A Common Solution: Dark Matter, Dark Energy and the Pioneer Anomaly

Roger Ellman

Abstract

Three major contemporary unresolved problems of astronomy and cosmology are:

- "Dark Matter", hypothesized to explain otherwise un-accounted for acceleration indicated by galactic rotation curves;
- "Dark Energy" hypothesized to account for indications resulting from distance measurements to Type Ia Supernovae that the expansion of the universe is accelerating; and
- the Pioneer Anomaly, unaccounted for acceleration exhibited by the Pioneer 10 and 11 spacecraft.

The present paper is a summary analytic presentation, in a brief 3 pages, of the three problems and the common solution to them. It presents the structure and logic of the situation but with only minimally sufficient data to illustrate the points.

The cited references provide the full data, analysis, calculations and explication of theory.

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I - Analysis of the Problem

a - The Rotation Curves + Pioneer Anomaly Indications.

Galactic rotation curves show the existence of an un-accounted for acceleration directed toward the galactic center of rotation. The cause of that acceleration has not been found.

The Pioneer Anomaly shows the existence of an un-accounted for acceleration directed toward the solar system center of rotation. The cause of that acceleration has not been found.

The magnitude and nature of both of these accelerations are the same:

- they are of magnitude about 8.3×10^{-8} $cm/s2$,
- they are centrally directed,
- their magnitude is independent of distance [there is no inverse square behavior].

Such a state of affairs would indicate that the accelerations are the same, not merely identical but the same single actual behavior, that they have the same common cause.

b - That same cause cannot be "dark matter".

"Dark matter" is for a gravitational explanation of the accelerations, but such gravitation depends on distance [has inverse square behavior].

The amount and distribution of "dark matter" necessary to account for the Pioneer Anomaly is on the order of $1,000 - 10,000$ times the amount to account for the galactic rotation curves.

Therefore, some common cause of the two observed behaviors other than "dark matter" must be found.

c - That cause cannot be gravitational nor any form of special case.

Einstein's principle of invariance correctly requires that the laws of physics and their fundamental constants must be the same everywhere in the universe.

To the Pioneer anomaly there is no analogous effect for planets. A gravitational cause would perturb the orbital radii and angular velocity of the planets to outside their known range and be inconsistent with the known level of accuracy of the overall planetary ephemeris.

Therefore, the common cause of the phenomena must be non-gravitational and must be universally consistent.

d - The Dark Matter + Dark Energy Contradiction

The existence of "dark matter" has been hypothesized to provide the un-accounted for acceleration indicated in galactic rotation curves by providing the requisite mass to produce an additional gravitational *attraction* [additional relative to the observed astral bodies of which the galaxies are composed].

Distance measurements to Type Ia Supernovae have indicated that the universe's expansion is accelerating. To account for that accelerating expansion "dark energy" has been hypothesized, its purpose being to provide an anti-gravitational *repulsion* throughout the universe.

Thus simultaneous new / additional gravitational *attraction* and anti-gravitational *repulsion* throughout the universe have been hypothesized. That simply will not work.

Therefore, at least one of the two hypotheses, "dark matter" and "dark energy", must be completely wrong. Quite possibly both are in error. Neither has so far been confronted with the challenge of plausible alternative hypotheses.

Also, the expansion of space and Hubble constant problems [see below] lead to significant error in the Type Ia Supernovae data and its interpretation upon which the "dark energy" theory relies.

e - The Expansion of Space + The Hubble Constant Problem.

Fundamental to contemporary cosmology is the Einstein theory that the universe's expansion is expansion of "space" itself [as compared to passive static space with its astral bodies moving in expansion outward within it]. The Einstein theory then leads directly to the Hubble Constant and its relationship of astral body outward velocity to its cosmic distance, $v = H_0 \cdot d$.

However, the Einstein expansion of space theory and the Hubble relationship have a number of increasingly severe problems that can only become worse as cosmic observations further improve.

- Observed greater redshifts leave little time for initial galaxy formation -- estimated several years ago to have required about $3\ billion\ years$ but reduced now to about only $300\ million\ years$ [Hubble-Einstein universe age less Hubble-Einstein age of observed high redshift light, that of z on the order of 10].

- The Hubble Constant itself has not even its first significant digit solidly determined and its currently favored value, $72\ ^{km}/_{sec}\ per\ megaparsec$, does not correspond to the currently favored age of the universe $13.7\ billion\ years$, which requires a Hubble Constant value of about 65].

- The theoretical limit on how far back into the past can be observed regardless of the quality of our instrumentation is barely $8\ billion\ years$ if one takes the age of the universe to be the Hubble-Einstein value of $13.7\ billion\ years$. That is quite substantially less than actual reported Hubble-Einstein observations. That conflict further challenges the Hubble-Einstein theory.

- The concept that the universe's expansion is expansion of "space" itself leaves the problem, "... relative to what" ? If space itself is expanding then the expansion must be relative to some static, non-expanding reference. A change must be relative to an unchanged reference, otherwise the change would be undetectable. But, what do we call that "static reference"? It is space itself, and it is the framework to which the expansion of the universe is relative, and relative to which the cosmos' astral objects are expanding outward.

Any solution to the "dark matter", "dark energy", Pioneer Anomaly problems must also successfully treat the problems of the Hubble-Einstein conception of the cosmos.

II - The Common Solution to the Various Problems

a - The Universal Decay

The entire universe has been and is undergoing a continuous exponential Universal Decay of the length, $[L]$, dimensional aspect of all quantities in the universe [e.g. distance $[L]$, speed $[^{L}/_{T}]$, gravitation constant, G, $[^{L^3}/_{M \cdot T2}]$ etc.] with a decay time constant of $\tau = 3.57532 \cdot 10^{17}\ sec$ [or about $11.3373\ billion\ years$] while the material universe expands outward within passive, static space.

- That the decay is of the length dimensional aspect of all quantities in the universe means that all of the physical laws of the universe and their fundamental constants remain continuously correlated with each other and are invariant; that is they are the same everywhere in the universe and in every reference frame at any moment in time.

- Rotational systems in orbital equilibrium such as our solar system or a galaxy have a balance of centrally directed inward acceleration and outward centrifugal acceleration. For such systems to then experience inward shrinking due to the Universal Decay there must be an

additional centrally directed inward acceleration. That acceleration is the Pioneer Anomaly acceleration and is the additional galactic acceleration for which "dark matter" was hypothesized to account.

- Because the effect is due to the Universal Decay its related acceleration is always centrally inward directed and is independent of distance [exhibits no inverse square behavior].

- 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 $c(t) = c_0 \cdot \varepsilon^{-t/\tau}$. [$c_0$ is the original speed of light at the instant of the "Big Bang" and t is time since the "Big Bang"].

- The speed of light is now decaying from its present value as we know it, c or c_{now}, as $c(t) = c_{now} \cdot \varepsilon^{-t/\tau}$. Therefore the rate of change of the speed of light now is as follows.

$$\frac{d[c(t)]}{dt} = \frac{c_{now}}{\tau} = -8.38505 \cdot 10^{-8} \ {}^{cm}/_{s^2} \quad (1)$$

$$\equiv \text{Pioneer Anomaly}$$

- 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, the rate of "shrinking" and the un-accounted for galactic centrally directed acceleration demonstrated in galactic rotation curves.

- 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 Pioneer Anomaly and galactic rotation curves.

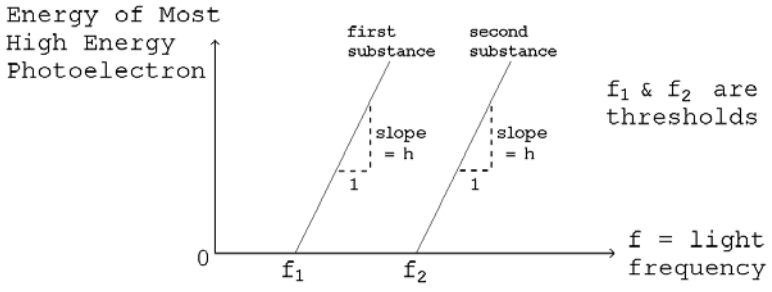
- Because the speed of light is decaying, light emitted long ago is faster than our present contemporary light, which causes the ancient light to appear to us to have a longer wavelength, that is, to be redshifted. [Some of redshifts, but not more than a minor portion, is due to the Doppler Effect of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

b - Validating The Universal Decay

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 or Pease and Pearson using the Foucault method is now superseded by the modern procedure, which is to modulate the light beam and use that modulation 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, h, 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.



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