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Red-shifts of Very Young Objects

I WOULD like to call attention to one of the consequences of our current belief that there is a red-shift–distance relation for galaxies. It is accepted that as we observe increasingly distant galaxies we see them at earlier and earlier stages of their life history because of the finite velocity of light. If we could therefore observe sufficiently faint galaxies, we would see galaxies very close to their moment of creation, or even, conceptually, close to the moment of creation of the matter which would make up the galaxies. Empirically we find that the red-shifts of more distant galaxies increase and we must conclude with a high degree of certainty that, if we could see distant enough matter, it would be very young and have an extremely high red-shift. We can summarize this reasoning in the following statement: If we observe the universe near age zero, then it has a very large red-shift.

Now suppose some matter were to be created locally (that is, at a distance at which normal galaxies do not have a very large red-shift). In the initial stages following the creation of this matter it would have an age very near age zero. We can then use the axiom that things equal to the same thing are equal to each other. We can say that the age zero universe is identically equal to itself, and, whether we see it at great distances or close by, that it will have a very high red-shift. I suggest that we have proved the following theorem: In the limit, observing the red-shift of matter at a great distance which was created at the same epoch as ours is equivalent to observing the red-shift of nearby matter which was created at a very recent epoch.

We can discuss this idea in a little greater detail by remarking that the curved space of general relativity predicts that, as we observe increasingly distant galaxies, their diameters will reach a point where they appear to enlarge again, until, if we could observe extremely distant galaxies, their diameters would begin to merge, and going further, in the limit, we would expect to see the age zero universe in every direction we look. The operational definition which we must give to the "creation" of local matter is that before the event instruments could detect no matter, but afterwards they could. Because a logical definition of the universe would include all matter, past or present, we would have to say that the new matter did not come into our universe from elsewhere. Rather we would have to consider that it existed, perhaps as a diffuse or virtual potential, and then started to localize at the time which we have called "creation". (Phenomenologically this may be indistinguishable from volumes in the initial universe which have had retarded expansion as discussed by a number of authors[1].) If these objects are eventually to be detected by normal observational methods, then the localization process must initially consist of decreasing the object's apparent diameter and lowering its red-shift, both effects naturally enhancing its visibility. There is no reason to expect discontinuity in this process so that we would expect some kind of continuous disengagement from the age zero universe toward the state of its ultimate character. On the other hand, there is no reason to expect the special case of linearity in this process and we can point to the physics on the edge of our observable universe which affects the red-shift in a nonlinear fashion at great time–distance (the deceleration curvature in the linear Hubble relationship on the macroscopic scale).

Because we know that the presence of matter defines the properties of space, it has been previously suggested[2] that, if new matter did materialize, it would form regions where large amounts of matter were already in a high density state. This would, of course, suggest the nuclei of galaxies as a possible materialization point, with the more compact nuclei being most favourable.

The reason for discussing the theorem at this time is to point out that we should deductively expect, if our present models of red-shift distances and finite light signal velocities are correct, if we were ever directly to observe an object recently created, in the sense defined here, it would have a very high red-shift regardless of the distance at which the object was located from us.

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Causality and Space-like Signals

ALTHOUGH we pointed out[1] in 1962 that space-like particles (signals) travelling "backward in time" carry negative energy—or must be reinterpreted—recent textbooks on the special theory of relativity (for example, refs. 2–7) still purport to show that causality arguments forbid the existence of faster-than-light particles. One book which is at least partially correct on this score is Ya. P. Terletskii's *Paradoxes in the Theory of Relativity*[8], but even this ignores the possibility of reinterpretation.

Here we present explicitly a proof that the sign reversal of the time interval between two events (for example, emission and absorption of a particle, or signal) is necessarily accompanied by sign reversal of the corresponding energy.

Consider two reference frames S and S′, with S′ moving at a velocity w in the x direction relative to S. Assume that at a time $t_0 = 0$, the reference axes of the two systems coincide and that the clocks are so synchronized that at $t_0 = 0$ the clocks in S′ indicate $t'_0 = 0$. Now consider the following hypothetical events. At $t_0 = t'_0 = 0$, a faster-than-light meta-particle (or tachyon, as it is now known[9]) is emitted in the x direction from the common origin of S and S′. Let the superluminal velocity of this meta-particle (or meta-signal) be $u > c$ relative to S, hence $v = (u - w)/[1 - uw/c^2] > c$ relative to S′. Assume now that at a time t_1, when it is at x_1 in the S frame, the meta-particle is absorbed. The corresponding time of absorption, as measured in S′, is given by

$$t'_1 = \gamma_w (t_1 - w x_1/c^2) \qquad (1)$$

where $\gamma_w = [1 - (w/c^2)]^{-1/2}$.

Because $x_1/t_1 = u$, the Lorentz transformation given here appears to be no longer orthochronous (preserving time direction) for a relative velocity $w > c^2/u$ (or for a tachyon velocity of $u > c^2/w$—we call such tachyon velocities ultraluminal). In these circumstances, the time interval $\Delta t = t'_1 - t'_0$ becomes negative. This is generally taken to imply that ultraluminal particles (or signals) must needs violate the causality principle. This argument was first advanced