A Non-Expanding, Non-Relativistic Universe*

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All "relativities"—whether Galileian, Machian, or Einsteinian—are ruled out on both principle and on observational grounds, irrespective of scale. From atoms up to galaxies, matter prefers to rotate, rather than expand. A slightly amended Newtonian gravitation theory, obeying the Third Principle, is able to account for the observed facts. Electromagnetic waves propagate (isotropically) in the fundamental frame of reference defined by the mass-energy distribution of the universe. Thermodynamics is a necessary ingredient in any cosmological theory. There is no cosmological "arrow of time".

Key Words: Steady state universe; Hubble's law; Machian relational theory; special relativity failure; cosmic entropy.

1. Cosmology and General Relativity

In spite of tenacious efforts to maintain the contrary (Peebles *et al.* 1991), there is mounting evidence against the "relativistic hot big bang cosmology" (Arp and van Flandern 1992). In our view, the clinging to the expanding universe model stems from two totally false ideas:

(a) Universal expansion is a consequence of Einstein's general theory of relativity (GTR)
(b) Cosmology ≡ relativistic cosmology

Textbooks and monographs alike try to convey the impression that the popular Robertson-Walker (RW) metric

$$(ds)^2 = c^2(dt)^2 - \left[\frac{R(t)}{R_o}\right]^2 \frac{(dr)^2 + (r\,d\theta)^2 + (r\sin\Theta\,d\varphi)^2}{\left(1 + kr^2/4R_o^2\right)^2} \quad (1)$$

with k standing for the curvature parameter, were implied by Einstein's equation:

$$G_{mn} = -kT_{mn}\,, \quad (m,n = 1,2,3,4) \quad (2)$$

where G_{mn} and T_{mn} denote Einstein's and the matter tensor, respectively

The latter equation, when applied to a distribution of masses and fields, has no solution if the space-time distribution of masses is not given in advance, but this distribution is unknown since it requires the geometry defined by the metric tensor g_{mn} (*i.e.* the very solutions of eq. (2)).

To find the "metric of the universe", is, therefore, an illusion. Seen in this light, *the hypothesis that the distribution of matter in the universe is homogeneous and isotropic is a declaration of impotence*, rather than a "cosmological *principle*". It is not difficult to show that, up to the "scale factor" $[R(t)/R_o]^2$, the RW metric (1) is a consequence of the "cosmological principle" rather than of (2). Keeping in mind that this principle automatically defines a "cosmic (or universal) time" t, the metric of the homogeneous universe has to be:

$$(ds)^2 = c^2(dt)^2 - (d\mathbf{s})^2 \quad (3)$$

where $(d\mathbf{s})^2 = g_{ab}\,dx^a dx^b$ $(a,b = 1,2,3)$ is the line element of a space with constant curvature, still to be determined.

To find $(ds)^2$, the following "intuitive" method could be employed:

(a) The dimensionality is lowered from 3 to 2;
(b) A two-dimensional Riemannian (or rather Gaussian) space is simulated by a spherical surface: $f(x_1,x_2) = 0$;
(c) The two-dimensional "curved space" is embedded in a flat (Euclidean) three-dimensional space in which:

$$x_1^2 + x_2^2 + x_3^2 = r^2 \quad (4)$$

is the equation of the spherical surface in the three-dimensional space, the radius r of the sphere being at the same time the scalar curvature of the two-dimensional Riemannian manifold;
(d) The procedure is formally generalized for a "curved three-dimensional space" embedded in a flat four-dimensional one. The equation of the three-

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dimensional spherical surface in the four-dimensional Euclidean space is "therefore":

$$x_1^2 + x_2^2 + x_3^2 + x_4^2 = R_o^2 \tag{5}$$

The distance between two neighboring points on (5) will be:

$$(\mathrm{d}s)^2 = (\mathrm{d}x_1)^2 + (\mathrm{d}x_2)^2 + (\mathrm{d}x_3)^2 + (\mathrm{d}x_4)^2 \tag{6}$$

Differentiating (5) yields:

$$x_1\mathrm{d}x_1 + x_2\mathrm{d}x_2 + x_3\mathrm{d}x_3 = -x_4\mathrm{d}x_4 \tag{7}$$

We can replace x_4 in (6) and obtain:

$$(\mathrm{d}s)^2 = \mathrm{d}x_1^2 + \mathrm{d}x_2^2 + \mathrm{d}x_3^2 - \frac{(x_1\mathrm{d}x_1 + x_2\mathrm{d}x_2 + x_3\mathrm{d}x_3)}{(R_o^2 - x_1^2 - x_2^2 - x_3^2)} \tag{8}$$

i.e. the so-called "Beltrami-Riemann metric" (Riemann 1876). In spherical co-ordinates, this expression of $(\mathrm{d}s)^2$ yields (1) up to a "scale factor".

Owing to Hubble's law

$$w = Hr \tag{9}$$

based on the interpretation of galactic redshifts exclusively as Doppler shifts, the (3)-spatial metric $(\mathrm{d}s)^2$ is multipied by the scale factor $[R(t)/R_o]^2$ allowing for expansion or contraction. The origin of both the RW metric (1) and of the amazing "relativistic" statement: "it is the space between galaxies which is expanding, while the galaxies themselves are fixed each relative to the other" is thus elucidated! We stress that *the cosmic universal time measure t entering in (1), like Hubble's law, definitely contradict the general covariance principle on which GTR was founded*. These contradictions notwithstanding, the RW metric is forced, so-to-speak, upon eq. (2) which then supplies two ordinary differential equations for the scale factor $[R(t)/R_o]^2$ provided the matter tensor is fed into eq. (2). The standard over-simplification is to identify "the matter tensor of the universe" with the matter tensor of an ideal (homogeneous, isotropic, non-viscous) fluid:

$$T_{\mu\nu} = (c^2\rho + p)u_\mu u_\nu - p g_{\mu\nu} \tag{10}$$

where the mass density ρ and the pressure p are functions of time alone:

$$\rho = \rho(t)\,; \quad p = p(t) \tag{11}$$

A further simplification is obtained by the use of co-moving reference frames in which the 4-velocity has only a "time-like component": $u_\mu = (1,0,0,0)$.

The "universe" of the standard "general relativistic cosmology" is, apparently, a structureless, featureless, amorphous *continuum*. Since our human brain cannot imagine a dilating or contracting continuum, the general relativistic dictum: "it is space itself which is expanding" is a verbal escape from a physical absurdity. Remarkably, if one neglects pressure—which in the cosmological context is a perfectly reasonable assumption—the simple Newtonian model of a gas of discrete masses interacting via the universal $1/r^2$ force yields the same differential equation for the radius $R(t)$ as GTR. The important thing is that it does so without exotic assumptions like "curved" and "expanding" space. This is the content of the *Milne-McCrea theorem* stated in 1934 (Sciama 1973).

2. Cosmology and "Special" Relativity

A "cosmological" red-shift follows directly from the RW metric written for "null-geodesics" (*i.e.* light propagation):

$$(\mathrm{d}s)^2 = 0; \qquad \frac{\lambda}{\lambda_o} = \frac{R(t)}{R(t_o)} \tag{12}$$

where λ_o, t_o; t, and λ refer to the wavelengths and the times of light emission from the distant galaxy and light reception on the earth, respectively.

Uniform expansion (of the universe) implies the classical Doppler formula:

$$R(t) = tw \tag{13a}$$

$$\frac{\lambda}{\lambda_o} = \frac{t_o + w\,t_o/c}{t_o} = 1 + \frac{w}{c} \equiv 1 + z \tag{13b}$$

where z, known as the spectral shift, is directly proportional to the recession velocity w. During the last decades, the observation of values $z > 1$ led to a questioning of formula (13b) for the interpretation of such high spectral shifts. An escape from this dilemma seemed to lie in replacing the Newtonian "time-of-flight" w-velocities, obeying

$$w = w_1 + w_2 \tag{14}$$

with the Einsteinian "radar" v-velocities for which hyperbolic addition is introduced:

$$v = \frac{v_1 + v_2}{1 + v_1 v_2/c^2} \tag{15}$$

Now, the *only* analytical relationship between w and v satisfying (14) and (15) is:

$$\frac{w}{c} = \operatorname{arctanh}\left(\frac{v}{c}\right) = \frac{1}{2}\ln\frac{1 + v/c}{1 - v/c} \tag{16}$$

If, following Milne (1948) and Prokhovnik (1967), we treat $(1 + w/c)$ in (13b) as the first approximation of $\exp(w/c)$, then:

$$\frac{\lambda}{\lambda_o} \equiv 1 + z \cong \exp\left(\frac{w}{c}\right) = \left(\frac{1 + v/c}{1 - v/c}\right)^{1/2} \tag{17}$$

This formula reconciles arbitrarily large z- and w-values with "subluminal" v-values, avoiding—seemingly—a direct conflict with "special" relativity. "Seemingly" is appropriate here, since "special" relativity operationally defines only "radar" v-velocities, measured by means of electromagnetic signals reflected from the moving body, without distinguishing, or even without entertaining the idea of the fundamental difference between "time-of-flight" and "radar" velocities! Insofar as light is concerned, "special" relativity takes the constancy of the *two*-way, averaged velocity of light as supported by experiment, while the measurement of the (time-of-flight) *one-way* velocity is decreed impossible and its value postulated as c. As a matter of fact, "special" relativity uses only the v-kind of velocities while applying (14) *within* one inertial frame of reference (IFR) and (15) *between* two IFR's. This is, of course, patently absurd, not to mention the fact that in "special" relativity, treating a moving mass as an "object" or a "frame of reference" prescribes whether one has to apply a linear or a hyperbolic velocity addition, respectively. On top of all this, Prokhovnik (1967) correctly pointed out that (16) is a consequence of *uniform expansion* (13a) and of *Mc Crea's light hypothesis*:

$$\frac{\mathrm{d}s}{\mathrm{d}t} = c + \frac{w\, s(t)}{R(t)} \qquad (18)$$

where d*s*/dτ is the velocity of light relative to a fundamental co-moving observer F and $s(t)$ is the distance between the light source and F. This hypothesis assures the constancy of the velocity of light with respect to every fundamental observer—in accordance with "special" relativity—the price being a variable velocity of light on its way from source to absorber!

To close this section, we remind the reader that even the most orthodox relativist books agree that "special" relativity is, actually, not applicable to the universe-as-a-whole, as it is a local (*i.e.* flat) approximation to general relativity in an overall curved Riemannian space.

3. Is "Special" Relativity a Viable Theory?

As the division of Einstein's historical paper into a "kinematical part" and an "electrodynamic part" indicates, the "special" theory of relativity was conceived as a new kind of *kinematics* purported to save Maxwell's equations, which—in contrast to Newton's dynamics—were not Galilei-invariant. The invariance of Newton's equation of motion:

$$\frac{m_i\,\mathrm{d}^2\mathbf{r}_i}{\mathrm{d}t^2} = \sum\nolimits_j' \mathbf{F}\left(\mathbf{r}_i - \mathbf{r}_j\right) \quad \text{with } \Sigma_j' \equiv \Sigma_{j\neq i} \qquad (18)$$

under the Galilei transformation

$$\mathbf{r}_i' = \mathbf{r}_i - \mathbf{w}\,t\,, \qquad t' = t \qquad (19)$$

is, however, valid for m_i = const. only! For $m_i = m_i(w_i)$, eq. (18) is no longer invariant, a fact which harmonizes well with electrodynamics formulated in a unique, privileged, inertial frame of reference (as Maxwell conceived it).

Einstein rejected the very idea of a privileged IFR and claimed the validity of all existing and still-to-be-discovered laws of physics in every one of the triple infinity of IFR's. Rather than imagine the IFR's as (infinitely) massive systems which, by virtue of the equivalence principle, would have required huge gravitational masses acting on the observed objects/systems, Einstein actually contemplated fictitious, massless coordinate systems which have no interaction with the observed objects/systems. The essence of STR is the formulation of the finite, linear transformations relating to IFRs, each moving relative to the others with a linear uniform velocity v:

$$x' = a(v)x + b(v)t \qquad (21a)$$

$$t' = d(v)x + e(v)t \qquad (21b)$$

Assuming the two IFR's on equal footing and imposing upon (21) the group properties of geometric (timeless) translations in Euclidean space, one obtains the "Lorentz boosts":

$$x' = (x - v\,t)\left(1 - mv^2\right)^{-1/2} \qquad (22a)$$

$$t' = (t - mv\,x)\left(1 - mv^2\right)^{-1/2} \qquad (22b)$$

with the constant *m* still to be determined.

The transformation (22) has the property:

$$(c\,t')^2 - (x')^2 = (c\,t)^2 - x^2 = \text{invariant} \qquad (23)$$

For a light signal propagating in the *x*-direction, (23) implies $x' = ct'$ for $x = ct$, which fixes the constant in (22) as $m = 1/c^2$. That a light signal propagates with the same velocity with respect to two relatively moving observers conflicts with our concept of (uniform) velocity, a concept which we are already supposed to possess while introducing the relative velocity *v* between two IFR's. For a point-like particle moving with uniform velocity *V*, (23) defines the so-called "proper time" of the particle:

$$t = t\sqrt{1 - \frac{V^2}{c^2}} \qquad (24)$$

The astonishing claim of STR was that a clock moving, so-to-speak, "together with the particle" would display t-time, no matter what its internal structure was. This claim was -without any trace of justification—generalized to non-uniform, curvilinear velocities $\mathbf{V}(t)$, so that a "time-lag"

$$\Delta T = T_o\,(g - 1) \qquad (25a)$$

with

$$g = \left(1 - mv^2\right)^{-1/2} \qquad (25b)$$

between a clock at some point A and another one transported from A along a closed polygonal path would necessarily occur. (The polygonal path is chosen as an escape from the difficulty of allowing travel in any direction without having to assume curvilinear velocities). Moreover, if the same clock—an extended physical structure—were subjected to *parallel* transport (*i.e.* the directions of its associated axes remaining parallel to themselves) along the same closed path, a net rotation:

$$\Delta e = 2p\,(g - 1) \qquad (26)$$

with respect to an identical clock kept at A is predicted by STR. Besides contradicting the Gauss-Bonnet theorem (Vranceanu 1951), which defines non-zero Δe for *curved* surfaces only, this so-called "Thomas Precession" given by (26) was found not to exist by experiment (Phipps 1974). Vanishing Δe, however, implies $m = 0$ which shows that STR, which relies upon (22), is untenable.

4. Cosmology and Machian Relativity

"Special" relativity is very special, because it is no relativity theory at all! STR divides the real world into *actual* objects and/or systems and *fictitious, phantom, non-interacting* "observers". Positions, velocities, and accelerations are "schesic" quantities defined with respect to observers/IFR's. Nevertheless, most of the many books on STR point out that *although velocity is relative, acceleration is absolute*. This is amazing, since if distance is accepted as relative, then all its higher time-derivatives *have* to be relative, too.

The genuine relativity theory was entertained by Ernst Mach as a theory which operates *only* with relative quantities $(\mathbf{r}_i - \mathbf{r}_j)$, $(\mathbf{w}_i - \mathbf{w}_j)$, $(\mathbf{a}_i - \mathbf{a}_j)$ and higher derivatives *defined between real objects. The "Machian observer" is just one of the interacting objects and belongs to this world.*

For two-body forces of the form:

$$F_{ij} = m_i m_j \mathbf{f}_{ij}\left[\left(\mathbf{r}_i - \mathbf{r}_j\right),\left(\mathbf{w}_i - \mathbf{w}_j\right),\left(\mathbf{a}_i - \mathbf{a}_j\right)\right] \quad (27)$$

where the m_i are *constant* masses, the Newtonian equation for motion for m_i is:

$$\frac{m_i \mathrm{d}\mathbf{w}_i}{\mathrm{d}t} = m_i \sum{}' m_k \mathbf{f}_{ki} \quad (28)$$

The acceleration $\mathrm{d}\mathbf{a}_i/\mathrm{d}t = \mathbf{a}_i$ is defined in an *absolute* frame of reference, while the right hand side of (28) is independent of the choice of the reference frame. Multiplying (28) by m_i and subtracting the equation obtained by interchanging i and j, one obtains:

$$\left(\mathbf{a}_i - \mathbf{a}_j\right) = \left(\sum{}' m_k f_{ki} - \sum{}' m_k \mathbf{f}_{kj}\right) \quad (29)$$

Summing (28) over all the particles, we get

$$\sum m_i \mathbf{a}_i = \frac{\mathrm{d}}{\mathrm{d}t}\left(\sum m_k \mathbf{w}_k\right) = 0 \quad (30)$$

i.e. the law of conservation of linear momentum. Eqs. (29) and (30) are equivalent to the set of eqs. (24). Eq. (29) *does not hold for velocity-dependent masses* $m_i = m_i(w_i)$. Moreover, *the law of conservation* (30) *requires the possibility of using the universal, absolute time parameter t for the entire system*!

Summing (29) over j and using $M \equiv \sum m_j$ and $M_j \equiv \sum{}' m_i$ we have:

$$\left(\frac{M_i}{M}\right)\left(\mathbf{a}_i - \frac{\sum m_j \mathbf{a}}{M_i}\right) = \sum{}' m_k \mathbf{f}_{ik} \quad (31)$$

The difference between (28) and (31) is that in (28) the acceleration a_i is *absolute*, while in (31) it is *relative* to all the accelerations in the system, *i.e.* "relative to the rest of the world". The acceleration of particle i depends on its mass m_i, since $M_i \equiv M - m_i$. Summing (31) over all particles, we arrive at:

$$\sum m_i \left(\mathbf{a}_i - \frac{\sum m_j \mathbf{a}_j}{M}\right) = 0 \quad (32)$$

which makes clear that the absolute and (very) privileged reference frame is that of the center of mass of the whole system—rigorously speaking of the universe-as-a-whole. Unfortunately, as already pointed out, this Machian theory fails for velocity-dependent masses, absolute velocity, of course. Moreover, since (27) is an action-at-a-distance type force obeying the simultaneous equality of action and reaction, the above Machian theory fails if retardation and/or radiation is taken into account!

The 1993 Nobel prize for the careful study of binary pulsars notwithstanding, *the claimed evidence for gravitational radiation is not convincing*. On the contrary, the evidence for the instantaneous action-at-a-distance nature of the gravitational interaction is overwhelming. According to Phipps (Phipps 1978): "the entire universe constitutes a gravity-inertial 'near zone', wherein acausal (instantaneous) actions-at-a-distance are mediated by permanently virtual particles (gravitons). The gravitational field is strictly coupled to its sources and lacks independent dynamical freedom. The universe is 'too small' to contain a far zone, so gravitational radiation and absorbers do not exist. The non-existence of graviton absorbers accounts for the observed physical absence of 'gravity shields'... If detection of gravitational radiation continues unconfirmed, Mach's viewpoint will command fresh attention." Indeed, "fresh attention" to Mach's ideas is displayed in the recent works of Assis (Assis 1993), Ghosh (Ghosh 1995a), and Roscoe (Roscoe 1995). The importance of these works resides in the fact that small corrections—relative velocity and acceleration—to Newton's gravitational force, obeying instantaneous equality of action and reaction, are able to account for the observed astronomical and astrophysical effects and even to predict new effects (Ghosh 1995a, 1995b) such as: (1) the secular retardation of the earth rotation without facing a close approach of the moon, as in the case of the tidal friction model; (2) the secular acceleration of Phobos; (3) the excess redshift of the spectrum of the solar limb; (4) the unexpected redshift of electromagnetic waves while grazing past the sun; (5) the transfer of angular momentum from a central spinning sun to the planets; (6) the unexplained mismatch between the "relativistic" and astronomical mass of white dwarfs; and (7) a servo mechanism to distribute matter in spiral galaxies in a unique way which results in flat rotation curves. General relativity, which causes nightmares even dealing with the two-body problem, is completely unsuited to deal which such a rich variety of phenomena.

Unfortunately, generalized Newtonian theory and Machian relativity do not work in electrodynamics when *radiation* (*i.e.* electromagnetic fields detached from their sources) is taken into account. *Radiation is always propagating with w-velocity c in the cosmologically defined, privileged, absolute frame of reference.*

In electrodynamics, many effects (like the Kennard-Müller localized unipolar induction (Müller 1987)) are determined by the (absolute) individual velocities of charges rather than by relative velocities alone!

5. Thermodynamics and Cosmology

The contradiction between the principle of general covariance and a cosmic, universal time—common to all fundamental ("co-moving") observers—notwithstanding, the ever-expanding ("evolutionary") scale factor $R(t)$ derived from GTR, has been associated with a cosmological "arrow of time". The time-symmetric tensor equation (2) was elevated by the "New Astronomical School of Unified Thermodynamics" (Bondi, Gold, Narlikar, Hogarth, Gal-Or,...) to the status of the source of "master asymmetry" (Gal-Or 1987) controlling not only irreversible thermodynamics, but *all* physical and biological phenomena! Gal-Or calls "gravitism" the philosophy (or, perhaps *ideology*) that gravitation is the prime cause of structures, irreversibility, time, geochemical and biological evolution, that the expansion of the universe is the cause of the second law of thermodynamics, that microscopic physics, and thermodynamics in particular, cannot be understood without reference to cosmology. However, because of the presently popular dictum: "cosmology $\equiv$ general relativistic cosmology", the above mentioned philosophy/ideology should have been called "Einsteinian relativism".

Actually, very few physical theories are in such a paradoxal situation as cosmology is today (Prigogine 1989). On one hand, the classical Einstein equations (2) are purely adiabatic and reversible and, consequently, can hardly provide an explanation of the origin of cosmological entropy. Prigogine (1989) and his school have tried to re-interpret the matter stress-energy tensor in Einstein's eq. (2) by proposing a phenomenological, macroscopic approach allowing for *both particles and entropy production* in the early universe. In the presence of matter creation, the appropriate analysis is performed in the *open system formalism* (Prigogine 1989). In Prigogine's cosmology, the "heat" received by the system is due to the transfer of energy from gravitation to matter, so that the creation of matter acts as a source of internal energy. This mechanism causes an entropy change ΔS which, in the case of the *traditional* closed universe and adiabatic cosmology, is nonexistent!

We would like to point out that the very concept of entropy is in clear contradiction to continuum mechanics. Entropy, as it is understood in statistical mechanics, demands discrete objects/structured systems and/or discrete energy levels. No partition function can be formulated for the phantom, homogeneous matter of the (homogeneous) continuum hypothesis. Here we encounter a similar difficulty as with the stretching of a continuum. All *physical* events demand the existence of *discrete* matter. The continuum is a mathematical convenience rather than a physical concept. The assumption of structureless matter underlying STR and GTR is one more reason why both relativities and thermodynamics remain incompatible.

The important role of thermodynamics in cosmology was recognized by Wesley (1995), too. There is an important difference between Gal-Or's (Gal-Or 1970) and Wesley's cosmologies. Gal-Or ties "irreversibility" to the "expansion of space itself", *i.e.* as far as space is expanding, the contribution of all kinds of radiation in space is weakened "irreversibly" due to the expansion phenomenon itself. Such loss or "degradation" of energy in the depth of the intergalactic expanding space may then be considered as a *universal sink* for all the radiation flowing out of the material bodies in the expanding universe.

On the other side, in *Wesley's steady state cosmology, the primary law for ordering processes in nature* (Wesley 1991) plays a central role. This law states that: "statistical thermodynamic systems open to deep space with temperature greater than 2.7 K proceed towards states of lower entropy". Since all planets, gas clouds, stars, and galaxies that can be seen, are statistical thermodynamic systems with temperatures greater than 2.7 K open to deep space, all *observable* portions of the universe are thus proceeding towards states of greater thermodynamic order, lower entropy, or lower chaos. This does not violate the second law of thermodynamics, since if a statistical thermodynamic systems in nature is observed to decrease in entropy, then a *larger* increase in entropy is produced somewhere else in the universe. Local order is created at the expense of global disorder of deep space... Stars, as low entropy condensations, are ordered by gravitational potential energy. Gravitational redshift involves conversion of low utility thermal energy to gravitational energy of 100% utility. The cosmological redshift "keeps the universe young. It keeps the universe from the *heat* death predicted by the second law of thermodynamics. It keeps the universe from running down" (Wesley 1995). This most important effect of gravitation is one case (and may be the only one) of energy conversion where nature works with unit efficiency.

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