ON THE HUBBLE LAW

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S.P.Smith
contact@stevepsmith.com

ABSTRACT

Since the announcement that supernovae data shows that the universe is expanding there has been little to no further analysis of the claim. Recent observations have cast doubt upon this result and suggest that new physics may be required. It is thought by the author that existing physics is adequate to explain current anomalous observations. To achieve an acceptable solution, there is however a requirement not only to accept the overwhelming observational data but also to set aside any preconceived notions that may exist in relation to the Hubble law and red-shift in general. It will be shown that an aspect of the mathematical model upon which almost all of the claims to recessional velocity are based, may indeed be erroneous.

Keywords: cosmology: observations — methods: observational — supernovae: general

1. Introduction

Recent observations have shown that there exists an unexplained anomaly in the estimated expansion rate of the universe. After many years the expansion rate has been calculated and assumed to be $73kms$, however extremely accurate measurements have been made which places a limit on the recessional velocity of $69kms$. It has been suggested by several cosmologists that "lacking a fundamental error that new physics is required to explain this unexpected result". It is shown in this paper that resolution of this apparent anomaly requires that any preconceived assumptions must be set aside and a detailed analysis of the fundamental methods used to arrive at these values is made. Prior to and including the original Saul Perlmutter paper[i] announcing that supernovae type Ia. data, showed the universe to be expanding one assumption is made throughout, inasmuch as Hubble's discovery of a correlation between distance and red-shift can be interpreted as a recession velocity. While it cannot be denied that the Hubble discovery of the correlation between distance and red-shift has without doubt been proven correct, the association of recessional velocity is obtained not from observation but rather is inferred using mathematical methods. Doubts about "Is the expansion real" being top of the Sandage list[ii] of the problems in cosmology in recent times surpassed by the elusive Dark Matter/Energy. In modern cosmology, the equation used to estimate the critical density of the universe commonly referred to as the Friedmann energy equation is given as;

$$v_r{}^2 = \frac{8\pi G r^2 \rho}{3} \tag{1}$$

Wherein, the symbol $v_r{}^2$ is taken to be the Hubble recession velocity by virtue of the Hubble law. The textbook description of Hubble's law is, *"Hubble's law is a statement that there exists a direct correlation between the distance to a galaxy and its recessional velocity as determined by the red shift"* and the commonly used equation is;

$$H^2 = \frac{v^2}{r^2} \tag{2}$$

These two equations are used in the current method to estimate the recessional velocities of distant objects.

2. Basic Theory

Considering for one moment the homogeneous Friedmann-Lemaître[iii] cosmological models [FLRW], the familiar and somewhat ubiquitous Robertson-Walker line element can be written;

$$ds^2 = c^2dt^2 - R^2(t) * \left(\frac{d\sigma^2}{(1-k\sigma^2)} + \sigma^2 d\theta^2 + \sigma^2 sin^2\theta d\phi^2\right) \tag{3}$$

s: four dimensional interval
c: speed of light
t: time
R: scale factor
σ: radial coordinate
k: curvature constant
θ: angular coordinate
ϕ: angular coordinate

Consequently, the dynamics of the universe is given by the equivalent Friedmann equations;

$$\dot{R}^2(t) = \frac{8\pi G\rho(t)R^2(t)}{3} + \frac{\Lambda R^2(t)}{3} - kc^2 \qquad (4)$$

And

$$\frac{\ddot{R}(t)}{R(t)} = -\frac{4\pi G\rho(t)}{3} + \frac{\Lambda}{3} \qquad (5)$$

Where accents denote derivatives with respect to t, G being Newton's gravitational constant, $\rho(t)$ the matter assuming negligible pressure, Λ Einstein's cosmological constant and k the curvature of the 3-dimensional space. From this, the ubiquitous equations for calculating the critical density of the universe using the Hubble law can be derived;

$$H^2 = \frac{8\pi G\rho}{3{v_r}^2} \qquad (6)$$

The combination of equation (2) and equation (6) above with subsequent rearrangement can be seen to be;

$${v_r}^2 = \frac{8\pi Gr^2\rho}{3} \qquad (7)$$

Where, the symbol ${v_r}^2$ is taken to be the Hubble recession velocity.

3. An alternative derivation

Before proceeding, it is considered prudent to clarify the FLRW equation and the symbols for consistency. The initial basic assumption being made is that the universe is expanding at a particular rate, evidenced by the subsequent inclusion of time (t) and the scale factor R. It would seem natural to assume that from this a value for the recession velocity can be derived. However a significantly simpler derivation of the Friedmann equation can be made by initially considering the Schwarzschild equation for escape velocity derived directly using Newtonian mechanics which suggests that this may not be the case;

$$\frac{1}{2}mv^2 = \frac{GMm}{r} \text{ and therefore } {v_e}^2 = \frac{2GM}{r} \qquad (8)$$

From this, mass M is nothing more than density by volume and volume represented by this mass is quite simply $4\pi r^3/3$. By substituting these equations into the Schwarzschild equation for escape velocity and simplifying the following equation is arrived at;

$${v_e}^2 = \frac{8\pi Gr^2\rho}{3} \qquad (9)$$

This equation is clearly not dissimilar to the derivation in (7) derived using the Hubble law, in actual fact being directly equivalent in all but one aspect, the velocity in equation (7) is a recession velocity whereby in equation (9) it is an escape velocity.

4. Results of the analysis

In the interests of clarity, two equations (7) and (9) can be shown to establish any differences which results in an obvious and somewhat disconcerting result;

$$\text{Equation (7)} \quad {v_r}^2 = \frac{8\pi Gr^2\rho}{3} \qquad (10)$$

$$\text{Equation (9)} \quad {v_e}^2 = \frac{8\pi Gr^2\rho}{3} \qquad (11)$$

It must be conceded that the identical equation is used to represent two different terms simultaneously, a recession velocity ${v_r}^2$ and an escape velocity ${v_e}^2$. Clearly this cannot be the case and there must be an error in one of the equations. Being that both equations are derived from the FLWR equation which has been shown to be directly equivalent to the Schwarzschild equation for escape velocity, there can be little doubt that the velocity returned in the FLWR equation is not as currently assumed a recessional velocity but can only be an escape velocity.

5. Summary and Conclusions

It has been shown conclusively that the FLWR equation used to estimate recessional velocity, contrary to current theories, must be considered an escape velocity. This dramatically affects modern cosmological theories as there is no further evidence to support the proposal that recessional velocity can be derived from the Hubble correlation between distance and red-shift. This being the case the Hubble law $v = H_0 r$ as a measure of recessional velocity must be discarded or subsequently reinterpreted as an escape velocity. This of course strongly suggests that the large body of published papers utilizing the Hubble law in regard to the expansion of the universe have no mathematical support. It should not be construed from the observations contained in this paper that the expansion of the universe is not a theoretical possibility, but merely proposes that in the following form there is no mathematical support as such. Indeed, even though lacking mathematical support, the universe may actually be expanding but equally so it may be contracting or indeed static, there is no evidence or mathematical support for the theory either way.

6. References

[i] Saul Perlmutter team on supernovae observations https://www.osti.gov/accomplishments/documents/fullText/ACC0426.pdf

[ii] Sandage A., Astronomical problems for the next three decades. In Key Problems in Astronomy and Astrophysics, Mamaso A. and Munch G. eds., Cambridge University Press (1995)

[iii] Lemaître, G., Un univers homogène de masse constante et de rayon croissant rendant compte de la vitesse radiale des n´ebuleuses extragalactiques, AASB. 47, 49 (1927)