This page introduces the calculation,
written 22 November 1994 and
published July 1998 in the 'Supplementary Papers'
volume to the Fifth Conference on
Physical Interpretations of Relativity Theory (PIRT V)
(British Society for the Philosophy of Science)
Imperial College, London, 6-9 September 1996
entitled

**Appendix A. Random transverse velocity (RTV) redshift**

(pp 242-249) to the paper:-

**"An interim outline of some research under the heading: Some aspects of a continuum theory of physical nature"**

by

**Miles F Osmaston**

## Appendix A. Random transverse velocity (RTV) redshift.

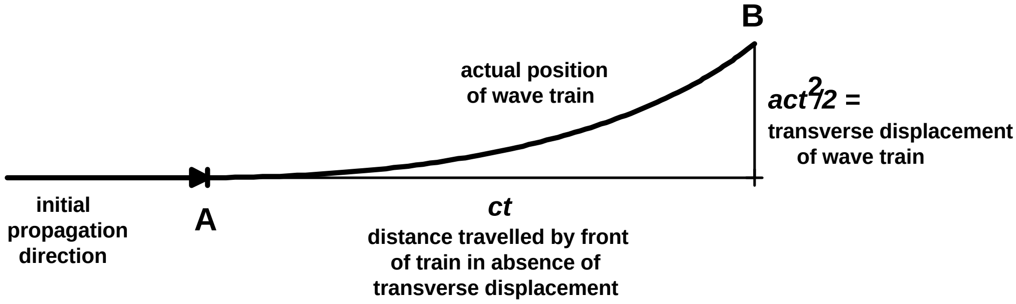
### Theoretical treatment.

Consider a wave train propagating in a medium in random motion.

Consider those components of the random motion that lie perpendicular to the initial direction of wave train propagation. Assume the velocities of random motion are very small compared with the velocity ($c$) of wave propagation.

At time $t = 0$ let the transverse velocity experienced by the front of the wave train be zero. Let the train then enter a zone where the longitudinal gradient of transverse velocity is $a$ cm/s per cm travelled in the wave propagation direction. The transverse acceleration experienced by a particular part (say the front wave) of the wave train must then be $ac$ cm/s$^2$.

After $t$ seconds we have:-




The equation of the wave train axis (AB) after displacement is given by

$$x = ct;\ \ y = \tfrac{1}{2}act^2.$$

Therefore $t = x/c$ and $y = \frac{1}{2}ax^2/c$;

hence $\frac{dy}{dx} = \frac{ax}{c}$.

Now the length ($s$) of a curve $y = f(x)$ is given by

$$\frac{ds}{dx} = \sqrt{1 + \left[\frac{dy}{dx}\right]^2} = \sqrt{1 + \frac{a^2x^2}{c^2}}$$

Therefore

$$s = \int_0^{ct_1} (1 + \frac{a^2x^2}{c^2})^{1/2}\, dx = \int_0^{ct_1} (1 + \frac{1}{2}\frac{a^2x^2}{c^2} + .......)dx$$

$$\approx ct_1 + \frac{1}{6}a^2ct_1^3 \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ (A_1)$$

The proportionate change in length of the wave train in travelling the distance $ct_1$ is therefore

$$\frac{S}{ct_1} = +\frac{1}{6}a^2t_1^2.$$

Notice that both the plus sign and the appearance of $a$, a random quantity, in the second order ensure that the result is always a stretching, or redshift, of the wave train.

Therefore

$$\left[\frac{\delta\lambda}{\lambda}\right]_{ct_1} = +\frac{1}{6}a^2t_1^2 \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ (A_2)$$

In this expression $a$, the gradient of transverse velocity, is clearly proportional to the amplitude (e.g. the most probable value) of the random motion velocities and to their (e.g. most probable) spatial frequency along the propagation path.

Similarly, $ct_1$ might be taken as the most probable spatial extent of a particular value of $a$, and its corresponding wave-stretching action, before the wave train moves into a region with a distinctly different value of $a$.

Successive regions of this kind may be called <u>influence cells</u>, each with the ability to produce a most probable amount of redshift corresponding only to the spatial and velocity parameters of the medium.

Let the propagation space be a gas. According to continuum theory the aether between the gas particles is in random motion that is a consequence only of the particle random motions.

In the absence, at present, of direct information as to how many particles contribute an effective velocity influence to the resultant velocity of the continuum (aether) at a particular point in the gas, it is not possible to determine the influence cell size directly from the gas conditions.

It is possible and useful, however, to consider how changes in the gas conditions will affect the redshift per unit distance.

The total redshift rate ($R$) per unit distance is

$$R = (\text{mean redshift per influence cell}) \times (\text{no. of influence cells per unit distance})$$

$$= \delta R \,.\, n \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (A_3)$$

where

$$\delta R = \tfrac{1}{6}\underline{\boldsymbol{a}}^2 t_1^2$$

in which $\underline{\boldsymbol{a}}$ is now the mean effective shear velocity gradient in the influence cell, and $t_1$ is the time taken to traverse it, so is a measure of the linear size of the cell.

We see at once that $n \propto \frac{1}{cell\text{–}size}$ ; but $\delta R \propto (\text{cell size})^2$

so $R \propto$ cell size (e.g. diameter).

Now consider the factors which affect $\underline{\boldsymbol{a}}$.

1. Velocity amplitude. If we assume that the influence at a given point (fixed with respect to the gas as a whole) of a particular gas particle decreases as some function of its distance from the point under consideration, then the resultant velocity of the continuum at that point will mainly depend on the velocities of the nearest particles to it. [Proof. If we divide the space around the point into concentric spherical shells of equal and finite thickness, the number of particles within each shell increases (in the mean) as the square of the shell radius. The resultant velocity influence which each shell contributes at the point will thus average to nearer zero the greater the shell radius.]

Notice that, by deriving its velocity from contributed influences of many particles, the continuum velocity acquires a smoothed random variation along any spatial traverse. If each particle only influenced its own private domain the variation would still be random but essentially discontinuous, with almost infinite spatial velocity gradients, where particles were in near-collision, that could affect the validity of the foregoing treatment.

If the linear scale of the gas particle distribution is increased by a factor P (i.e. all particles P times further apart) but the particle velocities are not changed and the particle sizes are taken as negligible in both cases, the radius and thickness of each "influence shell" around the point considered will have to be increased P times to contain the same number of particles as before, and therefore to contribute at that point a velocity influence differing from zero by the same amount as before. Thus the 10th (say) shell, working outward from the point, will contribute an influence equal to the same fraction of a (the most probable particle velocity) as it did before the change of scale. This argument is valid whatever the law of decrease, with distance, of an individual particle's influence (e.g. inverse square or any other).

We conclude that change of the scale of the distributions of particles (i.e. variation of the number density) does not affect the amplitude of the transverse velocities present along the wave propagation path.

2. Shear velocity gradient ($\underline{\boldsymbol{a}}$). For the same velocity structure, a P times increase in linear scale must decrease the gradient P times. That is to say: $\underline{\boldsymbol{a}} \propto (\text{particle no. density})^{-\frac{1}{3}}$.

3. Particle velocity. For a Maxwell-Boltzmann gas the most probable transverse velocity in the continuum is $a \propto \left[\frac{T}{m}\right]^{\frac{1}{2}}$, where $T$ is the absolute temperature and $m$ the particle mass.

Summarizing, we have

$$R \propto \underline{\boldsymbol{a}}^2 \,.\, t_1^2 \,.\, n$$

$$\propto \frac{T}{mP^2} \cdot P^2 \cdot \frac{1}{P}$$

$$\propto \frac{T}{mP}$$

$$\propto \frac{T}{m} \text{ . (particle number density)}^{\frac{1}{3}} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; (A_4)$$

**Observational evidence.**

In 1968 Sadeh, Knowles & Au, of the U.S. Naval Research Laboratory, Washington, published in *Science* the results of a series of experiments that seem directly relevant to our redshift problem.

They found, over horizontal distances of up to 1500km, a progressive decrease of radio-received caesium clock rate relative to that transmitted. Only the ground wave was used. The principal experiment ran northeastward from a transmitter at Cape Fear, North Carolina, eventually reaching Yarmouth, Nova Scotia. A 500km NW path to Washington, D.C., produced a result consistent with this. A 1000km southerly path to Jacksonville, Florida produced a redshift rate about 70% greater, but with large uncertainty.

Omitting the latter result, their results yield a redshift rate

$\underline{\boldsymbol{R_1 = 1{\cdot}75 \times 10^{-20}} \textbf{ per cm.}}$ (my reading from their graph)

The higher value for the Florida path may, on the RTV redshift interpretation proposed here, have been due in small part to higher atmospheric temperature. It is shown later, however, that a slightly increased degree of ionization along the path could amply explain the difference.

Sadeh et al. tried to interpret their results as an effect of mass, but their reasoning is very obscure.

**The "cosmological" redshift (henceforward the "cosmic" redshift).**

To interpret the Sadeh et al. result as RTV redshift in air it is necessary to assume a path temperature. No temperature or time of year is given in their paper. Accordingly $T$ = 290K will be asumed here. Standard atmospheric pressure is also assumed.

The Sadeh et al. result can now be used to extrapolate to intergalactic conditions.

Take (the values used are discussed later):-

| Air at ground level | In intergalactic space |
|---|---|
| $T_a$ = 290K | $T_{igs}$ = 2·75K |
| Gas density = $\rho_{STP-air} \cdot (\frac{273}{290})$ = 4·46 x $10^{-5}$ $m$ g/cm$^3$ | $\rho_{igs}$= $10^{-28}$ g/cm$^3$ |
| $m_a$ (atomic units) = 29 | $m_{igs}$ = 1 (neutral atomic hydrogen) |

Other quantities.

Mass of hydrogen atom = 1.66 x $10^{-24}$ g.

Avogadro number $N_0$ = 6.02 x $10^{23}$ mole$^{-1}$

Gramme molecular volume @ STP $V_0$ = 22.42 x $10^3$ cm$^3$.mole$^{-1}$

1 Megaparsec = 3.086 x $10^{24}$ cm = 3.261 light years.

Hence the number density of air particles @ 290K is

$$n_a = \frac{N_0}{V_0} \cdot \frac{273}{290} = \frac{6.02 \times 10^{23} \times 273}{22.42 \times 10^3 \times 290} = 2.52 \text{ x } 10^{19} \text{ cm}^{-3}$$

Number density in intergalactic space

$$n_{igs} = \frac{10^{-28}}{1.66 \times 10^{-24}} = 6.02 \text{ x } 10^{-5} \text{ cm}^{-3}$$

Hence, from ($A_4$) we have

Specific redshift in intergalactic space

$$R_{igs} = R_1 \cdot \frac{T_{igs}}{T_a} \cdot \frac{m_a}{m_{igs}} \cdot \left[ \frac{n_{igs}}{n_a} \right]^{\frac{1}{3}}$$

$$= 1.75 \times 10^{-20} . \frac{2.75}{290} . \frac{29}{1} . \left[\frac{6.02 \times 10^{-5}}{2.52 \times 10^{19}}\right]^{\frac{1}{3}}$$

$$= 6.43 \text{ x } 10^{-29} \text{ cm}^{-1}$$

or $$= 1.98_5 \text{ x } 10^{-4} \text{ Mpc}^{-1}.$$

Taking $c = 3 \text{ x } 10^5$ km. s$^{-1}$, the predicted Hubble "constant" $H_p$ is

$$H_p = R_{igs}c = 1.98_5 \text{ x } 10^{-4} \text{ x } 3 \text{ x } 10^5$$

$$= \underline{59.5_6 \text{ km. s}^{-1}.\text{Mpc}^{-1}}.$$

This is fully within the currently accepted range (50 - 100 km/s/Mpc).

Note that, to obtain the same result if $m_{igs} = 2$ (molecular $H_2$), $\rho_{igs}$ becomes $4 \text{ x } 10^{-28}$ g.cm$^{-3}$.

[Both this density and that used in the main calculation are appreciably too high unless one believes in very large amounts of cold dark matter (CDM), the main purpose of which is lost if the Universe is not expanding. This is returned to later.]

The foregoing result is only approximate, applicable to very low redshift ratios, because the RTV redshift mechanism actually involves compound growth of redshift with distance ($D$), thus

$$\frac{d\lambda}{dD} = R_{igs}.D$$

whence

$$\lambda_D = \lambda_0 e^{R_{igs}D} \quad \ldots\ldots\ldots\ldots \quad (A_5)$$

where $\lambda_0$ and $\lambda_D$ are the wavelengths at emission and after travelling distance $D$.

This effect is now illustrated numerically, using the foregoing result $R_{igs} = 6.43 \text{ x } 10^{-29}$ cm$^{-1}$, in terms of the increase of "$H_p$" (mean for distance) with distance.

| Distance D (Mpc) | $\frac{\lambda_D}{\lambda_0}$ | $z = \frac{\lambda_D}{\lambda_0} - 1 = \frac{\delta\lambda}{\lambda_0}$ | "$H_p$" (km.s$^{-1}$.Mpc$^{-1}$) |
|---|---|---|---|
| 1 | 1.000198 | 0.000198 | 59.6 |
| 1000 | 1.2195 | 0.2195 | 65.0 |
| 3000 | 1.814 | 0.814 | 81.4 |
| 6000 | 3.289 | 2.289 | 114.4 |
| 9000 | 5.965 | 4.965 | 165.5 |

It is seen that the redshift ($z$) more than doubles between 6 and 9 Gpc.

The latter distance corresponds to an "age since emission" of $3.261 \text{ x } 9 \text{ x } 10^9 = 29.3$ Ga, which is about twice the "age of the Universe" currently considered within the framework of big-bang cosmologies.

For comparison, note that observations (Sandage 1968) based on the brightness of the brightest galaxies in each galaxy cluster (as a measure of distance) showed redshift ($z$) proportional to (integrated light)$^{-2}$, i.e. $z \propto$ distance, if other causes of attenuation can be neglected, out to $z = 0.3$. If one were to accept a linear extrapolation of this result and assume $H_0 = 59.6$ km.s$^{-1}$.Mpc$^{-1}$ (as for 1Mpc in the above table) it yields a distance in a non-expanding Universe of 25,000 Mpc for $z = 4.965$; nearly three times the distance implied by the RTV redshift interpretation, requiring a nearly threefold further increase in the "age since emission".

Maximum observed values of $z$, so far, for quasars range up to 4.89.

As shown in the foregoing table, the RTV redshift process yields an apparent value of of $H$ that increases with distance, giving the impression that expansion rates have decreased with time, a feature that is also expected in all big-bang cosmologies in that the gravitational influence of the mass in the Universe will have this effect. [For further illumination of this matter, however, see the **Late Note** (2009) added on Page A8.]

It is by assuming a large value for the deceleration parameter, and hence a large density for the Universe, that big-bang cosmologies seek to evade the dilemma posed by the very large values of $z$ and an universe of 15Ga age or less.

For an expanding universe there is a critical density $\rho_{crit} = 3H_0/8pG$ for which expansion will gradually reduce to zero, but not reverse. For $H_0$ = 60 km/s/Mpc, $\rho_{crit} = 7.2 \times 10^{-30}$ g/cm$^3$. The corresponding (present) deceleration parameter $q_0 = -\ddot{R}/\dot{R} = ½$. For larger density values ($\Lambda = \rho/\rho_{crit} => 1$) the Universe will eventually collapse again and, for lower values ($\Lambda < 1$), $q_0 \rightarrow 0$ as time $\rightarrow \infty$.

**Discussion.**

**a)** The intergalactic density ($10^{-28}$ g.cm$^{-3}$) used in the foregoing calculations is much higher than the $10^{-30}$- $10^{-31}$, or even lower, that has been suggested when considerations **other than cosmological dynamics** have been at issue. Globular star clusters, which occur in the haloes of galaxies and typically contain only low-metal-content stars (Population II stars) have in many cases been inferred to have spent upwards of 15Ga in isolation from the metal-production that has been going on within galaxies by the stellar recycling of material. They have masses in the range $10^4$-$10^7 M_{sun}$ and it is tempting to regard them as possible primary condensations from which galaxies have grown by accretion. In a non-expanding universe, however, primary gravitational condensations below a certain mass (set by the Jeans Criterion for particle retention) cannot form; there is no, denser, big-bang stage to help out.

The minimum size is set by the Jeans initial radius ($R_J$)

$$R_J = \frac{V_{sound}}{\sqrt{G\rho}} \quad . . . . . . . . . . . . . . . . . . . . .(A_6)$$

where

$$V_{sound} = \sqrt{\frac{\gamma RT}{m}}$$

and

| | |
|---|---|
| $G$ = gravitational constant | $R$ = gas constant |
| $\rho$ = initial density | $T$ = temperature |
| $\gamma$ = ratio of specific heats | $m$ = molecular weight |

The mass of a spherical minimum condensation is then

$$M_{\min} = \tfrac{4}{3}\pi R_J^3 \rho$$

$$= \tfrac{4}{3}\pi\rho^{-\frac{1}{2}} G^{-\frac{3}{2}} \left(\tfrac{\gamma RT}{m}\right)^{\frac{3}{2}} = \tfrac{4}{3}\pi \left\{\frac{1}{\rho}\left(\tfrac{\gamma RT}{mG}\right)^3\right\}^{\frac{1}{2}} \quad . . . (A_7)$$

Substituting $G = 6.67 \times 10^{-8}$ dyn. cm$^2$.g$^{-2}$; $\gamma = 1.4$; $m = 1$; $T = 2.75$K;
$R = 8.32 \times 10^7$ erg.deg$^{-1}$.mole$^{-1}$; and using $M_{sun} = 1.989 \times 10^{33}$g
we find that a density of $10^{-28}$g.cm$^{-3}$ would be necessary in order to achieve condensations down to about $7 \times 10^4 M_{sun}$; about right for the primary formation of globular clusters. To achieve primary condensations as big as the mass (say $10^{11}$ $M_{sun}$) of galaxies comparable with our own, however, the initial density would have to be as low as $6 \times 10^{-42}$g.cm$^{-3}$.

In Appendix C, on the formation of galaxies, and in the corresponding part of the main text, it is argued that the accretion of additional mass drives the evolution of galaxies through a sequence of structural metamorphoses. If an arbitrary allowance is made, therefore, for a tenfold growth in mass (to the above value) the initial density required goes up 100-fold, to around $6 \times 10^{-40}$g.cm$^{-3}$.

At this point our line of reasoning, to arrive at some idea of the **present** density of inter-galactic space, has two possible courses. In a constant-mass universe the density of intergalactic space must go down as more and more of the mass is concentrated into galaxies but no good estimate of the degree of that reduction seems possible at this time.

On the other hand, in a universe in which some degree of mass creation continues until the present time (as favoured in the main text) it might be argued that the extraction of mass from intergalactic space would, to some extent, be offset by mass creation. But that depends on where the mass creation occurs. Surveys have revealed the existence of major voids in the Universe within which galaxies are apparently absent, suggesting that mass creation has avoided these voids. In that case, the present density in these voids may be even lower than one would infer in the case of a constant-mass universe.

The presence of these voids, however, is inferred from the existence of gaps in the spread of $z$ values in certain directions and an assumption that redshift increases similarly with distance in all directions. But on an RTV redshift interpretation these gaps could imply the presence of less-huge volumes with a **more**-than-usual redshifting capability. I shall not pursue that idea here.

It is of some interest to note that the Jeans Criterion (Eq. $A6$) has a basis in the time required for sound waves to traverse the pre-condensation volume, which therefore controls the time it takes for gravitational collapse to get under way. For the conditions assumed here, $v_{sound}$= 0.178km/s and, at a density of $10^{-42}$g.cm$^{-3}$, the sound-wave transit time amounts to 6876Ga! To bring this time within reach of the extended age of the Universe considered in the main text, say 50Ga, the density would need to rise to 2 x $10^{-38}$g/cm$^3$. Thus if the galaxy-deficient voids are no denser than this there will not have been enough time within the life of the Universe for gravitational condensations to form in these regions.

These arguments, and particularly the latter, show that to provide an RTV redshift interpretation of the cosmic redshift it may be necessary to assume an intergalactic space density as low as $10^{-38}$g/cm$^{-3}$ in the case of those wave-paths that mostly traverse galaxy-deficient void. This conclusion makes it essential to see whether the RTV redshift interpretation can be sustained when the density is some $10^{10}$ times less than was assumed in our original calculation.

**b).** On page A2, in deriving the dependence of redshift upon conditions of the transmitting gas region, I assumed that all particles are equal in respect of the way they influence the aether around them.

In fact, of course, the particles may vary in two ways - their mass and their electric charge - both of which should affect the surrounding aether on the basis provided in the present theory.

The particle mass affects its surroundings through the aether pumping mechanism of its constituent fundamental particles. It is shown below, however, that whatever the exact character of this effect it will be entirely negligible in comparison with that arising from any electric charges on the particles.

For electrically neutral gas particles there is obviously no charge effect except, perhaps, at distances of only a few atomic radii, at which any small temporary lack of perfect concentricity of the cancelling charges within the atom might be apparent. For air at STP the mean distance between molecules is around 60 atomic radii so the latter effect, if it exists, must be negligible under these conditions. This argument applies with even greater force, therefore, under the conditions of intergalactic space. So this matter can be neglected for the purpose of extrapolation from RTV redshift in air to that in intergalactic space.

The particle charge affects the surrounding aether through the aether density gradient that it causes.

The relative magnitude of these two effects (the charge effect and the gravity/particle mass/ aether-pumping effect) is directly calculable as the ratio of the electrostatic force $F_E$ to the gravitational force $F_G$ between two identical particles.

Now $F_G = G\frac{m^2}{r^2}$; $F_E = \frac{q^2}{r^2}$, where $m$ = mass; $q$ = charge (ESU).

so
$$\frac{F_E}{F_G} = \frac{q^2}{Gm^2} \quad \ldots \quad (A_8)$$

For **electrons** we get
$$\frac{F_E}{F_G} = \left[\frac{4.8\times10^{-10}}{9.1\times10^{-28}}\right]^2 \cdot \frac{1}{6.67\times10^{-8}} = \underline{4.17 \text{ x } 10^{42}}$$

and for **protons** (using $m_p = 1836m_e$) we get

$$\frac{F_E}{F_G} = \underline{1.24 \times 10^{36}}$$

Obviously the presence of only a very small proportion of ions or electrons in the gas will influence the aether r.m.s. velocity far more than differences in atomic/molecular weight in the range 1 to 32 pertinent to the principal (Earth) atmospheric and intergalactic gases.

**c).** To develop the foregoing result it is instructive to get some measure of the degree to which the particle motions are reflected in the r.m.s. aether velocity from which the observed redshift arises.

Let us consider, for this purpose, the redshift that would arise if the aether velocity were to change by a (the most probable particle velocity of the gas) every distance along the light ray path equal to the mean gas particle separation ($\underline{\mathbf{x}}$). This represents an ideal standard.

For the air redshift observations of Sadeh et al. (1968)

$$\text{a} = \left(\frac{2kT}{m}\right)^{\frac{1}{2}} = 4.1 \times 10^4 \text{cm.s}^{-1}. \quad (k = \text{Boltzmann's Constant})$$

$$\underline{\mathbf{x}} = (n_a)^{-\frac{1}{3}} = (2.52 \times 10^{19})^{-\frac{1}{3}} = 3.41 \times 10^{-7} \text{cm.}$$

Now the redshift per influence cell (Eq. $A_2$) is $\frac{1}{6} a^2 t_{\mathbf{x}}^2$

where $a$ = gradient of transverse velocity across the cell

and $t_{\mathbf{x}}$ = time taken to traverse the cell.

Therefore in the present case

$$\frac{\delta\lambda}{\lambda} \text{ per cell} = \tfrac{1}{6} a^2 t_{\mathbf{x}}^2 = \tfrac{1}{6} (a/\underline{\mathbf{x}})^2 . (\underline{\mathbf{x}}/c)^2$$

$$= \tfrac{1}{6} a^2/c^2$$

and

$$R = \frac{\delta\lambda}{\lambda} \text{ per cm} = a^2/6c^2\underline{\mathbf{x}}^2 = \frac{(4.1 \times 10^4)^2}{6 \times 9 \times 10^{20}} \cdot \frac{1}{3.41 \times 10^{-7}} = \mathbf{\underline{9.31 \times 10^{-7}}\ \underline{cm^{-1}}}$$

But the observed redshift was

$$R_1 = 1.75 \times 10^{-20} \text{ cm}^{-1} \ . \ . \ . \text{(p.A3)}$$

which is **5.3 x $10^{13}$ times smaller.**[1]

This reduction factor, or 'redshifting inefficiency' factor, shows how low is the aether random velocity compared with the particle random velocity. This is attributable to a combination of

1) the smoothing due to every point being influenced by many particles (and not just one, as in our ideal standard), resulting also in bigger and therefore fewer influence cells per centimetre, and

2) the very small modulation of aether density introduced by neutral particles (outside of themselves) - assuming that the air along the ground level observation path used by Sadeh et al (1968) was ionized very little.

Component 1) above appears unlikely to vary with the gas conditions until the gas temperature is so high that particle velocities become a major fraction of $c$, so have influences modified by retarded-field effects.

That component 2) could be enormously affected, giving a much larger redshift, if the gas were ionized, is demonstrated by the very large ratios, for ions and electrons, of charge-effect to mass-effect (Eq. $A_8$).

It follows at once that a quite modest degree of ionization of the hydrogen intergalactic gas would yield an acceptable value of Hubble 'constant' with a value of $\rho_{igs}$ even as low as $10^{-38}$g.cm$^{-3}$.

It also follows that the higher and more variable value of ground level Earth-atmosphere redshift observed by Sadeh et al. for the Florida path could be attributable to the higher

---

1 Since our ideal standard crudely approximates what would happen if each particle fully modulated the aether density in its immediate vicinity this ratio gives some idea of the increased redshifting rate that would then occur.

temperature and greater insolation along this path producing a slightly but variably increased degree of ionization of the atmosphere along the path.

**Conclusions.**

I conclude that the RTV redshift interpretation of the cosmic redshift is probably consistent with any value of $\rho_{igs}$ down to at least $10^{-38}$g.cm$^{-3}$, the lower limit being set by the need to supply the ionization energy required. There is already evidence of patchy ionization of the intergalactic medium in the form of the 'Lyman forest' hydrogen absorption lines that occur in quasar spectra shortward of the highly redshifted Lyman $\alpha$ emission line from the quasar itself. It seems likely that, to explain both the latter and the more widespread ionization required for the RTV redshift interpretation, it will be necessary to appeal to cosmic ray particles as the ionizing agent. An appeal to high temperature (currently in vogue for the Lyman forest absorptions) would conflict with the use herein of the radio background noise black-body temperature as the effective gas temperature of the intergalactic medium. There is no evidence that enough ionizing TEM wave radiation is traversing the intergalactic medium to ionize it appreciably. There is also the point raised by Martin Rees in 1987 (*In: Blades et al (eds)* STCI Symp Ser 2 (1988)), that the column density exhibited by these absorption lines raises a containment problem for such clouds if they are in the intergalactic medium. This difficulty is addressed in my quasar model as representing concentric shells around the central body, with progressively lower amounts of intrinsic redshift.

I also conclude that, for TEM wave transmission through highly ionized media, very much higher rates of redshift development are to be expected. This conclusion is pertinent to the solar redshift, redshifts (K-effect) in the atmospheres of other stars, and to intrinsic redshifts of galaxies and quasars. These matters are dealt with elsewhere.

* * * * *

Mainly written March 1992. Last revision 18 August 1994. 3820 words, 595KB. MFO
Typographical corrections 24 November 1994.

**Late Note added December 2009.**

The table on Page A4 points out the effect upon the redshift-distance relation of recognizing that RTV redshift actions produce proportional increments of the then-present wavelength, so is an exponentially cumulative process. This would be at variance with the observations, using Type IA supernovae as ‘standard candles’, that the redshift-apparent distance relation is substantially linear.

As discussed in my PIRT XI (2008) main paper, however, this difficulty disappears if one recognizes that in CT the transmission scattering, associated with the generation of RTV redshift, results in an exponentially cumulative attenuation of such candles with distance, in addition to the standard inverse square law assumption. At a given distance the greater-than-linear redshift is matched by the greater attenuation, so results in a linear correspondence. The residual effects are that actual distances are less than has been inferred but that energy outputs of sources can be correctly inferred, once any intrinsic redshift has been subtracted.