Redshift in Absolute Space: Periodicity of Quasars and Other Cosmological Implications

Héctor A. Múnera
Centro Internacional de Física
A.A. 251955, Bogotá D.C., Colombia

Assuming the existence of a preferred frame Σ (*i.e.*, absolute space), we start from a Newtonian model based on the equivalence of gravitational work and inertial energy. Microscopic processes for the absorption and emission of photons lead to frequency shifts in absolute space. The resulting expressions contain both gravitational and velocity components, but—in contrast to the conventional model—the gravitational term dominates. Redshifts are associated with very dense objects at almost any speed relative to Σ, and with normal stars at low speeds in Σ; on the other hand, blueshifts correspond to low density objects moving at high speeds in Σ. These results contrast with the conventional model where red/blueshifts are associated with recession/approximation from/to us. The present model predicts that photons may escape from extremely high-density objects, thus eliminating the concept of black holes. There is no connection assumed between redshift and distance, so that high-redshift objects may be associated with objects having smaller redshifts. Also, our theoretical equation for frequency shifts is completely consistent with the phenomenological equation describing the observed periodicity in the redshift of quasars, suggesting that such objects may be formed by an integer number of neutron stars, moving at speeds around 0.5c relative to Σ.

1. Introduction

Cosmological redshift has two components, Doppler and gravitational, both of them satisfactorily explained by relativity theory. In the conventional interpretation of Hubble's law, large redshifts are associated with objects located at large distance and moving at high speed away from us (observers on the Earth). Up to the mid-sixties, the cosmological evidence was compatible with the dominating model of Universe. The discovery of quasars led to a first inconsistency: it seems as if some quasars with very large redshift (hence, very far from us) were associated with galaxies with a smaller redshift (hence, comparatively closer to us). [1] Even more disturbing are the recently reported results from the COBE telescope, suggesting that there may exist stars older than the Universe!! In a Popperian interpretation of Science, [2] only one, reasonably good, contradictory observation suffices to falsify a model. Hence, previous contradictions suffice to strongly doubt the correctness of the connection between distance and redshift. If we add other difficulties of the conventional model, as missing matter (dark or otherwise), there is room for exploring alternative ideas.

Einstein's special theory of relativity (STR) *postulated* that a preferred frame of reference does not exist. The only empirical evidence supporting such postulate is Michelson-Morley's (M-M) celebrated experiment.[3] However, this author has recently argued that M-M-type experiments are actually consistent with absolute space. [4] In this context, in this paper we explore, once again, the possible existence of absolute space , that is, the existence of a preferred frame of reference Σ where all laws of physics hold as we know them, including some form of relativity theory (say, Lorentzian relativity).

The paper is organized thus: Section 2 describes Doppler and gravitational shifts in Σ, section 3 applies them to absorption and emission processes in frames S moving in Σ. Section 4 connects the results to the observed quasar periodicities. Section 5 closes the paper.

2. Frequency shifts in absolute space

Let us adopt the following model of the world. Matter and energy exist in a three-dimensional Euclidean space Σ. There may exist some "stuff" filling Σ described by vector field equations for the various forces (gravitational, electromagnetic, weak, strong). This "stuff" was the "aether" of the nineteenth century and is the "vacuum" of today's physics. By definition, photons travel in Σ at a constant, invariable, speed *c*, [5] independently of the magnitude of the force fields. Hence, an alternative definition for Σ is: the frame where photons have speed *c*, and rest-mass zero. In this context, photons in another frame S moving with speed *V* in Σ, *apparently* have a rest mass.[6]

A photon moving in Σ is characterized, like other particles, by the triplet (energy *E*, spin *s* and charge *q*). For a given *E* there is a unique de Broglie frequency ν defined by

$$E = h\nu \ , \tag{1}$$

where *h* is Planck's constant. Each frequency ν is then an intrinsic property of each photon (hence, observer-independent, like *s* and *q*). Since modern scales for measuring time are conventionally based on atomic clocks (*i.e.*, on ν associated with transitions between energy levels), the assumption that ν is observer-independent, automatically implies that time is also observer-independent, hence universal.

2.1. Doppler shifts

Let a photon of energy *E* interact with a force field (by exchanging work) to attain a new energy *E*' (higher or lower than *E*). Then, it becomes a new photon characterized by

$$\nu' = E'/h \ . \tag{2}$$

However, the speed of the new photon relative to Σ is still *c*. This constitutes a clear difference with the general theory of relativity (GTR), where photon acceleration changes its speed.

Consider now an emitter (*i.e.*, an atom) moving with speed *V* relative to Σ. Let a photon of energy *E* be emitted by a (nuclear, or atomic) transition between states S_2 and S_1: $S_2 \to S_1$. Then,

$$E = I_2(V_1) - I_1(V_2) \ , \tag{3}$$

where $I_i(V_i)$ is the inertial energy associated with the atom in state *i* moving with speed V_i in Σ, in first approximation, $V_1 = V_2 = V$. Inertial energy of state i is related to inertial energy at rest $I_i^0 \equiv I_i(V=0)$ by

$$I_i(V) = I_i^0(1-\beta^2)^{-1/2} = I_i^0\gamma(V) \ , \tag{4}$$

where β = V/c and γ(V) is implicitly defined. Eq. (4) may be obtained either from our Newtonian model based on absolute space and conservation of inertial energy, that implies the interconvertibility of gravitational work and inertial energy, [5,7] or from the Einsteinian STR. [8,9] Obviously, the physics behind both models is completely different.

Substituting eq. (4) in (3), one obtains

$$E(V) = (I_2^0 - I_1^0)\gamma(V) = \Delta E^0\gamma(V) \ , \tag{5a}$$

where ΔE^0 is the energy associated with the transition $S_2 \to S_1$ when the atom is at rest in Σ. It is thus clear that the energy of the photon produced in a given physical process depends on V, the speed of the laboratory where the event occurred.

Let E_C and ν_C be the energy and frequency of light emitted by the transition $S_2 \to S_1$ in arbitrary cosmological object C moving with speed V_C relative to Σ,

$$E_C = E(V_C) = h\nu_C = \Delta E^0 \gamma(V_C) \tag{5b}$$

and let subscript E refer to same transition in the Earth,

$$E_E = E(V_E) = h\nu_E = \Delta E^0 \gamma(V_E)\ . \tag{5c}$$

Dividing we get,

$$\frac{E_C}{E_E} = \frac{\nu_C}{\nu_E} = \left(\frac{1-\beta_E^2}{1-\beta_C^2}\right)^{1/2}, \tag{6}$$

which is a completely general expression for Doppler shift.

Discussion. In the present Newtonian inertial model (NIM), there is redshift when $\nu_C < \nu_E$, or $V_C < V_E$, *i.e.*, when C moves slower than Earth relative to Σ. Obviously, there is blueshift in the opposite case ($V_C > V_E$), and no shift when $V_C = V_E$. Note that only speeds are involved (*i.e.*, no vector addition between V_C and V_E). This result completely differs from the conventional relativistic model ascribing redshift to recession from Earth:

$$\frac{\nu_C}{\nu_E} = \frac{(1-\beta_{CE}^2)^{1/2}}{1-\beta_{CE}\cos\theta(t)}, \tag{7}$$

where the speed of the moving source relative to an observer on Earth is V_{CE} and $\theta(t)$ is the time-dependent angle between the direction of V_{CE} and the line-of-sight from the source to the observer. [9, page 80] The implicit presence of time in eq. (7) leads to a Doppler broadening of the lines in spectra obtained by photographic means during an extended time period. This broadening is another difference with the present NIM model (eq. 6).

It is worthwhile to note that while eq. (4) is *formally* consistent with STR, the resulting eq. (6) is not the same relativistic prediction. The difference may be traced to the different meaning of V in STR and NIM: relative motion between inertial frames in the former, motion relative to Σ in the latter.

2.2. Gravitational shifts

Consider a photon created at time $t = t_0$ with energy E_C (see eq. 5b) by an emitter in object C. At time $t = t_0$, let C have gravitational (= inertial) mass m_C, radius r_C and inertial energy $I_C = m_C c^2$. At time $t = t_C + \delta$, $\delta \to 0$, the photon comes under the influence of any force field that may be present, the gravitational field for certain. Consider now time $t > t_0$, in our NIM the gravitational force pulling a photon outside C, at distance $r \geq r_C$ from the center of C, towards C is given by [7]

$$F = \frac{GIE}{c^4 r^2}, \tag{8}$$

where G is the gravitational constant, and I and E are the time-dependent inertial energies of C and the photon respectively, given by

$$I = I_C + W = m_C c^2 + W = m_C^0 \gamma(V_C) c^2 + W\ , \tag{9}$$

$$E = E_C - W = h\nu_C - W\ . \tag{10}$$

The energy extracted by object C from the photon is W (alternative phrasing: work done by the photon against F), given by

$$W = \int_{W=0}^{W} dW = -\int_{r=r_C}^{r} F dr = E_C \frac{1-e^{-u}}{1+k_C e^{-u}}, \tag{11}$$

where eqs. (8) through (10) were substituted into eq. (11) for the integration, and u is defined as

$$\begin{aligned} u = u(r) &= \frac{GI_C(1+k_C)}{c^4}\left(\frac{1}{r_C}-\frac{1}{r}\right) \\ k_C &= \frac{E_C}{I_C} \end{aligned}. \tag{12}$$

Typically, $k_C \approx 0$. As expected, for small values of u, eq. (11) reduces to

$$W = E_C u = \frac{GE_C I_C}{c^4}\left(\frac{1}{r_C}-\frac{1}{r}\right), \tag{13}$$

which is the classical expression for potential energy.

Substituting eq. (11) into eq. (10) one obtains the final expression for the energy of a photon as function of position in the gravitational field of C:

$$\frac{E(r)}{E_C} = \frac{\nu(r)}{\nu_C} = \frac{(1+k_C)e^{-u}}{1+k_C e^{-u}}. \tag{14}$$

A photon reaching an observer in Earth is a photon that escaped to infinity ($r \to \infty$) with energy E_∞:

$$\begin{aligned} E_\infty &= E_C \frac{(1+k_C)e^{-u_\infty}}{1+k_C e^{-u_\infty}} \approx E_C e^{-u_\infty} \\ u_\infty &= \frac{G(E_C+I_C)}{c^4 r_C} \end{aligned}, \tag{15}$$

Clearly, u_∞ always is finite provided that $V_C < c$, hence $E_\infty > 0$ even for extremely massive objects (say, black holes). This means that photons may escape with a finite energy from any stellar object. This prediction is different from the original prediction for "completely black" holes. Our prediction is consistent with empirical observations assigning electromagnetic energy in the radio-frequency range to very massive objects.

Redshift is conventionally expressed in terms of the shift parameter z defined as [10]

$$z = \frac{\lambda_\infty}{\lambda_{source}} - 1 = \frac{\nu_{source}}{\nu_\infty} - 1 = e^{u_\infty} - 1, \tag{16}$$

where eqs. (14) and (15) were substituted with the approximation $k_C = 0$. For small u_∞, eq. (16) reduces to

$$\begin{aligned} z &\approx u_\infty + \frac{u_\infty^2}{2} + \frac{u_\infty^3}{6} + \ldots \\ z &\approx u_\infty\left(1 + \frac{u_\infty}{2} + \frac{u_\infty^2}{6} + \ldots\right) \end{aligned}. \tag{17}$$

Discussion. In one of his 1907 papers, Einstein derived an approximate expression for gravitational shift [8, page 105]. For more recent alternative derivations see [10, page 85] or [11, page 402]:

$$z \approx \frac{1}{1-u\lambda_\infty} - 1 = u_\infty + u_\infty^2 + u_\infty^3 + \ldots$$
$$z \approx u_\infty (1 + u_\infty + u_\infty^2 + ..),\ for \quad u_\infty << \frac{1}{2} \tag{18}$$

Comparing eqs. (17) and (18), the conventional predictions of STR and the new predictions of NIM are the same up to first order in u_∞. For the Earth, $u_\infty = 7\times10^{-10}$, so that both eqs (17) and (18) predict the same results, up to one part in 3.5×10^{10}. Hence, both models are consistent with the well-known results of Pound and Rebka [12], and Vessot *et al.* [13] (the latter confirmed the predictions of relativity up to one part in 14,000, well-below the sensitivity required to distinguish between STR and NIM with terrestrial measurements (1 in 10^{10}). Although for measuring a different variable, up to our knowledge, the most sensitive tests of STR are those measuring the variation of speed c with direction, where δc/c is of the order of 1.6×10^{-9}, [14] just in the limit of the required sensitivity.

In GTR, an object of mass m_C compressed to its Schwarzchild radius r_S is the less dense black hole, where

$$r_S = \frac{2Gm_C}{c^2} = \frac{2GI_C}{c^4} \tag{19}$$

For such radius r_S, $u_\infty = ½$. Hence, in GTR photons cannot escape when $u_\infty > ½$. On the other hand, our derivation of NIM was not based on relativity. According to eq. (15), a photon will escape from a black hole of radius r_S with energy $E_\infty = E_S\exp(-½) = 0.6065\ E_S$. The corresponding shift parameter is obtained from eq. (16) as $z_S = \exp(½) - 1 = 0.65$. As announced, there are no "black holes" in the NIM model.

Absorption and emission spectra

3.1. Shifts in absorption lines

Let us consider the absorption of a photon of energy $E(r)$ (eq. 14) by a cloud of gas containing emitter atoms, and located at distance r_A in the gravitational field of object C. There is absorption if, and only if, the speed of the absorber V_A is such that E_A exactly matches $E(r_A)$:

$$E_A = h\nu_A = E(r_A) = \Delta E^0 \gamma(V_C) \frac{(1+k_C)e^{-u_A}}{1+k_C e^{-u_A}}$$

where eqs. (5) were used. The frequency ν_A of the missing lines is thus

$$\nu_A = \nu_0 \gamma(V_C) \frac{(1+k_C)e^{-u_A}}{1+k_C e^{-u_A}}. \tag{20}$$

The frequency ν_E of the emission line produced by the same physical process on Earth is given by eq. (5c). Dividing (20) by (5c):

$$\frac{\nu_A}{\nu_E} = \frac{\gamma(V_C)}{\gamma(V_E)} \frac{(1+k_C)e^{-u_A}}{1+k_C e^{-u_A}}, \tag{21}$$

or in terms of z:

$$z = \frac{\nu_E}{\nu_A} - 1 = \frac{\gamma(V_E)}{\gamma(V_C)} \frac{(1+k_C e^{-u_A})}{(1+k_C)e^{-u_A}} - 1\ . \tag{22}$$

For the typical case , $k_C \approx 0$, so that

$$z \approx \frac{\gamma(V_E)e^{u_A}}{\gamma(V_C)} - 1 = \left(\frac{1-\beta_C^2}{1-\beta_E^2}\right)^{1/2} e^{u_A} - 1\,. \tag{23}$$

Discussion. Note that shift z (eq. 23) is produced by both Doppler and gravitational effects. The relative importance of the Doppler contribution depends on speeds V_C and V_E. The relative importance of the gravitational contribution depends on u_A. Say, if absorption occurs close to the surface of object C, then $r_A \approx r_C$ and $u_A \approx 0$, $\exp(u_A) \approx 1$, so that there is no gravitational contribution. On the other extreme of the range, if absorption occurs far away, from the surface of C, then, $u_A \to u_\infty$.

As a numerical example consider our sun, where $u_\infty = 2\times10^{-6}$; let $V_S =$ 300 km/s, so that $\beta_S = 10^{-3}$. The velocity of the earth is the vector addition $\mathbf{V}_E = \mathbf{V}_S + \mathbf{V}_O + \mathbf{V}_R$, where O and R are the orbital and rotational velocities ($V_O \approx 30$ km/s). Consider two extreme cases for the orientation of the solar velocity V_S: (a) V_S perpendicular to the ecliptic. Neglecting in first approximation the effect of terrestrial latitude and the obliquity of earth's rotation axis, the magnitude of earth's velocity is $V_E = \sqrt{V_S^2 + V_O^2}$ = 301.5 km/s, so that $\beta_E \approx \beta_S = 10^{-3}$ (*i.e.*, no Doppler shifts). (b) V_S parallel to the ecliptic. Assuming a circular orbit, over a solar year earth's speed varies in the range $270 \le V_E \le 330$ km/s. Granting the required sensitivity, in principle, seasonal Doppler shifts could be observed. For the small values of β of this illustration, eq. (23) reduces to

$$z \approx \frac{(\beta_S+\beta_E)(\beta_S-\beta_E)}{2} + u_A\,. \tag{24}$$

Note that the Doppler and gravitational shifts become additive. According to Miller [15], motion of the sun is closer to case (a) than (b), so that there should not be appreciable seasonal variations in the sunlight absorption spectra.

3.2 Shifts in emission lines

Consider now a photon produced in object C, that escaped and eventually comes under the influence of earth's gravitational field. Earth's pull transfers energy W to the photon

$$W = \int_{W=0}^{W} dW = -\int_{r=\infty}^{r} F dr = E_\infty \frac{e^{u_E}-1}{1+k_E e^{u_E}}\,, \tag{25}$$

where $I_E = m_E c^2$ is the earth's inertial energy before the arrival of the photon, and I and $E(r)$ are earth's inertial energy and photon's energy when the latter is at distance r from the center of earth, given by

$$I = I_E - W, k_E = \frac{E_\infty}{I_E}, u_E = \frac{GI_E(1+k_E)}{c^4 r}\,, \tag{26}$$

$$E(r) = E_\infty + W = E_\infty \frac{(1+k_E)e^{u_E}}{1+k_E e^{u_E}}\,. \tag{27}$$

Let detection be at distance $r \ge r_E$ from the center of the earth, substituting eqs. (15) and (5b) into eq. (27) we get

$$\nu(r) = \nu_0 \gamma(V_C) \frac{(1+k_C)(1+k_E)e^{u_E - u_\infty}}{(1+k_C e^{-u_\infty})(1+k_E e^{u_E})}\,. \tag{28}$$

The same transition on earth is given by eq. (5c). Shift factor z is then

$$z = \frac{\nu_E}{\nu(r)} - 1 = \frac{\gamma(V_E)}{\gamma(V_C)} \frac{(1+k_C e^{-u_\infty})(1+k_E e^{u_E})e^{u_\infty - u_E}}{(1+k_C)(1+k_E)} - 1\,. \tag{29}$$

Since $kE \approx 0$ and and $kC = 0$, and exponents u are finite for E and C, then

$$z \approx \frac{\gamma(V_E)}{\gamma(V_C)} e^{u_\infty - u_E} - 1 \,. \tag{30}$$

Note that eq.(30) depends on the difference $u_\infty - u_E$ (between dimensionless potential energies) in C and E. This is the same functional dependence of relativity theory. [8, page 105]

Discussion. The gravitational contribution of earth's pull to eq. (30) is $u_E = 6.96 \times 10^{-10}$, which is negligible compared to other u's in Table 1. Then, the absorption and emission spectra only differ in the value of u_A (eq. 23) and u_∞ (eq. 30). Hence, for a given object C the frequency shift is about the same in both spectra when absorption occurs far away from the surface of C, but may be significantly different when absorption occurs close to the surface of C.

Table 1 illustrates the variation of z (calculated with eq. 30) for light emitted in various objects C of different density, and moving at different speeds V_C in Σ. For this illustration it was assumed that $\beta_E = 10^{-3}$.

TABLE 1. Shift factor *z* for emission spectra produced in different cosmological objects C at various absolute speeds V_C

Object	***C***	***u***$_\infty$		***V_C, km/s***	
		200	300	3,000	30,000
		z	z	z	Z
Star (our sun)	2×10^{-6}	2.278×10^{-6}	2.0000×10^{-6}	-4.752×10^{-5}	-9.997×10^{-3}
White dwarf	2×10^{-4}	2.003×10^{-4}	2.0002×10^{-4}	$+1.50 \times 10^{-4}$	-9.801×10^{-3}
Neutron star	2×10^{-1}	2.214×10^{-1}	2.2140×10^{-1}	$+2.213 \times 10^{-1}$	$+2.092 \times 10^{-1}$
Black hole	0.5	0.6487	0.64872	+0.64864	+0.63224
Black hole	1.0	1.71828	1.71828	+1.71814	+1.69110

It is quite remarkable that blueshift (*i.e.*, negative z) only arises for low density objects (like our sun) moving at high V_C. For dense objects, redshift appears at almost all speeds. These predictions are consistent with astronomical observations, where redshift is far more frequent than blueshift (such an asymmetry is, of course, consistent with the conventional assumption that redshift and expansion are linked).

3. Periodicity of quasar redshifts

Arp [1, pages 79 and 146] has shown that redshifts of quasars fall into narrow discrete ranges, as if they followed a periodic law given by

$$\Delta \ln(z+1) = cons\tan t \,, \tag{31a}$$

with a zero offset factor of the form

$$(z+1)(1+a) = cons\tan t \,. \tag{31b}$$

Parameter "*a*" varies for one group of quasars to another. For quasars in the 12^h region of sky, $0.03 < a < 0.06$, for quasars in the 0^h region , $0.02 < a < 0.03$. [16, page 47]

It may be immediately seen that empirical eq. (31) follows from our eq. (30), written next in two manners resembling eqs. (31)

$$\ln(z_i+1)=u_\infty(i)-u_E+\frac{1}{2}\ln\left(\frac{1-\beta_Q^2}{1-\beta_E^2}\right), \tag{32a}$$

$$z_i+1=\frac{\gamma(V_E)}{\gamma(V_Q)}e^{u_\infty(i)-u_E}. \tag{32b}$$

where the zero offset parameter "*a*" is defined as

$$\begin{aligned}1+a&=\frac{\gamma(V_E)}{\gamma(V_Q)}e^{u_\infty(1)-u_E}\\&=\left(\frac{1-\beta_Q^2}{1-\beta_E^2}\right)^{1/2}e^{u_\infty(1)-u_E}\approx(1-\beta_Q^2)^{1/2}e^{u_\infty(1)}\end{aligned}. \tag{33}$$

Neglecting the small u and β corresponding to earth, a group of quasars is characterized by the same speed V_Q relative to Σ, given by

$$\beta_Q^2=1-(1+a)^2e^{-2u_\infty(1)}. \tag{34}$$

Within each group there are different classes i = 1,2,...,n, implicitly defined in eqs. (32). The difference in redshift between two consecutive classes is then

$$\Delta\ln(z+1)\equiv\ln(z_{i+1}-z_i)=u_\infty(i+1)-u_\infty(i)\equiv\Delta u_\infty \tag{35}$$

Eq. (35) identifies the "constant" in the empirical eq. (31a) with Δu_∞. A crude estimate (a simple average) for the latter may be immediately obtained from the observational data provided by Arp. [1] This is done for three different groups of quasars in Tables 2 through 4.

Table 2. Evaluation of Δu_∞ for the group of "all quasars". Data from Arp [1, page 79]

Class, i	*z*	*ln(z+1)*	Δu_∞
2	0.30	0.2623	0.2077
3	0.60	0.4700	0.2029
4	0.96	0.6729	0.2067
5	1.41	0.8796	0.2056
6	1.96	1.0852	
	Average =	$\overline{\Delta u_\infty}$ =	0.2057

Table 3. Evaluation of Δu_∞ for the group of "objective prism quasars". Data from Arp [1, page 79]

Class, i	*z*	*ln(z+1)*	Δu_∞
2	0.35	0.30010	0.39812]
3	——	——	——]
4	1.01	0.69813	0.24194
5	1.56	0.94007	0.23858
6	2.25	1.17865	
	Average =	$\overline{\Delta u_\infty}$ =	0.21966

Table 4. Evaluation of Δu_∞ for the group "quasars close to M87 line of galaxies". Data from Arp [1, page 146]

Class, *i*	*z*	ln(*z*+1)	Δu_∞
2	0.42	0.35066	0.22166
3	0.72	0.54232	0.26861
4	1.25	0.81093	0.21511
5	1.79	1.02604	0.22672
6	2.50	1.25276	
	Average =	$\overline{\Delta u_\infty}$ =	0.23302

Tables 2 to 4 show the average difference between two consecutive classes $\overline{\Delta u_\infty}$ for each group. Our crude estimate for the group of all quasars (0.2057) is exactly the same as the best value for the constant (0.206), recently reported by Arp *et al.* [16, section 7]

From Table 1, $u_\infty = 0.2$ corresponds to a neutron star. It thus appears as if quasars were formed by integer number of neutron stars. Each group of quasars being characterized by $\overline{\Delta u_\infty}$ and β_Q (see Table 5) according to

$$\ln(z_i+1) = i\overline{\Delta u_\infty} + \frac{1}{2}\ln\left(\frac{1-\beta_Q^2}{1-\beta_E^2}\right). \tag{36}$$

Table 5. Parameters for quasar equation (34)

Group	$\overline{\Delta u_\infty}$	Δ_Q	z_1	z_7
All quasars	0.206	0.508	0.058	2.636
Objective prism quasars	0.220	0.493	0.084	3.049
Quasars close to M87	0.233	0.454	0.128	3.553

Using the best values reported by Arp *et al.* [16] we can calculate β_Q using eq. (34) with $u_\infty(1) = 0.206$. For $a = 0.02$, $\beta_Q = 0.558$, and for $a = 0.06$, $\beta_Q = 0.506$. Then, $\beta_Q \approx 0.5$ indicates that, according to the NIM, quasars move at about 0.5 *c* relative to Σ.

Eq. (36) may be used to make predictions. Therefrom we calculated redshifts for $i = 1$ and $i = 7$ and included them in Table 5. Observation of such shifts afford experimental confirmation for the model advanced herein. Indeed, Arp *et al.* [16] report a peak at $z \approx 0.062$, and note that it was originally discovered by Burbidge [17] in 1968. This coincides with our quick estimate for z_1 (all quasars). For the high-redshift region, Fig. 9 of Arp *et al.* [16] shows a peak at $z = 2.66$ for 0^h quasars, and at $z = 2.73$ for 12^h quasars, which coincide reasonably well with our crude estimate for z_7.

5. Concluding remarks

As a general conclusion, we propose a model for frequency shifts that resolves some of the inconsistencies present in the current interpretation of redshift as an indicator of distance and speed on cosmological scales. Our model [5,7] is based on the equivalence of gravitational work and inertial energy in absolute space. It thus belongs to one of the generic models discussed by Hsu [18] (world pictures of class T with $F \neq 0$). Hence, it is consistent with all relativistic predictions for weak gravitational field; in particular, gravitational shifts discussed in section 2.2. above, and perihelion shift, as noted elsewhere. [5] Moreover, Hsu [18, page 208] notes that his generic models are *"also consistent with the generalized Poincaré-Einstein principle for the laws of physics (i.e. they have the same form in all inertial frames)."*

Passing to some details, it was found that gravitational effects dominate over Doppler effects. As seen in Table 1, redshifts are associated with very dense objects (*i.e.*, high u or m/r) at almost all speeds relative to absolute space Σ, and with low density objects (*i.e.* small u and m/r). These results contrast with the conventional interpretaion, where blueshifts are produced by approaching objects, and redshifts by objects receding from us.

Although our NIM is consistent with relativity in the region of weak gravitational fields, in the presence of strong fields the predictions are quite different. The most striking is the non-existence of "black holes". Indeed, photons may escape with a significant fraction of their initial energy, even from massive "black holes". For instance, photons may escape from an object with $u_\infty = 2$ with a fraction exp(–2) = 0.135 = 13.5% of their initial energy (see eq. 15).

Turning to quasars. Since there is no connection in our NIM between distance and redshift, objects with quite different frequency shifts may co-exist in the same region of three-dimensional space. This may shed some light on the controversy about the nature of quasars. [1,16] If quasars are pictured as formed by an integer number of neutron stars having $u = 0.2$ (or, $m/r \approx 3 \times 10^{27}$ g/cm), then the empirically observed periodicity in the quasar redshift is predicted by our NIM. The zero-offset empirically observed is connected to the speed of quasars relative to absolute space, which is of the order of 0.5 c.

Hence, I cannot resist advancing a speculation related to my own field (nuclear physics). Alpha particles are formed by four nucleons, and they are very stable (*i.e.*, they have a large binding energy = emit a large amount of energy during formation). Arp [1, ch.5] notes that quasars with redshifts $z \approx 1$ are particularly bright (*i.e.* they liberate a large amount of energy). From eq. (36) and tables 2 and 3, $z \approx 1$ corresponds to $i = 4$. Speculation: are neutron stars the cosmological nucleons?

Finally, since our NIM is based on a modification of the Newtonian scalar potential, [5,7] and given the encouraging results reported in this note, it may be worthwhile to elaborate a scalar theory of gravity, that, as suggested by Hsu [18, page 218], may help solve some of the difficulties associated with current theories. Such an approach may eventually lead to a quasistatic model of the universe, [19] as an alternative to the current expansionary model.

Acknowledgements

The author thanks O. Guzmán, R. Martínez and J.M. Tejeiro of the Physics Department, National University, Bogotá, for discussions at an informal seminar in May 1992.

References

1. Arp, H.: *Redshifts and Controversies*, Interstellar Media, Berkeley, California, USA (1987) 198 pp..
2. Popper, K. R.:*The Logic of Scientific Discovery*, First English edition (direct translation of original German text, 1934), Hutchinson of London (1959) 480 pp.
3. Michelson, A.A. and Morley, E.W.: On the relative motion of the earth and the luminiferous aether, *Philos. Mag.* **S. 5, vol. 24**, No. 151 (1887) 449-463.
4. Múnera, H.A.: Michelson-Morley experiments revisited: Systematic errors, consistency among different experiments, and compatibility with absolute space, *Apeiron* **5** (January-April 1998) 37-54.

5. Múnera, H.A.: A quantitative formulation of Newton's first law, *Physics Essays* **6**, No. 2 (1993) 173-180.
6. Múnera, H.A.: An absolute space interpretation (with non-zero photon mass) of the non-null results of Michelson-Morley and similar exeriments:An extension of Vigier's proposal, *Apeiron* **4**, No. 2-3 (Apr.-Jul 1997) 77-80.
7. Múnera, H.A.: Gravitational potential energy as a form of mass and conversely, *Revista Colombiana de Física* **10**, Nos.1/2 (1974) 96-149.
8. Einstein, A.: On the influence of gravitation on the propagation of light, translated from *Annalen der Physik* **35** (1911) 35. Translated in H.A. Lorentz, A. Einstein, H. Minkowski, and H. Weyl: *The Principle of Relativity*, Dover Publications (1952) 97-108.
9. Resnick, R., and Halliday, D.: *Basic Concepts in Relativity*, Macmillan (1992) 192 pp.
10. Harwit, M.: *Astrophysical Concepts*, John Wiley (1973) 561 pp.
11. Kittel, C., Knight, W.D., and Ruderman, M.A.: *Mechanics, Berkeley Physics Course*, Vol. 1, 2nd. ed., McGraw Hill (1973) 426 pp.
12. Pound, R.V., and Rebka, G.A.: Apparent weight of photons, *Phys. Rev. Lett.* **4** (1960) 337.
13. Vessot, R.F.C., Levine, M.W., Mattison, E.M., Blomberg, E.L., Hoffman, T.E., and Nystrom, G.U.: Test of relativistic gravitation with a space-borne hydrogen maser, *Phys. Rev. Lett.* **45** (1980) 2081.
14. Wolf, P. and Petit, G.: Satellite test of special relativity using the global positioning system, *Phys. Rev. A* **56**, No. 6 (Dec. 1997) 4405-4409.
15. Miller, D.C.: The ether-drift experiment and the determination of the absolute motion of the earth, *Rev. Mod. Phys.* **5** (1933) 203-242.
16. Arp, H., Bi, H.G., Chu, Y., and Zhu, X.: Periodicity of quasar redshifts, *Astronomy and Astrophysics* **239** (1990) 33-49.
17. Burbidge, G.R.: *Astrophys. J. Lett.* **154** (1968) 241.
18. Hsu, J.P.: Laser experiments and various four-dimensional symmetries, *Found. Phys.* **7**, Nos. 3/4 (1977) 205-220.
19. Keys, C.R.: Quasistatic cosmology: an outline, unpublished manuscript, 1984, 24 pp.