In Defence of Dingle's Opponents

ARMSTRONG[1] has suggested that if Dingle's work did not deserve serious thought and discussion it might have been better to ignore it completely.

After several letters of his, all of them embodying the same basic mutation of conventional views on relativity, had been answered by various people[2-4], his next two or three letters were indeed neglected. The result of this was a letter from him saying that as nobody seemed to be able to answer his points, he could only take it that everybody now agreed with them.

I continued a desultory private correspondence for some time. I stopped when he answered a particularly detailed analysis which I gave, involving no mathematics worse than simple algebra, showing where I believed his error to lie, by saying simply that it was not his business to find the error in my analysis. As my analysis led to the conclusion with which he disagreed, it must clearly be wrong, and it was up to me to find the error for myself.

His basic error has been to suppose that because it is impossible for one observer to determine whether or not he is moving with respect to another, when each of them is in continuous uniform relative motion, it is therefore impossible to tell which of them has been accelerated. At no time has he been willing to accept that this could make any difference, and at no time therefore has he discussed quantitatively the results of this acceleration.

I do not suggest for an instant that his persistence has had no value. His public persistence has for years made the teaching of relativity more interesting, and has led innumerable students of physics to find a real interest in calculating exactly by how much one of the twins in the paradox could return younger than the other. After doing this calculation themselves they rarely believe that there could be no difference in age.

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1 Armstrong, H. L., *Nature*, **242**, 214 (1973).
2 McCrea, W. H., *Nature*, **216**, 122 (1967).
3 Landsberg, P. T., *Nature*, **220**, 1182 (1968).
4 Fremlin, J. H., *Nature*, **180**, 499 (1957).

Another Answer to Dingle's Question

DINGLE[1], in restating his question to avoid the answers of Ziman[2] and Ellis[3], has erred. It is not necessarily true that a time interval measured by two observers in two frames of reference, A and B, will be related by the factor $\gamma\ (v)=(1-v^2/c^2)^{1/2}$ where v is the velocity of one frame relative to the other.

If I define a time interval (Δt) by causing two light flashes, and this interval is measured by an observer in A who is moving from my right to my left with speed u and also by one in B who is moving with the same speed but in the opposite direction, so that the two observers pass each other directly in front of me, then by symmetry, both will record the same time interval between the two events ($\gamma(u).\Delta t$) even though their relative velocity is $v=2u/(1+u^2/c^2)$ and even though each observes that the clock in the other frame of reference appears to be running slow.

In this problem I am considering three frames of reference, A and B, and C which is the one in which the two events appear to occur at the same point. In general, no two of these frames will be stationary with respect to one another and their relative velocities will determine whether it is the observer in A or the one in B who records a longer time interval. There is no ambiguity.

In the particular case when one of the observers is at rest in C it is he who records the shorter time interval. As far as I know, whenever the twin "paradox" is restated to avoid accelerations (by using more than two observers and synchronizing clocks) the "paradox" disappears and all observers agree as to who measures the longer time intervals.

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1 Dingle, H., *Nature*, **242**, 423 (1973).
2 Ziman, J., *Nature*, **241**, 143 (1973).
3 Ellis, G. F. R., *Nature*, **242**, 143 (1973).

Whippman's Answer

THE answer to the question posed by Professor Dingle[1] is quite simply that the Lorentz transformation formula does not imply what he claims it does. In the situation he describes, the interval dt' that B's clocks would show is related to the interval dt shown by A's clock by the usual formula

$$dt' = \gamma(dt - \beta D)$$

where β and γ have their usual significance, and D is the coordinate difference between the two events as measured in A's frame. This formula involves only the relative velocity β of A and B, and it is clearly impossible to deduce from it anything about the relative sizes of dt and dt'. The common result, described too succinctly by the phrase "the moving clock appears to be slow", refers only to the very special case where the coordinate difference D is zero. Even in this case, the corresponding difference measured by B will not be zero, the situation is clearly asymmetric and no paradox arises.

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1 Dingle, H., *Nature*, **242**, 423 (1973).

Stedman's Answer

THE feature of the situation for which Dingle[1] is searching is that the two events he considers define a third inertial frame, C say, in which the two events occur at the same position. My one sentence answer to Dingle's question is: the time interval calculated by A is greater (less) than that calculated by B if the relative speed of C and A is greater (less) than the relative speed of C and B.

In connexion with the question which Ziman and Ellis answered[1], and which was suggested by Dingle's earlier, imprecise, formulation of his question, it might be noted that it is sometimes necessary to choose between geodesics which connect the same events[2].

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1 Dingle, H., *Nature*, **242**, 423 (1973).
2 Holstein, B. R., and Swift, A. R., *Am. J. Phys.*, **40**, 746 (1972).