wavelength, that is, to be redshifted. [Some of redshifts, but not more than a minor portion, is due to the Doppler Effect of the astral sources’ outward velocities.]

Aside from observation of redshifts, each such observation of which is actually an observation of the universal decay, there are two other specific experimental observations that can be conducted to verify the universal decay and the value of its decay time constant.

- It can be tested that the speed of the light from distant astral sources is larger than our contemporary light speed. The earlier procedure of Michaelson and Morely or of Pease and Pearson using the Foucault method is now superseded by the modern procedure, which is to pulse modulate the light beam producing markers and use those to measure the time required for the light to traverse a known distance.

- It can be tested that the Planck Constant of the light from distant astral sources is larger than our contemporary Planck Constant, \( \hbar \), using the photoelectric effect. Measuring the retarding potential that reduces the photoelectric current to zero, for light spectrally selected of a specific frequency, plots [for a set of different frequencies] as diagonal straight lines whose slope is the Planck Constant of that light.

\[ \Delta a_{\text{Anomalous}} = 8.7 \cdot 10^{-8} \text{ cm/Sec}^2 \]

6.1 The “Dark Flow” Anomaly

To the above three anomalies can be added the “Dark Flow Anomaly” reported in 2008 and recently further analyzed in terms of extensive new data reported in NASA Goddard Release No.: 10-023.

Distant galaxy clusters mysteriously stream at a billion miles per hour towards a single point in the sky, separate from the expansion of the universe ... this collective motion dubbed the "dark flow"...

The clusters appear to be moving along a line extending from our solar system toward Centaurus / Hydra ... away from Earth. The distribution of matter in the observed universe cannot account for it. Its existence suggests that some structure beyond the visible universe --
outside our "horizon" -- is pulling on matter in our vicinity.

Figure 10 – Dark Flow Galaxy Clusters and Flow Direction by Distance

There is not sufficient data to make possible demonstrating that the “Dark Flow” is a result of the ubiquitous anomalous acceleration. On the other hand, something is producing the effect and the ubiquitous anomalous acceleration is not an unreasonably likely cause.

References


