On the Relativity of Lengths (*Apeiron* 2:16)

In a recent article (*Apeiron* 2(1):6), Prof. Wen-Xiu Li rediscovers paradoxes and criticisms due to Dingle (1972) and Essen (1971), and even the logic of Bridgman (1983): "The STR Can only be disproved by experiments, but not verified." Only in the third (last) section, Li proposes his own theory of the length of a moving rod. It is based on Li's novel "principle of the constancy of length": "The length of a rod is independent of its motion relative to any body." This hypothesis is experimentally refuted, since a metallic spring parallel to the radial gravitational field of the earth is (i) elongated if suspended in space at its distant end and (ii) shortened if supported in space at its close end (relative to Earth). The same holds for any elastic (stretchable and compressible) rod. Even in the absence of gravitating bodies, Li's hypothesis is untenable since a rod parallel to its velocity $\mathbf{v}°$ relative to the ether (cosmic microwave frame $\mathbf{S}°$) is length contracted $\ell = \ell_o\left[1-(\mathbf{v}-\mathbf{w})^2/c^2\right]^{1/2}$ as a result of the contraction of the equipotential surfaces of its nuclei and electrons into ellipsoids of revolution in the direction $\mathbf{v}-\mathbf{w}=\mathbf{v}°$ ($\mathbf{v}$ = ether velocity in the inertial frame [IF] of observation S)(Wilhelm 1993).

In order to measure the length of a rod AB moving with a velocity $\mathbf{v}=v\hat{\mathbf{x}}$ parallel to the *x*-axis in a Galilean observation frame S(*x*,*t*), Li introduces two *arbitrary* but *fixed* points x_1 and $x_2 \geq x_1$ on the *x*-axis as time-measurement positions and the definitions:

(a) t_1 = time at which the *rear* end A of the rod passes the *fixed* point x_1;

(b) t_2 = time at which the *front* end B of the rod passes the *fixed* point x_1;

From the equations (which are not even dimensionally correct; x_1' position of B at $t=t_1$),

$$\ell = AB = x_1x_1'\,;\ x_1'x_2 = v(t_2-t_1)\,;$$

$$x_2 - x_1 = x_1x_1' + x_1'x_2 = \ell + v(t_2-t_1) \quad \text{(Li-0)}$$

Li alleges to have "found" the final result of h is theory in the form of a *novel* formula for the length of a rod moving with velocity $\mathbf{v}$ along the *x*-axis of S:

$$\ell = (x_2-x_1) - v(t_2-t_1) \quad \text{(Li-1)}$$

Even if one reinterprets the products as differences $x_1x_1' \to x_1 - x_1'$, $x_1'x_2 \to x_1' - x_2$, the equations in (Li-0) are flawed ($x_2 - x_1 \neq x_1 - x_2$!) and do not result in (Li-1). Nevertheless, Li arrived at the "correct" answer (which he may have known to begin with).

The derivation of (Li-1) from the kinematics of a moving rod, which is not permitted to undergo physical interactions and length changes, is trivial. The Lagrangian positions $x_A(t)$ of the rear end A and $x_B(t)$ of the front end B of the rod moving uniformly with velocity $\mathbf{v}=v\hat{\mathbf{x}}$ along the *x*-axis are at time *t* in S

$$x_A(t) = x_{Ao} + vt\,,\ x_{Ao} \equiv x_A(t=0) \quad (1)$$

$$x_B(t) = x_{Bo} + vt\,,\ x_{Bo} \equiv x_B(t=0) \quad (2)$$

Hence

$$\begin{aligned}\ell(t) &= x_B(t) - x_A(t) = x_{Bo} - x_{Ao} \\ &= \ell(t=0) = \ell_o\end{aligned} \quad (3)$$

is the length of a Li-rod at an arbitrary time *t*, which equals its length ℓ_o at an arbitrary reference time $t=0$. For a rod at rest, $\mathbf{v}=0$ in S, (2) and (3) yield for the rod length: $\ell_{v=0}=\ell_o=\ell$. Hence, the length ℓ of the rod moving in S equals the length ℓ_o of the same rod when at rest in S. *This is necessarily so since (1)-(3) have been derived kinematically in absolute space and time, under the Li-assumption that the rod undergoes no physical length change as a result of interactions with other bodies or the ether.* Since by definitions (a) and (b)

$$\begin{aligned}x_1 &= x_A(t=t_1) = x_{Ao} + vt_1, \\ x_2 &= x_B(t=t_2) = x_{Bo} + vt_2\end{aligned} \quad (4)$$

the length (3) of the rod moving (ℓ) or resting (ℓ_o) in S can be rewritten in the form of (Li-1):

$$\ell = x_{Bo} - x_{Ao} = (x_2 - x_1) = \ell_o \quad (5)$$

Li's assertion "we cannot directly measure the length of the rod" indicates that he does not comprehend that (Li-1) implies that the length of a hypothetical Li-rod is independent of its state of motion relative to the observer, $\ell=\ell_o$. That Li fails to understand the simple formula (Li-1) is further obvious not only from his queer "deduction" but, in particular, from his subsequent criticism of Einstein, since by (Li-1)

$$\ell = v(t_1 - t_2) \text{ for } x_1 = x_2, \quad \text{(Li-2/3)}$$

$$\ell = (x_2 - x_1) \text{ for } t_1 = t_2$$

Li reprimands Einstein for his derivation of the relativistic length $\mathsf{x}_2 - \mathsf{x}_1 = (\mathsf{x}_2^\circ - \mathsf{x}_1^\circ)(1-\mathbf{v}^2/c^2)^{1/2}$ of a rod (of proper length $(\mathsf{x}_2^\circ - \mathsf{x}_1^\circ)$ in its own frame S°, note different font for x) moving in S with velocity $\mathbf{v}$ as follows:

> *We are now ready to see what Einstein relativity of length is. It can be seen that Einstein takes for granted that Li-3) must hold without preconditions. In other words, Einstein takes (Li-3) as valid, but at the same time regards its preconditions as wrong. Under Einstein's new conceptions of time and length, the conclusion of the relativity of length is completely fallacious.*

These assertions show that Li is completely confused. As Li stated in the left column (but then forgot in the right column) of page 18, "x_1 and x_2 are taken at random on the *x*-axis." Indeed, x_1 and $x_2 > x_1$ are arbitrary, fixed points on the *x*-axis of S, where clocks measure the times t_1 and t_2 defined in (a) and (b). Accordingly, $x_2 - x_1$ has in general nothing to do with the length ℓ_o of the rod moving or resting in S, *i.e.* this point-distance may be larger or smaller than ℓ_o.

For example, in the Li-limit (Li-2), $x_2 - x_1 = 0$ and $t_1 < t_2$, whereas the Li-length of the moving rod is $\ell \neq 0$ by (Li-1). In contrast, in the Li-limit (Li-3), $t_1 - t_2 = 0$, B can arrive at x_2 and A at x_1 at the same time $t_1 = t_2$ if and only if x_1 and x_2 are chosen such that $x_2 - x_1 = x_{Bo} - x_{Ao} = \ell_o$ by (5). If $x_2 - x_1 \neq \ell_o$, the limit $t_1 = t_2$ does not exist. Vice versa, if $t_1 \neq t_2$ then also $x_2 - x_1 \neq \ell_o$.

Using the Lorentz transformation $\mathsf{x}° = (\mathsf{x} + v\mathsf{t})/(1-\mathbf{v}^2/c^2)^{1/2}$ (note different font for x), Einstein obtains for a rod (of length $\mathsf{x}_2^\circ - \mathsf{x}_2^\circ$ in the rod rest frame S°) a contracted length $\mathsf{x}_2(\mathsf{t}) - \mathsf{x}_1(\mathsf{t}) = (\mathsf{x}_2^\circ - \mathsf{x}_1^\circ)(1-\mathbf{v}^2/c^2)^{1/2}$ in an IF S in which the rod moves with a velocity $\mathbf{v}$. Now, we recognize another mistake in Li's criticism of Einstein: Li confuses the arbitrary, fixed points $x_{1,2}$ in S of his formula (Li-1) with the *moving* points $\mathsf{x}_{1,2}(\mathsf{t})$ in S of Einstein's relativistic length contraction theory!

In summary, Li's criticism of Einstein is without physical or logical foundations. Li's reference to his formula (Li-1), "this is simply where the power of a correct theory lies," is completely misleading, for the following reasons: (i) Li's theory of the length of a moving rod is false due to the untenable assumption of a *noninteractng* rod; (j) Li did not establish a *novel* rod contraction theory, since for a *hypothetical*, *noninteracting* rod the length is invariant $\ell = \ell_o$, no matter what its state of motion in S (this is self-evident for physical reasons); (k) The self-flattering assertion of a "correct" theory is a slip into metaphysics, since theories cannot be proven but only refuted by experiments (Bridgman 1983). One has the impression that Li reinvented Bridgman but failed to understand him. The contraction of a rod moving relative to the ether is well understood through Galilei covariant electrodynamics (Wilhelm 1985), which shows that the length of a rod is independent of its velocity **v** relative to the observer (Wilhelm 1993).

Publications such as that of Prof. Li provide evidence for relativists who claim that criticisms of Einstein's relativity theories are founded on incompetence.

References

Li, Wen-Xiu, 1995, On the relativity of lengths and times, *Apeiron* 2:16.

Dingle, H., 1972, *Science at the Crossroads*, Martin Brian & O'Keefe, London.

Essen, L., 1971, *The Special Theory of Relativity*, Clarendon Press, Oxford.

Bridgman, P.W., 1983, *A Sophisticate's Primer of Relativity*, Wesleyan University Press, CT.

Wilhelm, H.E., 1993, Physical invariants, particle dynamics and measurement processes in Galilei covariant electrodynamics, *Hadronic J.* 8:441.

Wilhelm, H.E., 1985, Galilei covariant electromagnetic theory for inertial frames with substratum flow, *Radio Science* 20:1006.

H.E. Wilhelm
AED-Technologies
Thermopolis, WY 82443 USA

Reply by Wen-Xiu Li

Dr. Wilhelm may be correct in his sweeping remark "Prof. Wen-Xiu Li rediscovers paradoxes and criticisms due to Dingle and Essen, and even the logic of Bridgman," without pointing out how my arguments are completely identical to Dingle's, Essen's and Bridgman's. But if so, we have no reason not to say in the same sense that Wilhelm rediscovers absolute space and time, and theories of an ether due to Newton and Maxwell, and even the length contraction of Lorentz, paying no attention to the fact that absolute space and time concepts have been refuted down to the last point by Mach and others; in his papers there is therefore nothing new of his own. "Publication such as those of Prof. Wilhelm provide evidence for Einsteinian relativists who claim that alternatives to Einstein's relativity theories are founded on incompetence."

Wilhelm takes his great discover that a metallic spring will be elongated if suspended over the surface of the Earth at its distant end and shortened if supported at its close end as his argument against my principle of the constancy of length, even though I stated: "Low temperature contracts a rod." I do not think it is proper for a scientist first to misrepresent an author's meaning and then to criticize it. What I mean by the principle of the constancy of length is very clear. I mean that the length of the spring in an arbitrarily given situation (suspended or supported) is definite and absolute, independent of observers who may be in different states of motion with respect to the spring, not that the length of the elongated spring equals the length of the same spring when shortened. I do not think that even a child could have come to this conclusion. Even when vibrating, the length of the spring at any instant is definite and absolute, independent of any observer's motion relative to it. The simple length-determining theory presented in my paper can also be used to determine the length of the spring suspended at its distant end by observers in an elevator going up or down uniformly with respect to the spring. The principle of the constancy of length never meant that the rod (spring) does not "undergo physical interactions."

What I did with the simple length-determining theory is demonstrate that Einstein's two operations for determining the length of one and the same rod are not equivalent under Einstein's new conceptions of length and time. Wilhelm fails to point out where I went wrong and how Einstein's two operations are equivalent under Einstein's new conceptions of time and length, but talks about what is called "the kinematics of a moving rod" instead, unconsciously, if not intentionally, switching the subject from how to determine operationally the length of a rod moving relatively to us to what he discusses, which is not clear to me. I fail to find his starting point, his arguments or his conclusions, much less understand his logic, in particular, in criticizing my equations (2) and (3) which are easily understood by a high school student. Before the full equivalence of Einstein's two operations is proven under Einstein's new conceptions of time and length, it is of no use to discuss ℓ and ℓ_o as well as how to deduce "a contracted length" from the Lorentz transformation, not to mention the fact that Wilhelm's consideration of $x_{Bo} - x_{Ao} = \ell_o$ as the length of the same rod when at rest in S" is utterly wrong, since x_{Bo} and x_{Ao} are also instantaneous positions of the ends of the moving rod in S "at an arbitrary reference time $t = 0$". Wilhelm's letter seems to be scrambled in a fluster of exasperation to refute my paper, which destroys the basis of his theory.

Wilhelm also shows his ignorance of elementary geometry by regarding $x_1 x_1'$ and $x_1' x_2$ as "products." Fortunately, he did not regard AB as a product, nor reinterpret it as A – B.

According to Wilhelm's logic, I may not assert the correctness of my theory, but he may. For he has taken his result that "a rod parallel to its velocity **v**° relative to the ether (cosmic microwave frame S°) is length contracted..." as the criterion of truth. His "self-flattering assertion of his correct theory is *not* a slip into metaphysics", but mine is. This can only be because he is the famous Wilhelm, while am a relative unknown.

Wen-Xiu Li
Dept. of Earth and Space Sciences
Univ. of Science and Technology of China
Hefei, Anhui, P.R. of China

Relativity of Simultaneity: Reply to Xu Shaozhi and Xu Xiangqun

I have read Xu Shaozhi and Xu Xiangqun's observations on my letter commenting on their paper (*Apeiron* (1):48) with great interest, and must thank them for the attention they have given to my rather simplistic exposition. As they say, I think we are in general agreement—certainly over the ROS; I take their point about the bullet, which in the circumstances was an unwise illustration, which I used only figuratively for emphasis and was not intended for a detailed analysis.

In an attempt to clarify the issues discussed, I proffer a less complicated "experiment." A rocket is launched from earth, containing a laboratory. In the centre of the laboratory is a light source emitting a single flash of light; fore and aft at identical distanced *d* from the source are two identical clocks set to read identical times. The arrival of the light signal from the source instantaneously stops the clocks. The rocket is accelerated to some relativistic speed, and whilst cruising at constant unaccelerated velocity, the source is flashed, and both clocks stop. Note that as all parts of the laboratory are co-moving, a Fitzgerald contraction does not apply within it. The rocket is then brought back to Earth and the clocks read. The outcome of the experiment is unequivocal—either the clocks read the same or they read different values.

Calculation by observers on Earth suggests that as during the time of light transmission from source to clock, each clock has moved a distance dv/c nearer to or further from the source, the light transit times will be $d/(c-v)$ and $d/(c+v)$, respectively. Incidentally, the terms $(c-v)$ and $(c+v)$ arise solely from calculation of the effects of changes in location, and in themselves do not imply a change in the value of c as Xu Shaozhi and Xu Xiangqun appear to suggest. On this basis, the forward clock should read a later time than that at the rear.

Within the laboratory, however, there has been no change in the relative locations of source and clocks, as may be verified with measuring rods during the trip. The light transit times to each clock are the same; they will be triggered to stop simultaneously and will read the same time. This is surely what the experiment would reveal and is the essence of the phenomenon—if it were not so the results of earthbound laboratory experiments would vary because of the changing velocity vector of the earth both diurnally and at different times of the year!

We have to consider what was wrong with the reasoning from those in the frame of reference of the earth, which engendered a contrary conclusion. In its function as a medium in which light is transmitted at constant velocity c, it is evident that space in this mode is homogeneous and has no markers against which the velocity of a moving body can be registered. Any attempt to relate the velocity of a moving body on the one hand to light transit time in space on the other is therefore doomed to failure. For this reason, the Michelson-Morley and similar experiments, where the observer is situated at the eye-piece of the apparatus and comoving with it, must give a null result.

The issue cannot be evaded by the assumption that light travels at speeds $(c + v)$ or $(c - v)$ as a result of the motion of the rocket relative to the Earth, thus allowing earthbound calculators to claim that they have derived simultaneity of the clocks, because if the same rule of light emission by a source in motion is applied within the rocket, the clocks will then read differently (and the workers in the laboratory will also observe obscure Doppler effects!). The value of c has to be invariant and the PIVL holds.

Put in another way, and perhaps stating the obvious, between two bodies there is an extent of space, and the light transit time depends solely on c and this extent, motion of the bodies being irrelevant provided this extent is unchanged. But if the velocities of the bodies are different, so that the spatial extend is changed, the light transit time is then related to the relative velocities of source and receptor. In the universal generalization of this concept, it is the failure of to provide a basic stationary frame of rest, as a sheet-anchor against which velocities may be gauged, which leads to the various apparent inconsistencies in STR, *e.g.*, the so-called paradox of "which twin is aging faster."

My contention also is that it is incorrect to assume that the light transit time between a source A, presumed to be stationary, and an observer O receding at velocity V, is equivalent to that obtained if we assume the observer to be stationary, and the source in recession at the same velocity; the two situations are not equivalent, because the time of commencement of the light transit is set by the event of emission by the source irrespective of its motion.

As for empirical evidence for the PIVL, it is true that "one-way" experiments are thin on the ground. I would cite the experiment of D. Sadeh (*Phys. Rev. Lett.* 10:271, 1963), showing that the velocity of γ-rays is constant (±10%), independent of the velocity of the source, for a source velocity close to $c/2$, compared to a source at rest. Must such a result be ignored because its interpretation is via dynamic processes of interaction rather than purely from relative motion?

Simultaneity in my view is defined by the occurrence of two or more events which occur at precisely the same time on a time-scale general to all of them. Observed simultaneity merely arising from a light time delay in transit to the observer, or theoretically from the utilization of mathematically manipulated and differing time scales, is spurious, and to me it is a meaningless concept to consider this apparent simultaneity to have any reality.

John Watson,
Iddons, Henley's Down, Catsfield,
Battle, E. Sussex TN33 9BN

Cosmological Candor

Given a spate of recent scientific discoveries that have caused perplexity among astrophysicists, scientific humility is clearly in order for the field of cosmology.

A recent discussion of the standard big bang model by P.J.E. Peebles of Princeton University and several colleagues (*Scientific American*, October 1994) seemed at first to take such a position. The article began and ended with broad-minded scientific objectivity. The authors openly acknowledged a subtle, but crucial point: the region of spacetime modeled by the standard big bang paradigm may not represent the entire universe. The expanding system we observe might only represent a small, perhaps an even infinitesimal, portion of the cosmos. We simply do not have adequate empirical evidence for deciding this matter scientifically, and it is a welcome change to see the situation stated candidly.

However, sandwiched in between these bookends of objectivity and scientific wisdom we find an unabashed sales pitch for the idealized standard big bang model of the cosmos. This makes some of us think that the professors have not ventured out from their mathematical towers for some time. For example, the authors tell us that: "there are no fundamental challenges to the big bang theory, although there are certainly unresolved issues." But consider the challenge of the dark matter, which makes up at least 90% of the universe. The big bang paradigm did not predict this amazing discovery, nor can it uniquely retrodict what the dark matter is composed of. The big bang proponents' vague assertion that it might be some new and heretofore unobserved subatomic particles seems to have been contradicted by microlensing experiments which suggest that the galactic dark matter objects have masses of about a tenth of a solar mass. When a theory draws a blank on 90% or more of the universe, that is what I would call a "fundamental challenge."

Modern surveys confirm the fundamental tenet that the universe is homogeneous on large scales." But, as virtually every observational astronomer knows, this is just plain false. The line-in-the-sky where homogeneity is *supposed* to begin has been moved back repeatedly as observations falsified the successive predictions. The evidence for anything more than a very crude approximation to homogeneity is weak; the evidence for inhomogeneity to the very limits of observability is strong (see Coleman, P.H. and Pietronero, L., *Physics Reports*, vol. 231, 1992). The authors state that: "Indeed, the predictions of the theory have survived all tests to date." But what about serious and well-known observational problems such as the unexpected large-scale inhomogeneity in the cosmos, an unacceptably low value for the density of the universe, and a strange new limit on how low a star's mass can be. We are told that: "

Another astounding claim is that the big bang model's predicted age of the universe and the ages of the oldest known stars "agree, at least approximately." If stars in a globular cluster or galaxy have a stated age of 15 billion years, that still does not take into account the time needed for the universe to make a first generation of stars and then the following generation of detected stars. In short, the age of the universe predicted by the big bang model appears to miss by at least 5 to 9 billion years. In my book that not only misses the barn door, but also the whole barn.

The main point is this. The original big bang model and its many artfully modified versions have been useful approximations over the last 30 years. Yet the paradigm is coming into increasing conflict with serious observational challenges that seem to be popping up at a rate of one every few months. It is time to question of our psychological dependence on the big bang paradigm, in its idealized form or in subsequent versions with epicycles. We can probably retain the concept that the observable region of the universe appears to be expanding from a more dense state, but this may well be only one facet of a far more encompassing and sophisticated cosmos.

Robert L. Oldershaw
Box 2262, Amherst College
Amherst, MA, 01002

Instructions to authors

APEIRON is a scientific journal devoted to cosmology and fundamental physics. It publishes only convincingly argued, adequately documented papers in English, as well as English translations of historically important texts. *APEIRON* appears three times a year, and is indexed in *Physics Abstracts*. Submission implies that a paper is not under consideration by another publication and has not been published previously. All submissions will be reviewed by anonymous referees with expertise in the field, and every effort will be made to publish material presenting original viewpoints. There is no page charge or offprint charge. Send contributions to C. Roy Keys, 4405 St-Dominique, Montreal, Que, Canada H2W 2B2.

All papers must be submitted typewritten or printed in three copies, and once accepted, on MS-DOS or MAC diskette (Word, RTF or ASCII format preferred). The first page must include the title, the author's name and address, and a brief abstract. The International System is the preferred system of units. References must be indicated between brackets in the text by the author and year of publication, with a full alphabetical listing at the end of the manuscript. For books, the listing should include the full title, place of publication, publisher and year of publication. Journal articles should be referenced with the full title (between quotation marks), journal name, volume and page number. Graphical elements should be approximately 3x oversized, clearly numbered, labeled and captioned.