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# Space, Time, and Matter

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*Abstract*

One of the principal tasks of current cosmology is to determine the amount of matter in the present universe. This task, however, is hampered by two basic errors, one the present method of measuring distances, particularly the reliance on the notion of a "standard candle," and the other the way the amount of matter is estimated, namely, by counting objects in the visible universe and estimating the amount of invisible matter. Underlying these two errors is the failure to study the universe in terms of spacetime.


### *Introduction*

The most pressing problem in current cosmology is the fate of the universe, whether it will continue to expand indefinitely or will contract into a singularity. This question is based on the generally accepted assumption that the universe was created from a singularity in a gigantic explosion ("Big Bang").[1] All agree that the answer depends, first and foremost, on our ability to accurately measure the amount of matter in the universe. It is further agreed that such measurement, to have any validity at all, must be made at one single time, like the present. Any discussion of the present universe, be it in the professional or popular literature, treats it as a datum, i.e. a fact derived by observation or other forms of experimentation. Thus in a recent article four eminent cosmologists cite what they describe as a fundamental tenet the notion that in "the *present-day universe* [italics added] ... there are some 100 billion billion stars similar to the sun,"[2] by which they mean all stars currently visible. Likewise, a popular article describes photographs of the Orion Nebula, some 1,500 light years from the earth, as representing the present nebula.[3]

These statements, thoroughly representative of current mainstream cosmology,[4] contain, in my view, the reason for, *inter alia*, our continuing inability to determine the total amount of matter in the universe today. Stated in the simplest possible manner, current cosmology is hampered by two basic errors, one having to do with space and the other with spacetime.

*The Problem with Space*

At present, there is one direct and several indirect methods of measuring distances in the universe. Direct measurement, typically by aiming electromagnetic signals at bodies, is feasible only for very close bodies, such as the earth's moon and neighboring planets and their satellites. Beyond that, only indirect techniques are presently possible. For bodies closer than about 1,000 light years, the trigonometric parallax technique is considered accurate.[5] Measuring bodies farther than that must rely on a comparison between their intrinsic or true brightness and their apparent brightness, i.e. the brightness as perceived on earth. This method is applied to several types of bodies and phenomena, as follows: main sequence fitting to about 30,000 light years, Cepheid variables to about 1 million light years, planetary nebulae to about 50 million light years, globular clusters and galactic rotation to about 200 million light years, type 1 supernovae to about 400 million light years, and red shift for bodies still farther away.

These methods are extremely risky, and the conclusions thence derived utterly unreliable, because they are based on the assumption that there is such a thing as a "standard candle" which has never been proven and is unlikely to be proven because we already know that a galaxy's intrinsic luminosity varies considerably during the course of its existence. Even if, for argument's sake, we could prove the existence of "standard candles", these methods still would not result in accurate measurements because there is still no precise way of measuring the effect of forces that interfere with electromagnetic radiation between a body and observers on earth. These forces include, but are not limited to, dust causing light absorption and massive bodies such as black holes causing light bending. The points just raised are more than sufficient to invalidate the widely-held view that if one does enough measurements of this kind and they agree, one gets the correct results. It is just as likely, maybe even more so, that all measurements are wrong because one ignores absorption, bending, and perhaps other crucial but as yet unknown factor missing in the calculations. The lesson here is simply and most regrettably that we have no certain way to measure distances in the universe beyond our immediate neighborhood.

*The Problem with Spacetime*

If the problem with space is difficult because of unknown obstacles between us and the cosmic objects we see in the sky, the problem we are facing in the current handling of spacetime is far more serious because, for starters, we cannot even see the objects we need to see in order to be able to solve the fundamental question I posited at the beginning of this essay: how much matter is there at this time in the universe. Although, as my earlier examples showed, leading astrophysicists routinely speak of the present universe as if it were knowable, the regrettable fact is that, with the current level of scientific knowledge, the present universe is unknowable. I will demonstrate this point by means of two graphic examples. The first one takes us on an imaginary journey back in time to about one billion years after the Big Bang when, it is currently thought, the first galaxies were formed (Fig. 1a below). At that time, the galaxies[6] A and B were quite close to one another. If we imagine us being somewhere in galaxy A, we would not only see B but see it almost in real time. In other words, at the time of our looking at it, B was almost exactly where we saw it. Moving back to the present time, about 13 million years after the Big Bang,[7] we still see B but it is the B of billions of years ago. The present B, if it still exists at all, has become unknowable to us inhabitants of A because the distance between the two galaxies has increased to 9 billion light-years (Fig. 1b).[8]

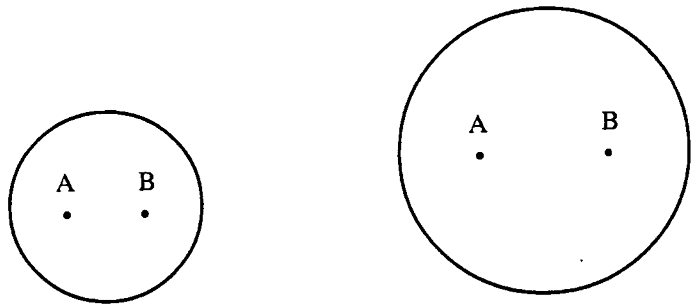


**Figure 1a-b.**
**The Young Universe and at Present**
Fig. 1a (left): At + 1 billion years, distance A-B 0.001 light-years; Fig 1b (right): At + 13 billion years, distance A-B 9 billion light-years.

Given the current state of scientific knowledge, the only way of estimating the size of the present universe is by extrapolation from the past, a method fraught with great uncertainties. We cannot know how much luminous matter has been generated over the past several billion years anywhere except in our immediate neighborhood. It has been demonstrated that there is such a thing as a "late bloomer," i.e. gases that ignite relatively late into stars and galaxies. Recently, photographs were taken of the creation process of one or more stars in the gas cloud B335, only 800 light-years from Earth.[9] It is reasonable to assume that there are many similar proto-stars both within the window of the visible universe as well as in regions beyond. In addition to not knowing the existence of bodies, we also cannot know their location in the present universe because of constant and complex motions in the universe.[10]

The question of what portions of the universe we can and cannot see may also be approached diagrammatically, as shown in Figure 2.[11] Theoretically, the only objects visible to any observer, at the intersection of time and space, are clustered along the diagonal line which is equidistant from the time and space axes.[12] The diagonal line represents spacetime. If we accept, as we have done throughout this paper, the notion of an expanding universe, both axes are neither finite nor infinite but continuously expanding.

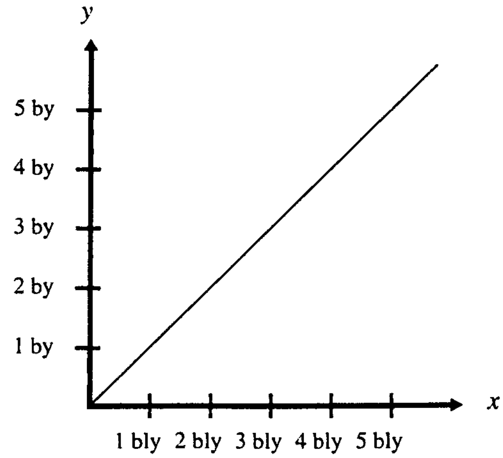


**Figure 2. Spacetime**
x = space; y = time; by = billion years; bly = billion light-years

Within the context of our current understanding of physical laws, it is impossible, indeed inherently nonsensical, to see an object at 1 billion light-years distance and 2 billion years time. It is, therefore, also impossible to find the same object at 0 years time, i.e. the present. This same observation can be made of objects up close, like the moon, the horizon or the cat on the neighbor's roof, the only difference being that we are not aware of it because the time that it takes for the light from these close objects to reach us is too short for us to notice.

*Conclusions*

The facts presented in this paper have a bearing on several major topics in current cosmology. I will briefly touch upon five of them.

1. *Missing matter*. The search for missing matter has been carried out within the confines of the visible universe, by which I mean to include the entire electromagnetic spectrum. As demonstrated in Figure 2, we are able to observe only a narrow slice of the entire universe. Because the universe is expanding, the percentage that this slice represents of the entire universe at any given point in spacetime is directly proportional to the distance in spacetime from us, the observers. It may well be that the "missing matter" need not be some exotic, "dark" material, nor located in parallel universes. Instead, it may well be ordinary matter in the *present* universe, represented by the horizontal axis, *x*, in Figure 2,

that for reasons already explained, we cannot see.

2. *A lumpy universe?* What we observe today is not only a slice of past spacetime, as discussed earlier, but for this very reason is also a melange of conditions over a wide range of cosmic time, all superimposed on one another, all located on the diagonal line in Figure 2. Therefore, the lumpiness that we perceive in the universe may be more apparent than real. If we could see, from a higher dimension, all of the present universe, it may well be, except for obvious local conditions like stars and planets, as smooth as the early universe.

3. *Intelligence in the Milky Way.* Calculations underlying the search for extraterrestrial intelligence (SETI) may have to be redone. The radio dish at Arecibo is presently scanning for a ten-year period certain selected stars for signs of intelligent life. Evidently not only Congress but quite a few scientists are sufficiently convinced that the outcome will be successful. They base their optimism on the so-called 10% formula, an estimate that starts out with the figure of 20 billion stars in our galaxy,[13] the Milky Way, of which 10% may be yellow, or Sun-like stars, of which 10% will have planets, and so forth. The end result of this calculation is the impressive figure of 200,000 stars that are likely to have some form of intelligent life in their systems.[14] What is absent from this statement is the percentage of these 200,000 stars that is located in the 100 light-year slice Arecibo is currently scanning. Obviously, it must be extremely few because the galaxy stretches for 70,000 light-years[15] and most stars are concentrated at and near the galactic center, far away from the fringes where we are located.

4. *Intelligence in the universe.* Related to point 3 is that SETI may be doomed to slim pickings because it takes a long time to develop a certain level of intelligence plus perhaps the availability of nth-generation stars which would of course require even more leadtime. All this might lead to the possibility that intelligent life may well exist but it came into being very recently, say during the past one million years in widely separated parts of

the *present* universe. It follows that we cannot ascertain their existence, let alone communicate with them.

5. *Wormholes to the present.* The notion of "wormholes," as currently used in cosmology, has been applied mostly in efforts to somehow bring travel time to remote parts of the visible universe closer to human dimensions. The popular press generally refers to it as "time travel," another example of the impermissible separation of space and time. The points made in this paper strongly suggest that the search should not be confined to the visible universe, which represents the past, but be extended to ways to reach other parts of the present universe. To put it colloquially, all we have been able to know so far is the "here and now" and the "there and then"; the time has come to seek ways to also know the "there and now." Perhaps the strongest impetus for this new direction in our search is the likelihood, explained in point 4 above, that if there is intelligence in the universe, it is likely to have arisen in relatively recent times.

Finally, simultaneously with or, even better, prior to a search for wormholes to the entire present universe, members of our species should start looking at the world around them in terms of spacetime. Even though the distances to the moon or the cat on the neighbor's roof are extremely close, we should become aware of the fact that the images of these two objects we perceive are ever so slightly in the past. More importantly, as humanity becomes more involved with objects in deep spacetime, it is to be hoped that statements like "[an] explosion *is occurring* in the core of one of our nearest neighbor galaxies, M82, *just a few million light-years* away"[16] will never be seen again.

*Notes*

(1) Not all cosmologists have been caught up in the recent euphoria. Steven Weinberg, for example, admits that "we do not have enough confidence in the applicability of [the laws of nature] at extreme temperatures and densities to be sure that there really was such a moment [i.e. Big Bang], much less to work out all the initial conditions, if there were any."

("Life in the universe," *Scientific American* 271:4 (October 1994), p. 45).

(2) Peebles, Schramm, Turner, and Kron, "The evolution of the universe," *op. cit.*, p. 57.

(3) James Reston, Jr., "Orion : where stars are born," *National Geographic Magazine* 188:6 (December 1995), pp. 90-101.

(4) They do not include adherents to the "anthropic principle," an unfortunate interpretation of nature that I have called the creationism of cosmology.

(5) This method's accuracy was greatly enhanced in 1989 when the satellite Hipparchus was first used for measuring distances.

(6) To be more accurate, one should speak of galaxy *clusters* here. See John D. Barrow, *The Origin of the Universe* (New York : Basic Books, 1994), p. 5.

(7) While the age of the universe is still being vigorously debated, the exact age is not important for our purpose here.

(8) The two figures are not drawn to scale. The present universe is believed to be at least 1,000 times larger than it was at the time when the first galaxies formed. It should also be pointed out that unlike many other similar illustrations found in contemporary cosmological texts, this illustration does not place the galaxies A and B on the "surface" of the universe, but within it.

(9) John Noble Wilford, "In dust cloud, rare glimpse of new star aborning," *The New York Times*, October 10, 1995, p. B5.

(10) For example, it has been estimated that in the short span of 200,000 years, a tiny fraction (0.0000133) of the universe's estimated age of 15 billion years, such familiar pattern as Ursa Major would change beyond recognition. See text and illustration in Colin Roman, *The Universe Explained* (London: Thames and Hudson, 1994), p. 110. This statement, of course, ignores the problem of the gravity-induced curving of light.

(11) This spacetime diagram is quite different from the kind of spacetime diagram described by Robert M. Wald in the second edition of his *Space, Time, and Gravity : The*

*Theory of the Big Bang and Black Holes* (Chicago : University of Chicago Press, 1992), pp. 3-5.

(12) It should be emphasized that any representation of four-dimensional spacetime on two-dimensional paper results in certain distortions that one must mentally compensate for. Thus the straight diagonal line actually represents a figure that curves off the page and into four-dimensional spacetime.

(13) This figure represents about one-fifth of all stars in the observable universe, or approximately 100 billion. See, e.g., John Gribbin and Martin Rees, *Cosmic Coincidences* (New York : Bantam Books, 1989), p. 34; and Fred Alan Wolf, *Parallel Universes* (New York : Simon and Schuster, 1988), p. 71.

(14) Michio Kaku, *Hyperspace* (New York ; Oxford : Oxford University Press, 1994), p. 283.

(15) Gribbin and Rees, p. 170.

(16) Sylvain Veilleux, Gerald Cecil and Jonathan Bland-Hawthorn, "Colossal galactic explosions," *Scientific American* 274:2 (February 1996), p. 101 [italic added].