Edwin Hubble and Modern Cosmology's Wax Nose: The Redshift

Robert Sungenis

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The main impetus for the expanding universe theory was Edwin Hubble (1889 – 1953), although the idea actually originated with Willem de Sitter. Hubble based his theory of expansion on the redshift of starlight. As we have cited earlier, although Hubble admitted to other viable interpretations of redshift, nevertheless, the interpretation the science establishment connects to Hubble is that redshift is caused by the stretching of the starlight's wavelength, a stretching that is said to be the result of the star's enormous recession speed away from the Earth. The faster the recession, the more the wavelength would be stretched, and thus, the larger the redshift and the further away the star was said to be. The calculation of its recession speed became known as Hubble's Law.

To fit with the data he observed in 1929, Hubble figured that his "H" constant, which was the proportion between the speed of the galaxy compared to its distance away from us, would have to be 100 kilometers per second per megaparsec.[1] Thus, if a galaxy was said to be 10 megaparsecs away from us, Hubble's Law held that it must recede with a velocity of

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[1] A "megaparsec" equals 3.3×10^6 light years. A "light year" is the distance light travels in a year, at 300,000 kilometers per second, which equals 3×10^{19} kilometers. Edwin Hubble, "A Relation Between Distance and Radial Velocity Among Extra-Galactic Nebula," *Proceedings of the National Academy of Science*, 15, 1929, pp. 168-173. Edwin Hubble and Milton Humason, "The Velocity-Distance Relation Among Extra-Galactic Nebulae," *Astrophysical Journal*, 74, 1931.

1000 kilometers per second. If the galaxy were a gigaparsec from us (which is 1000 megaparsecs), it must recede with a velocity of 100,000 kilometers per second.

Why was Hubble's Law so important to modern cosmologists? With this law, one could calculate the rate of expansion, and once one knew the rate, one could then determine how long the expansion had been taking place and, therefore, determine when the universe began. If one could imagine the expansion being reversed until the universe went back to its original form, the Hubble Law could retroactively calculate the age of the universe. If scientists could make the age long enough, then there would be sufficient room to fit in both cosmic and biological evolution. Indeed, the stakes were certainly high.

The circumstances surrounding Hubble's interpretation of the redshift are intriguing. Hubble worked with Milton Humason, but only Hubble's name is associated with the redshift/expansion theory. The primary reason is that Humason was very reluctant to provide evidence for an expanding universe. The scientific community, based on Einstein's reworked mathematical formulas (courtesy of de Sitter and Friedmann), had already decided that the universe was expanding, but they were missing observational evidence. Consequently, the science community was predisposed to interpret redshift as a Doppler phenomenon wherein galaxies are understood to be moving away at great speeds from the observer.[2] This is in the face of the fact that there was no proof for a connection between

[2] A Doppler shift, as it is known in sound mechanics, is the expansion of sound's wavelength as the source of the sound recedes from you (or contraction as the source approaches you). We hear a rapid change in pitch, for example, when a speeding train blowing its whistle either approaches us or recedes from us. Many scientists today claim that the same thing happens to light when it travels, that is, those who believe light is a wave say that the wave expands as the source of light recedes from the observer. The principle of the lengthening or shortening of wavelength was first proposed by Johann Christian Doppler in 1842 but resisted by the science community for two decades. His findings were confined to sound waves. His theory was confirmed by the Dutch scientist C. H. D. Buijs-Ballot in 1845. In 1860 Ernst Mach proposed the Doppler effect was true for light waves, which was tested by W. Huggins in 1868. It wasn't until 1901 that Russian scientist and editor of the *Astrophysical Journal*, Aristarkh Belopolsky, found the same effect in light waves, which was confirmed by J. Stark in 1905 and Quirino Majorana in 1918. One theory posits that redshift is caused by light's travel through an electron-positron net pervading all space (M. Simhony, *Invitation to the Natural Physics of Matter, Space, Radiation*, Singapore, New Jersey, World Scientific Publishing, 1994, p. 252; and John Kierein, "Implications of the Compton Effect Interpretation of the Redshift," *IEEE Trans. Plasma Science* 18, 61 (1990), et al.). In any case, it should be noted that the "Hubble Constant" has not been very constant. In 1926 it had a value of 500 km/sec/megaparsec. With several intermittent decreases, it now stands at 50.3 km/sec/megaparsec (Michael Rowan-Robinson, "Extragalactic Distance Scale," *Nature*, Dec. 16, 1976, vol. 264, p. 603).

receding galaxies and redshift, or that galaxies are receding at all, or that redshift is to be interpreted as a Doppler shift. In a paper published in 1931 Humason wrote:

Milton Humason (1891 – 1972)

> It is not at all certain that the large redshifts observed in the spectra are to be interpreted as a Doppler effect but, for convenience, they are interpreted in terms of velocity and referred to as apparent velocities.[3]

To refer to them as only "apparent" velocities means that Humason was not committing himself to the Friedmann-Lemaître-Einstein-de Sitter hypothesis. Hubble, of course, knew of Humason's doubts and makes reference to them: "But later, after the 'velocity-distance relation' had been formulated, and Humason's observations of faint nebulae began to accumulate, the earlier, complete certainty of the interpretation began to fade."[4] We might say that Humason paid a dear price for his non-conformance. Whereas in the early going, the discovery of the redshift/velocity ratio was attributed to "Hubble-Humason," later, when it was clear that Humason would be the first not to commit, his name was dropped, which is why the public only knows it as "Hubble's Law."

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[3] "Velocity-Distance Relation Among Extra-Gallactic Nebulae," *Astrophysical Journal*, 74, 1931. We even see Humason's reluctance positioned in the very title of another article containing the word "apparent": "The Apparent Radial Velocities of 100 Extra-Galactic Nebulae," *Astrophysical Journal*, 83, 1936. Humason held his ground even in the face of redshifts he found between 1931-1936 corresponding to 40,000 km/sec.

[4] *The Observational Approach to Cosmology*, p. 29.

Interestingly enough, regardless of what the science establishment now associates exclusively with Edwin Hubble, the fact remains that even Hubble never fully committed himself to the now popular interpretation. Hubble was quite aware of what the science community desired, but maintained his distance. He writes:

> This explanation interprets redshifts as Doppler effects, that is to say, as velocity-shifts, indicating actual motion of recession. It may be stated with some confidence that redshifts are velocity-shifts or else they represent some hitherto unrecognized principle in physics…. Meanwhile, redshifts may be expressed on a scale of velocities as a matter of convenience. They behave as velocity-shifts behave and they are very simply represented on the same familiar scale, regardless of the ultimate interpretation. The term "apparent velocity" may be used in carefully considered statements, and the adjective always implied where it is omitted in general usage.[5]

Obviously, Hubble is making the same conclusion as Humason, that is, he was only committing to the idea of an "apparent velocity" of the galaxies, not an actual velocity. Confirming his meaning is a 1934 lecture in which Hubble cautioned:

> The field is new, but it offers rather definite prospects not only of testing the form of the velocity-distance relation beyond the reach of the spectrograph, but even of critically testing the very interpretation of redshifts as due to motion. With this possibility in view, the cautious observer refrains from committing himself to the present interpretation and prefers the colorless term "apparent velocity."[6]

This is especially significant since in Hubble's day an alternate explanation to redshift had not yet been postulated. Doppler shift was the only game in town, yet Hubble still was not committing himself to it. This skepticism is stated clearly in many works, but especially in the following:

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[5] *The Realm of the Nebulae*, Yale Univ. Press, 1936, pp. 122-123. *The Observational Approach to Cosmology*, p. 22.

[6] 1934 lecture titled: "Redshifts in the Spectra of Nebulae," *The Halley Lecture*, May 8, 1934, Oxford: Clarendon Press, 1934, p. 14.

> The investigations were designed to determine whether or not redshifts represent actual recession. In principle, the problem can be solved; a rapidly receding light source appears fainter than a similar but stationary source at the same momentary distance....
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> For velocities of a few miles or a few hundred miles per second, the dimming factor is negligible. But for the extremely distant nebulae, where the apparent recessions reach tens of thousands of miles per second, the effects are large enough to be readily observed and measured. Hence, if the distances of the nebulae were known quite accurately we could measure their apparent faintness and tell at once whether or not they are receding at the rates indicated by redshifts.
>
> Unfortunately, the problem is not so simple. The only general criterion of great distances is the very apparent faintness of the nebulae which we wish to test. Therefore, the proposed test involves a vicious circle, and the dimming factor merely leads to an error in distance. However, a possible escape from the vicious circle is found in the following procedure. Since the intrinsic luminosities of nebulae are known, their apparent faintness furnishes two scales of distance, depending upon whether we assume the nebulae to be stationary or receding. If, then, we analyze our data, if we map the observable region, using first one scale and then the other, we may find that the wrong scale leads to contradictions or at least to grave difficulties. Such attempts have been made and one scale does lead to trouble. *It is the scale which includes the dimming factors of recession, which assumes that the universe is expanding*.[7]

As we have noted in our earlier discussion of Hubble, he then came to the place where he knew (considering what he actually saw in his telescope) that there were only two options left to him. He writes:

> Thus the use of dimming corrections leads to a particular kind of universe, but one which most students are likely to reject as highly improbable. Furthermore, the strange features of this universe are merely the dimming corrections expressed in different terms. Omit the dimming factors, and the oddities vanish. We are left with the simple, even familiar concept of a sensibly infinite universe. All the difficulties are transferred to the interpretation of redshifts which cannot then be the familiar velocity shifts….Meanwhile, on the basis of the evidence now available, apparent

[7] "The Interpretation of the Redshifts," pp. 108-109, in "The Problem of the Expanding Universe," *American Scientist*, Vol. 30, No. 2, April 1942, emphasis added.

> discrepancies between theory and observation must be recognized. A choice is presented, as once before in the days of Copernicus, between a strangely small, finite universe and a sensibly infinite universe plus a new principle of nature.[8]

In his 1937 book, *The Observational Approach to Cosmology*, he is even more candid about his doubts regarding the interpretation of redshift, as well as his doubts about the Relativity theory behind it. He was honest enough to admit that there was another viable interpretation, and his book shows that he was deeply troubled by it, for he had no way to disprove it. It was the interpretation which holds that redshift, among other factors, may simply be due to light's energy loss as it collides or interacts with the mediums or debris in space. As Hubble puts the possibility:

> …light loses energy in proportion to the distance it travels through space. The law, in this form, sounds quite plausible. Internebular space, we believe, cannot be entirely empty. There must be a gravitational field through which the light-quanta travel for many millions of years before they reach the observer, and there may be some interaction between the quanta and the surrounding medium…. Light may lose energy during its journey through space, but if so, we do not yet know how the loss can be explained.[9]

The longer light must travel, the more it will interact with the particles of space and the more energy it will lose, and thus the longer will be its shift to the red end of the spectrum. Estimates say that light would lose about 5-7% of its energy every 109 light years of

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[8] Edwin Hubble, "The Problem of the Expanding Universe," *American Scientist*, Vol. 30, No. 2, April 1942, pp. 99f; *The Observational Approach to Cosmology*, p. 21. Hubble also states: "for a stationary universe, the law of redshifts is sensibly linear.…The results may be stated simply. If the nebulae are stationary, the law of redshifts is sensibly linear; redshifts are a constant multiple of distances. In other words, each unit of light path contributes the same amount of redshift" (p. 111). Likewise, in a paper Hubble wrote with Richard Tolman in 1935, he concludes that the observational information is "not yet sufficient to permit a decision between recessional or other causes for the redshift" (Edwin Hubble and Richard Tolman, "Two Methods of Investigating the Nature of the Nebular Redshift," *Astrophysical Journal*, 82:302-37, 1935). Of the "two methods," of course, one is that redshift does not represent velocity.

[9] *The Observational Approach to Cosmology*, p. 30.

distance.[10] Hubble is so bothered by this possibility that he feels compelled to mention it about a dozen times throughout the book.[11]

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[10] Fritz Zwicky was the first to propose the theory of "tired" light ("Redshift of Spectral Lines," *Proceedings of the National Academy of Sciences*, 1929, v. 15, pp. 773-779), but this was merely the default position for the fact that "Hubble has shown that the observational data which he has obtained do not agree satisfactorily with the homogeneous relativistic cosmological models [*viz.*, the Big Bang theory]" (Guy Omer, "A Nonhomogeneous Cosmological Model," 1949, p. 164). Among the many advocates of the "tired" light theory is the Ukrainian team of N. A. Zhuck, V. V. Moroz, A. A. Varaksin who, rejecting Big Bang cosmology due to the distribution and nature of the 23,760 quasars they examined, are forced to conclude that "the Cosmic Microwave Background Radiation can be either the remainder of the high temperature explosion of the super-dense substance *or the total radiation of all stars of the stationary universe with the said dissipation of the energy of light*." ("Quasars and the Large Scale Structure of the Universe," N. A. Zhuck, V. V. Moroz, A. A. Varaksin (*Spacetime and Substance, International Physical Journal*, Ukraine, Vol. 2, No. 5 (10) 2001, p. 193, emphasis added); and N. A. Zhuck in "The Microwave Background Radiation as aggregate radiation of all stars," XVII International Conference, April 12-14, 2000, Moscow (in Russian); and in *Spacetime and Substance* 1:1, 29-34 (2000). The same conclusion comes from Alex M. Chepick: "The urgency of "tired" light is proved for the stationary universe model and the value of energy loss of a photon on one cycle of light's wave is constant….The most surprising conclusion…is the value of energy loss of a photon on one cycle of light's wave is not dependent on a wavelength! Therefore it is a global physical constant….In a 1 meter vacuum a part of the energy loss of light makes $z = 10^{-27}$…because of equal contribution of electrical and magnetic components into the energy of the wave EMF, and that during one cycle there are 4 power transmissions between the electrical and magnetic fields, probably it is necessary to consider energy loss for each such transformation at $\varepsilon/4$." The writers also conclude: "The constancy of this loss suggests [the] existence of stable particles with approximately 10^{-69} kg [*i.e.*, mass of the photon] ("The Calculation of the Indispensable Accuracy of the Measuring of an EM's Wave Energy," *Spacetime and Substance*, Vol. 3, 2002, No. 3, 13, p. 111). See also Goldhaber and Nieto "New Geomagnetic Limit on the Mass of the Photon," *Physical Review Letters* 21:8, 1968, p. 567, which establishes a limit of 2.3×10^{-15} ev. Lakes, "Experimental limits on the Photon Mass and Cosmic Magnetic Vector Potential," *Physical Review Letters* 80:9, 1998, p. 1826. In 1981, David A. Hanes address the "tired light" issue in the article "Is the Universe Expanding?" (*Nature* 289:745). Other scientists who proposed the "tired light" theory were Max Born and Erwin Finlay-Freundlich but they never developed the theory. Paul LaViolette also advances the theory ("Is the Universe Really Expanding? *Astrophysical Journal*, 301, 544-553, 1986). Halton Arp holds "tired light" is discounted by the fact that no increase in redshift has been seen from light traveling through dense galactic material; that quasars close together can have vastly different redshifts; that younger quasars have higher redshift; the Butcher-Oemler effect of galaxies of moderate redshift having blue and ultraviolet light; high redshift quasars in the middle of low redshift galaxies (*The Einstein Cross* – G2237+ 0305). Arp holds redshift is intrinsic to the object, and since each object is different because it is "created" at a different time, varying redshifts are produced (*Seeing Red*, pp. 97, 108, 159, 166, 173, 195).

[11] *The Observational Approach to Cosmology*, Oxford, 1937, Preface: "the phenomena of red-shifts whose significance is still uncertain"; p. 21: "the law of redshifts…but the uncertainties were considerable"; p. 26: "…red-shifts as velocity-shifts…seems to imply a strange and dubious universe, very young and very small…seems to imply that red-shifts are not primarily velocity-shifts…the observer is inclined to keep an open mind…"; p. 31: "Red-shifts are produced either in the nebulae, where the light originates, or in the intervening space through which the light travels….At present, however, the direct investigation ends in a vicious circle, and the persistent observer is forced to consider a possible indirect attack on the problem"; p. 39: "There seems to be no *a priori* necessity for a linear law of expansion, a

Throughout the book we see Hubble struggling to make the data conform to the theories of the day. On the one hand, he knows that if he interprets redshift as a velocity-indicator, then he winds up with a universe that is too small and too young to accommodate the theory of biological evolution. As he puts it:

> A universe that has been expanding in this manner would be so extraordinarily young, the time-interval since the expansion began would be so brief, that suspicions are at once aroused concerning either the interpretation of redshifts as velocity-shifts or the cosmological theory in its present form.[12]

But if Hubble interprets redshift as a loss of light's energy, he has a more "plausible" model for redshift but one that produces an "indefinitely large" universe and, most of all, does not allow for the postulates of Special or General Relativity. As he puts it:

> On the other hand, if the recession factor is dropped, if red-shifts are not primarily velocity-shifts, the picture is simple and plausible. There is no evidence of expansion and no restriction of the time-scale, no trace of spatial curvature, and no limitation of spatial dimensions.[13]

What a dilemma for science! Hubble's only other alternative had already been discounted – an Earth-centered cosmos that was closed and finite. So what does a good scientist do in such a situation? He preserves the sacrosanct theory of General Relativity as best he can by making convenient *ad hoc* assumptions and creating arbitrary variables that will give it some semblance of respectability. The first assumption needed is that the universe is "homogeneous," that is:

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strict proportionality between red-shifts and distance"; p. 43: "Thus, the familiar interpretation of red-shifts as velocity-shifts leads to strange and dubious conclusions; while the unknown, alternative interpretation leads to conclusions that seem plausible and even familiar"; p. 44: "The fundamental question is the interpretation of red-shifts"; p. 55: "At this point the cosmologist seizes upon the observed red-shifts, interprets them as velocity-shifts…" Radio astronomer, Grote Reber (d. 2002), who built the first radio telescope in 1937, points out many of these very pages in Hubble's book to indicate that Hubble had "grave doubts about redshifts being caused by relative motion." As noted previously, Reber is the true discoverer of the Cosmic Background Radiation, not Penzias and Wilson ("Cosmic Static at 144 meters wavelength," *Journal of the Franklin Institute*, vol. 285 (Jan. 1968), pp. 1-12). A biographical note reveals that Reber's mother was Edwin Hubble's seventh-grade teacher.

12 *Ibid*., p. 46.

13 *Ibid*., p. 63.

> …there must be no favored location in the universe [*i.e.*, no central Earth], no center, no boundary; all must see the universe alike. And, in order to ensure this situation, the cosmologist postulates spatial isotropy and spatial homogeneity….[14]

Once "homogeneity" is assumed (not proven), one needs to get to an "expanding universe," for this will help support the trend in modern cosmology toward the Big Bang theory. But if one introduces expansion into a homogeneous universe, this will cause an imbalance in the "law of distribution" wherein, as Hubble warns his reader:

> …the density of the nebular distribution increases outwards, symmetrically in all directions, leaving the observer in a unique position. Such a favoured position, of course, is intolerable; moreover, it represents a discrepancy with the theory, because the theory postulates homogeneity. Therefore, in order to restore homogeneity, and to escape the horror of a unique position, the departures from uniformity, which are introduced by the recession factors, must be compensated by the second term representing effects of spatial curvature. There seems to be no other escape.[15]

In other words, rather than the nebulae thinning out as the distance from their origin increases (as one would expect in an expanding universe), conversely, Hubble's telescope tells him that the distant nebulae have the same concentration as the nearer nebulae. So now Hubble needs to invent another variable that will compensate for this lack of thinning out. Hubble makes no excuses for the *ad hoc* nature of this seemingly desperate attempt to salvage modern theory. He writes:

> To the observer the procedure seems artificial…in testing the relativistic theory, he introduces a new postulate, namely recession of the nebulae, and it leads to

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[14] *Ibid*., p. 63.

[15] *Ibid*., pp. 58-59. Hubble adds: "Observations demonstrate that: $\log_{10} N = 0.6m_c + \text{constant}$. Relativistic cosmology requires that $\log_{10} N = 0.6(m_c - d\lambda/\lambda + C_v) + \text{constant}$, therefore $C_v = d\lambda/\lambda$. The curvature of space is demonstrated and measured by the postulated recession of the nebulae." N = number of nebulae per square degree; m_c = the limiting faintness express as a magnitude; $d\lambda/\lambda$ = the recession factor; C_v is the effect of spatial curvature.

> discrepancies. Therefore, he adds still another postulate, namely, spatial curvature, in order to compensate the discrepancies introduced by the first.[16]

In other words, geodesic geometry is used to curve the space of the homogeneous universe so that it can bend to conform with the mathematics of General Relativity. As Hubble puts it:

> Theoretical investigators, guided by the assumption of homogeneity, adopt Riemannian geometry which operates in curved space. The curvature cannot be visualized….It is sufficient to say that the nature of the curvature is indicated, and the amount is measured, by the radius of curvature (which projects, as it were, to higher dimensions). The radius in our universe might be positive, negative or zero, and might be large or small. A positive curvature implies closed space, a universe with a definite, finite volume but with no boundary. A negative curvature implies open space, an infinite universe. The limiting case of zero curvature is 'flat' Euclidean space with an infinite radius…and, in all but flat space, the amount of curvature has a wide range of possible values.[17]

But, even after admitting that his "theoretical investigators" produce such *ad hoc* solutions, nevertheless, in order to remain with the consensus, Hubble adds his own *ad hoc* touches to round out the picture:

> Actually, no curvature can be found which exactly compensates for the apparent departures from uniformity in each of the surveys. Nevertheless, if we admit the presence of rather considerable systematic errors in the observations, it is possible to select a curvature which will more or less restore homogeneity. Hidden errors of the necessary dimensions are by no means impossible in the very delicate investigations near the limits of a great telescope. Therefore the expanding universe can be saved by introducing a sufficient amount of spatial curvature.[18]

All in an effort to save the "expanding universe," Hubble is so desperate that, realizing even "curvature" cannot solve the problem, he proposes that perhaps there was an error in what he saw with his own eyes through his own telescope. He doesn't know for certain

[16] *The Observational Approach to Cosmology*, p. 59.
[17] *The Observational Approach to Cosmology*, pp. 54-55.
[18] *The Observational Approach to Cosmology*, p. 60.

such error exists, but he depends on it nevertheless. This is quite ironic since Hubble's book is titled *The Observational Approach to Cosmology*, wherein the operative word is "Observational." In the end, Hubble's view is not about what Hubble "observes" but only what his philosophical presuppositions will allow him to believe. In the end Hubble makes a travesty of "observational" cosmology.

As far as modern science is concerned, Hubble remains somewhat of an enigma. Although he dismissed the viable Earth-centered solution for his "observations," his book leaves his colleagues with an equivocation that they would rather he not have said: "Two pictures of the universe are sharply drawn…*we seem to face, as once before in the days of Copernicus, a choice*…" The science establishment has made a concerted effort to ignore this equivocation, however. As they did in order to support Einstein's Relativity theory when, in 1919, the world's scientists promoted only one of Eddington's eclipse photographs (and ignored the rest) to show anyone who would believe them that light bent around the sun in accord with the predictions of General Relativity, so they ignore Hubble's alternate interpretation of redshift and cite only his initial paper of 1929, for it appears to be the only one that indicates redshift as the sole indicator of radial velocity. These unconscionable breeches of protocol are common in the science establishment. In most cases, only the evidence supporting the prevailing view will be published in the journals and popular books.

Allan Sandage, who is known for taking over the work of Hubble and who was dubbed by the *New York Times* as "the grand old man of cosmology," makes a concerted effort to give the impression that either Hubble made a mistake in doubting that redshift is a velocity indicator, or that he didn't mean what he wrote:

> We now come to one of the most remarkable episodes in all of science. Hubble's detailed analysis...is a most fascinating study of how an interpretation, without caution concerning possible systematic errors, led to a conclusion that the systematic redshift effect is probably not due to a true Friedmann-Lemaître expansion, but rather to an unknown, then as now, unidentified principle of nature. Indeed, even in the abstract to this 1936 paper on the *Effects of Redshift on the Distribution of Nebulae*, Hubble concluded: 'The high density suggests that the expanding models are a forced interpretation of the data.' His belief that the

expansion probably is not real persisted even into his final 1953 paper which was the Darwin lecture of the RAS, given in May of the year he died in September. What were the steps leading to this conclusion that, in today's climate, seems so remarkable?[19]

It is "remarkable" to Sandage because he is the heir-apparent to Big Bang cosmology, and it is his job to make sure that Hubble's doubts about the redshift/velocity relationship are covered up. Sandage has made it quite clear that, opposed to Hubble, he is firmly committed to Big Bang expansion theory. In one popular venue Sandage says: "The expansion of the entire universe is the most important single hard scientific fact of cosmology,"[20] but, of course, it is not a "fact" at all, let alone a "hard" one. That Sandage is aware of Hubble's reluctance to interpret redshift as a function of velocity is freely admitted:

> Hubble concluded that his observed log *N(m)* distribution showed a large departure from Euclidean geometry, provided that the effect of redshifts on the apparent magnitudes was calculated as if the redshifts were due to a real expansion. A different correction is required if no motion exists, the redshifts then being due to an unknown cause. Hubble believed that his count data gave a more reasonable result concerning spatial curvature if the redshift correction was made assuming *no recession*. To the very end of his writings he maintained this position, favoring (or at the very least keeping open) the model where *no true expansion* exists, and therefore that the redshift "represents a hitherto unrecognized principle of nature." This viewpoint is emphasized *(a)* in *The Realm of the Nebulae*, *(b)* in his reply (Hubble 1937a) to the criticisms of the 1936 papers by Eddington and by McVittie, and *(c)* in his 1937 Rhodes Lectures published as *The Observational Approach to Cosmology* (Hubble 1937b). It also persists in his last published scientific paper which is an account of his Darwin Lecture (Hubble 1953).[21]

Not only was Hubble opposed to the "Friedmann-Lemaître expansion," but in the same 1936 paper he points to another target – General Relativity:

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[19]http://nedwww.ipac.caltech.edu/level5/Sandage2/ Sandage2_3.html).
[20] "Cosmology," *Hammond Barnhart Dictionary of Science*, Barnhart Books, 1986.
[21] Allan Sandage, *Journal of the Royal Astronomical Society of Canada*, Vol. 83, No. 6, Dec. 1989.

…if redshifts are not primarily due to velocity shifts, the observable region loses much of its significance. The velocity-distance relation is linear; the distribution of nebulae [galaxies] is uniform; there is no evidence of expansion, no trace of curvature, no restriction of the time scale.[22]

The reader should stop and digest what an amazing statement this is. Without any equivocation, Hubble declares that, if he is correct that the redshift/velocity relationship is mistaken, Einstein's theory of Relativity is totally erroneous. Space "curvature" and "restriction of the time scale" were Relativity's basic tenets. Without them, there is no Relativity. No wonder Sandage does his best to silence Hubble's doubts. Without the relation between redshift and velocity, Einstein has become worse than the medievals he accused of practicing superstition.

All in all, the importance of this cross-section of astrophysical theory cannot be underestimated due to the esteem Hubble enjoys as the world's greatest astronomer of the twentieth century. As Sandage says of Hubble: "His success was remarkable, and his proportionate influence nearly unparalleled in modern astronomy."[23] But as they did with Humason, so they did with Hubble. If a scientist does not support the *status quo*, he or she is ostracized or reinterpreted, and that is why hardly anyone in college physics classes knows of Hubble's alternatives or the grave problems he saw in the redshift/velocity relationship.

Irrespective of his quandary regarding whether redshift is related to velocity, Hubble's proposed age of the universe gave at least some semblance of a time-scale that would not force science to capitulate to the six-day creation of Genesis. In his 1953 George Darwin lecture he states:

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[22] *Astrophysical Journal* 84, 517 (1936), p. 553; and *The Observational Approach to Cosmology*, p. 63. Hubble continues: "The unexpected and truly remarkable features are introduced by the *additional assumption that redshifts measure recession*. The velocity-distance relation deviates from linearity by the exact amount of the postulated recession. The distribution departs from uniformity by the exact amount of the recession. The departures are compensated by curvature, which is the exact equivalent of the recession. Unless the coincidences are evidence of an underlying necessary relation between the various factors, *they detract materially from the plausibility of the interpretation*, the small scale of the expanding model, both in space and time is a novelty, and as such will require rather decisive evidence for its acceptance" (emphasis added).

[23] Allan Sandage, *Journal of the Royal Astronomical Society of Canada*, Vol. 83, No. 6, Dec. 1989.

> When no recession factors are included, the law will represent approximately a linear relation between redshifts and distance. When recession factors are included, the distance relation is...accelerated expansion... the age of the universe is likely to be between 3000 and 4000 million years, and thus comparable with the age of rock in the crust of the Earth.[24]

Although it is difficult to know from the syntax whether Hubble was basing the time-span of 3-4 billion years upon the inclusion or elimination of recession factors, nevertheless, he gives us only 3-4 billion years for the "age of the universe." Note that Hubble did not say "age of the Earth." This is what is known in cosmology as "Hubble time," since it was derived directly from Hubble's Law of Expansion, and it was only one of three dating methods used at that time, the other two being radiometric dating by isotope decay and the composition of stars.

Hubble's conclusions caused quite a problem. A universe that was expanding for only 3-4 billion years would mean that the Earth, which was understood to come long after the initial expansion, would not be old enough to match the evidence from the burgeoning field of radiometrics that the Earth itself had to be at least 3-4 billion years old, which would require the universe to be much older. "Hubble time," of course, was far lower than that allowed by radiometric dating or star composition. In fact, even though Sandage claims that Hubble's 3-4 billion year time-span is based on "no recession factor" (and, therefore, Hubble's time-span would be higher if a recession were included), nevertheless admits:

> There was, of course, the embarrassment that the inverse of the Hubble expansion rate (*i.e.,* the Hubble time) was only two billion years on Hubble's 1930 to 1953 distance scale whereas the Earth was believed to be a bit older than three billion years even in 1936. It was left to the inventors of the steady state cosmology to emphasize this discrepancy of time scales, pointing out that any of the Friedmann models (*sans* cosmological constant) that were used to espouse a 'beginning' could not be true"[25]

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[24] "The Law of Redshifts," George Darwin Lecture, May 1953, *Royal Astronomical Society*, 113, 658. Allan Sandage claims that the sentence "the age of the universe is likely to be between 3000 and 4000 million years" refers to the fact that "no recession factor is included," but this cannot be proven based on the syntax of Hubble's paragraph.

[25] Allan Sandage, *Journal of the Royal Astronomical Society of Canada*, Vol. 83, No. 6, Dec. 1989.

Guy Omer had already pointed out these difficulties in the late 1940s. He writes:

> E. Hubble has shown that the observational data which he has obtained do not agree satisfactorily with the homogeneous relativistic cosmological models....The model has a short time scale. The present age of the model must be less than 1.2×10^9 [1.2 billion] years. This is about one-third the recent estimation of the age of the earth as an independent body, made by A. Holmes. This is probably the most serious difficulty of the homogeneous model. Because of the unrealistic aspects of the homogeneous relativistic model, Hubble proposed an alternate model which would be essentially static and homogeneous and in which the red shift would be produced by some unknown but nonrecessional mechanism.[26]

Since it was necessary to have the age of the Earth coincide with radiometrics, and since Hubble's law only provided half the needed age, various theories were proposed to bridge the gap so as to add the needed years to evolutionary theory. Hubble had already come across some ingenious solutions from his colleagues. He writes:

> Theories may be revised, new information may alter the complexion of things, but meanwhile we face a rather serious dilemma. Some there are who stoutly maintain

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[26] Guy C. Omer, Jr., "A Nonhomogeneous Cosmological Model," *Journal of the American Astronomical Society*, 109, 1949, pp. 164-165. Omer continues: "There have been several suggestions of possible mechanisms which would produce red shifts without having actual physical recession. As noted earlier, F. Zwicky [*Proceedings of the National Academy of Sciences*, 15, 773, 1929] has proposed that photons may lose energy with time, perhaps by a gravitational interaction with the matter along their trajectories. R. C. Tolman [*Relativity, Thermodynamics, and Cosmology*, Oxford, Clarendon Press, 1934, pp. 285ff], however, has shown that 'gravitational drag' cannot account for the observed red shift if the relativity theory is valid. If the extragalactic red shift were produced by 'gravitational drag,' we should expect to measure red shifts within our own local group which would be greater than those indicated by Hubble's linear law, since the mean density of matter within the local group is greater than the average density of matter for the entire universe. If the photon's loss of energy were dependent upon time alone, we should expect to measure red shifts within our own local group which would be exactly equal to those predicted by Hubble's linear law." In order to save face for the theory, Hubble was ready to "suggest that the law of red shifts does not operate within the local group" (Omer, p. 166). The same difficulty arose: how to square this theory with evolution. Omer continues: "P. A. M. Dirac has proposed that the physical 'constants' are not constant with time but may vary in a systematic manner. This proposal would account for an observed red shift without any actual physical recession....E. Teller [*Physical Review*, 73, 801, 1948] has recently criticized Dirac's proposal, since there is considerable geological and biological evidence that the surface temperature of the earth has been reasonably constant for the last 5×10^8 years. With Dirac's hypothesis and the additional assumption that the masses of the earth and the sun have remained constant, Teller finds that the surface temperature of the earth would have been near the boiling-point for water within this time interval" (Omer, p. 166).

> that the Earth may well be older than the expansion of the universe. Others suggest that in those crowded, jostling yesterdays, the rhythm of events was faster than the rhythm of the spacious universe today; evolution then proceeded apace, and, into the faint surviving traces, we now misread the evidence of a great antiquity.[27]

But Hubble admitted that such excuses "…sound like special pleading, like forced solutions of the difficulty."[28]

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[27] *The Observational Approach to Cosmology*, p. 44.
[28] *Ibid*.