Problems in special relativity

Arguments that have been used to defend the special theory of relativity against criticism contain many inconsistencies. These problems should be thoroughly and objectively examined by scientists and philosophers to attempt to ascertain the truth of the matter.

Ever since Einstein's special theory of relativity became a prominent part of physics, it has been a subject of some controversy. One of the foremost critics of the theory was the late Herbert Dingle (1890-1978), who spent much of his time and energy during the last two decades of his life in trying to persuade the scientific world that the special theory, although mathematically valid, contains an inconsistency in its physical application. Although most scientists seem to be convinced that the controversy stirred up by Professor Dingle's criticisms has been conclusively settled in favour of the theory, a close examination of the relevant literature shows many inconsistencies in the arguments by which the special theory has been defended. The present article does not attempt to settle the matter; in fact it shows that the issue has not yet been satisfactorily settled. It is hoped that scientists and philosophers may be encouraged to continue the search for the truth of the matter, whatever it may be.

Simple example of inconsistency

Readers who are not experts on relativity may feel convinced that the inconsistencies that have been mentioned are beyond their understanding; on the contrary, many of them are perfectly obvious to anyone who takes the trouble to read them. To take a specific example, consider two inconsistent statements that were made in the British journal *The Listener* in 1971.

Professor J. Taylor claimed[1] that the results of the well-known experiment of Hafele and Keating, which had then been recently performed, supported Einstein's special theory. Professor Dingle published a letter rebutting Taylor's article, and further correspondence continued to be published, in the course of which another scientist, Professor M. A. Jaswon, published a letter[2] which disagreed with some of Dingle's points, but which agreed with Dingle that the experiment in question had "no relevance whatever for the special theory". Although that statement was directly contrary to Taylor's claim, Taylor later published another letter[3] which continued to criticise Dingle but which took no notice whatever of Jaswon's statement.

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Some observers of the controversy may believe that inconsistent statements like these result from attempting to express abstruse technical matters in simple language, and that such inconsistencies may therefore be dismissed as being inconsequential. But the inconsistency between the statements mentioned above cannot be dismissed in that way. A statement that the

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results of a particular experiment support a certain theory is a perfectly simple factual statement (however abstruse may be the reasoning by which that statement is justified), and the same applies to the contrary statement. The fact that Taylor's and Jaswon's statements are contrary to one another (that is, they cannot both be true, though they could both be false) shows that, unless there is an inconsistency in the special theory itself, one or other of the two scientists (or both) misunderstood either the theory or the experiment (or both).

It will also be clear to any reader, scientist or not, who reads the whole of the correspondence that includes the above items (refs 1-3), that no attempt was made to resolve the inconsistency between Taylor's and Jaswon's statements. If science is the search for truth, wherever the search may lead, the serious inconsistency between the statements of the two scientists ought to be followed up to find out which statement, if either, is true. The fact that both statements have been accepted in spite of their obvious incompatibility is evidence that there is not enough scientific curiosity about the truth of the matter. The remainder of this article presents further evidence in support of the same point of view.

Further examples of inconsistency

Professor Dingle's criticisms of special relativity are presented at length in his book *Science at the Crossroads*[4], and it is in the published reviews of that book that many of the inconsistent attempts to defend the theory have been made. To study some of these attempts, consider Dingle's crucial question, which is central to his book, and which is worded as follows:

> "According to the special relativity theory, as expounded by Einstein in his original paper, two similar regularly-running clocks, A and B, in uniform relative motion must work at different rates. In mathematical terms, the intervals dt and dt′, which they record between the same two events are related by the Lorentz transformation, according to which $dt \neq dt'$. Hence one clock must work steadily at a slower rate than the other. The theory, however, provides no indication of which clock that is, and the question inevitably arises: How is the slower-working clock distinguished?"

In a review[5] of Dingle's book, Professor J. M. Ziman quoted the above question and then wrote: "This is a perfectly reasonable question to which science should indeed give an answer." Later in his review he gave his own answer, in the following words: "In fact, the answer to Dingle's 'question' is simple: the fastest-working clock between any two events is one that travels between them by free fall." But, as Dingle subsequently pointed out[6], neither of the events need be at either of the clocks concerned. Also, since the question asked for a distinction between two clocks, not for a choice among all possible clocks, Ziman's answer, whether or not it is a true statement, is simply not an answer to the question that was asked.

Dingle also supplemented his question by referring to a specific example in Einstein's original paper on special relativity, in which Einstein had stated that a balance-clock at the equator would work more slowly than an exactly similar clock at one of the poles. Dingle stipulated that any answer to his question should specify what it was that entitled Einstein to conclude, from the special theory, that the equatorial and not the polar clock worked more slowly. Dingle stressed that the special theory did not take any account of possible effects of acceleration, gravitation, or any difference at all between the two clocks except their state of uniform relative motion. It should be strongly emphasised, however, that he did not assert that acceleration and gravitation were *absent* from the situation described by Einstein, but that those phenomena are not dealt with by special relativity, and consequently it is not legitimate to invoke those phenomena to explain what entitled Einstein to conclude *from the special theory* that the equatorial clock worked more slowly.

The attempts to answer this supplementary question show an interesting diversity. In the first place, it is obvious that Ziman's answer, quoted above, does not apply to this situation; after the two clocks are in their positions at the pole and at the equator, there is no event at which both clocks are present, so there is no way in which Ziman's criterium can distinguish between them unless some pair of events is specified.

Consider now some of the other attempts to answer the question about the polar and equatorial clocks. For example, Professor G. J. Whitrow wrote as follows[7]:

> "For a supporter of relativity, the essential difference between the two clocks is that relative to the centre of the Earth (which for the purpose concerned can be regarded as the origin of an inertial frame) the clock at the equator describes a circle and so cannot be associated with an inertial frame, whereas the polar clock is at rest and can be associated with an inertial frame for a period of time during which the curvature of the Earth's orbit can be neglected. The time difference mentioned by Einstein can be demonstrated by means of the Minkowski diagram, in which the track of the polar clock will be rectilinear whereas that of the equatorial clock will be curved."

Two comments may be made about this. First, if the equatorial clock is not in an inertial frame, then its motion lies outside the scope of the special theory, which applies only to inertial frames[8]; it is therefore invalid to deduce from the special theory *any* conclusion about the relative rates of the two clocks. Second, the answer raises the equally difficult question of why a clock that moves in a large closed curve is in an inertial frame, while one that moves in a smaller closed curve is not.

Compare Whitrow's answer with the following answer, which is found in an unsigned editorial article in *Nature*[9]:

> "It seems now to be accepted that Einstein's original argument was uncharacteristically loose. The point of the illustration is that a clock at the pole of rotation may be taken to be in an inertial frame which is nearly (but not quite) properly defined by the direction of the Earth's motion around the Sun. The clock at the equator is in another. Einstein's lack of clarity concerns the inertial frame of the observer of the two clocks."

This statement implies that the answer to the question about which clock works more slowly depends on the observer. But Einstein's statement clearly implies that the slowing of the equatorial clock is a real effect and not merely an effect of observation, and this is confirmed by the fact that he added a footnote to say that his statement did not apply to pendulum clocks[10]. The answer[9] also states that the equatorial clock is in an inertial frame, and this explicitly contradicts Whitrow[7], who states that it is not.

Another answer to the same question is given by Stadlen[11], who writes:

> "But the relative motion involved in this case, being circular, is non-uniform. I submit, therefore, that Einstein was wrong in saying that his prediction followed from the special theory, which deals only with the effects of uniform motion. This is not to say that the prediction was invalid. For Einstein was, intuitively, anticipating his later general theory, according to which the equatorial clock runs slower because of the centripetal force exerted upon it."

This answer is inconsistent with *both* the previous answers, since it disagrees with Whitrow[7] about whether the result follows from the special theory, and it disagrees with the *Nature* editorial[9] about whether the slower working is real or dependent on the motion of the observer. Furthermore, the fact that the prediction follows from the general theory does not make Einstein's prediction *from the special theory* valid, as Stadlen implies it does. As is well known to logicians, the fact that the conclusion of an argument is true does not guarantee that that argument is valid.

Another interesting attempt to identify a false step in one of Dingle's arguments was made by McCrea[12], who wrote:

> "The false step is that Dingle regards the situation treated by relativity as the symmetric comparison of one single clock with another identical single clock (in relative motion). This is not the situation. Actually many colleagues have pointed this out, or given an equivalent answer."

Unfortunately McCrea does not identify any of the "many colleagues" whom he claims to support his argument, but it is clear from the foregoing that Ziman, for example, does not. Ziman states[5] that Dingle's question is perfectly reasonable, and the question, as he correctly quoted it, includes a statement that if there are two clocks in uniform relative motion, the special theory requires one to work steadily at a slower rate than the other. McCrea's statement is also inconsistent with Einstein's statement that a (single) clock at the equator would work more slowly than an exactly similar (single) clock at one of the poles.

Other illogical arguments

In addition to the inconsistencies already mentioned, some of the arguments used in defending special relativity are lacking in logical rigour. To illustrate this, consider some examples.

In one of the earliest attempts to refute Dingle's criticisms, Born[13] wrote as follows:

> "The simple fact that all relations between space co-ordinates and time expressed by the Lorentz transformation can be represented geometrically by Minkowski diagrams should suffice to show that there can be no logical contradiction in the theory."

As the Lorentz transformation is contained in the special theory, but is not the whole theory, it is not logically valid to claim that some property of the Lorentz transformation is a sufficient condition for the whole theory to be free of logical contradiction.

In another attempt to refute Dingle, Professor I. Roxburgh[14] discusses Dingle's argument that if there are two clocks A and B in uniform relative motion, the special theory requires A to work faster than B and B to work faster than A, and this makes the theory internally inconsistent. Roxburgh states that Dingle does not even discuss what he means by "faster", and then goes on to say:

> "Secondly, why is it impossible for A to go faster than B and B to go faster than A? This depends on the definition of faster. To illustrate this, consider the following two statements:
>
> The moon is bigger than the sun.
> The sun is bigger than the moon.
>
> Are these statements mutually contradictory? This depends on the meaning of bigger. For terrestrial beings the first statement is true, for Martians the second is true. The relative size depends upon the position of the observer. So it is with time and clocks."

If it is important to define "faster", it is also important to use other words precisely; yet it is clear from the quotation that Roxburgh does not literally mean "is" in the two contrasted statements, but something like "appears to be". Thus, the two contrasted statements are not analogous to the two statements that Dingle claims to be inconsistent. Or, if Roxburgh does mean the pair of contrasted statements to be taken literally, then he, as a terrestrial being, is asserting that the moon is bigger than the sun. Although we are terrestrial beings, we know that the sun is bigger than the moon, and we know it from observations that have been made from the earth.

To put the matter in terms of logical relations, the expression "is bigger than" represents an asymmetrical relation, whereas Roxburgh's pair of contrasted statements asserts that "is bigger than" is not an asymmetrical relation[15]; there is therefore a contradiction inherent in what Roxburgh has written. Of course, a contradiction between any two statements can be avoided if one is free to disregard literal meanings of words and interpret the meanings of the statements in such a way as to avoid the contradiction. This is similar to the technique described by Dingle (ref 4, page 180) for avoiding the inconsistency in special relativity: "When the theory appears to lead to incompatible objective results, they are written off as merely different *appearances*, but claimed as *realities* when some actual phenomenon has to be explained."

Whitrow has also published an argument[7] which purports to refute Dingle's claim that the special theory is inconsistent in requiring each of two relatively moving clocks to work faster than the other. The last sentence of his argument is:

> "Dingle's requirement is therefore equivalent to introducing the Newtonian concept of universal time, and this is incompatible with special relativity."

Now whether or not Whitrow's statement about Newtonian time is true, the sentence quoted does not prove that Dingle is wrong; all it states is that either Dingle is wrong or special relativity is wrong. As the point at issue is the validity of special relativity, and as the context obviously implies that the argument that ends with the quoted sentence proves that Dingle is wrong, Whitrow's argument shows an excellent example of the textbook fallacy known as begging the question[16]. Since Whitrow has subsequently published the same argument two more times[17,18], in obituary notices on Professor Dingle, the pointing out of this logical fallacy is overdue.

The foregoing examples of inconsistencies and logical fallacies in the arguments used to defend special relativity do not in themselves prove that Dingle is right, or that special relativity is wrong. However, if two scientists make inconsistent statements about the same theory, one or other of them must have made an error in deduction, or else the theory itself contains an inconsistency. In other words, the inconsistencies in the statements that have been made by the defenders of the special theory actually support Dingle's case that there is an inconsistency in the theory, rather than refuting it.

Although scientists may be convinced that the conclusion they have already reached is true, they should also be concerned with whether the arguments by which that conclusion has been reached can withstand scrutiny without revealing inconsistencies. I suggest that the scientific ideal toward which science should strive in this case is that stated by T. H. Huxley when he wrote[19] that "the scientific spirit is of more value than its products, and irrationally held truths may be more harmful than reasoned errors." It is time for the truth of this matter to be actively and carefully sought.

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