10 Simultaneity

The first chapter of Einstein's 1905 paper has the heading *Definition of Simultaneity.* The choice of this heading indicates the point of departure and the direction of the initial thrust of the Einsteinian argument. The concept of time has been chosen as target, and it is its fundamentality and universality which has to be demolished. After briefly introducing the notion of a Newtonian mechanical system, Einstein says: *If we wish to describe the motion of a material point, we give the values of its co-ordinates as functions of time.*

Motion is a function of space as well as time, but the question of space is not analysed in Einstein's discourse on special relativity, although it is obviously just as important as the question of time. The argument continues: *A mathematical description of this kind has no physical meaning unless we are quite clear as to what we understand by "time".* The word "time" is now placed in quotations marks indicating that Einstein is not prepared to concede that the concept of time is entitled to exist in its own right and to be considered as a primary and basic component of physical reality together with space. This denial of the real existence of time prior and apart from matter is one of the most persistent ideas of Einsteinian relativity. It is repeated again and again by Einstein himself and by his followers, directly and by implication, because any admission that time is primary and universal would destroy the edifice of relativity. One of the most forthright statements on the non-reality of time is contained in Einstein's reply to continuous questions by uninitiated outsiders about the quintessence of relativity: *It was formerly believed that if all material things disappeared out of the universe, time and space would be left. According to the relativity theory, however, time and space disappear together with the things.*

Einstein's view is derived from his metaphysical outlook and is not demanded by any physical requirements. Just as metaphysical is his reduction of the problem of time to a question about the simultaneity of two events. Einstein claims that *all our judgments in which time plays a part are judgments of simultaneous events.* Obviously, not *all our judgments* in which time is involved are of this kind. In fact, in most cases it is the past or the future, the sequence of events, cause and effect relationships, and the inescapable flow of time which are the substance of our judgments. Simultaneity is sometimes of importance, and when it is, the reconciliation of the times of two separated events has never created any physical problem. Why is it necessary to attach such prominence to simultaneity and see difficulties where there are none? The difficulties arise only if the generally accepted principle of the independent and constant time-flow is rejected. Einstein does not find it necessary to offer a rational argument in favour of his point of view. In his opinion, it is not necessary to say anything about a non-existent principle, despite the fact that in reality he makes frequent use of it.

After having conceived the idea that time is nothing more than periodically recurring motion of matter, Einstein suggests that *it might appear possible to overcome all the difficulties attending the definition of "time" by substituting "the position of the small hand of my watch" for "time"*. These words were written in 1905. Later, he cast away the cautious wording and said positively that by the time of an event we understand nothing else but the reading of a clock, i.e. the position of the hands of the clock, which is in the immediate vicinity of the event. This definition is considered by him entirely satisfactory when we are concerned with the determination of local time, that is, time associated with the place where the clock is located. It should be noted that Einsteinian time necessarily requires an observer to be present at the event, to be in possession of a clock, and to be able to read it. Only if these conditions are complied with is Einstein prepared to permit the use of the word "time".

The timing of an event with a clock which is located at the event, and the synchronisation of two clocks which are placed side by side, can be accomplished quite satisfactorily and does not present any difficulties, according to Einstein. But the situation *is no longer satisfactory when we have to connect in time series of events occurring at different places, or to evaluate the times of events occurring at places remote from the clock* (Einstein). The problem posed by Einstein is this: how do we compare and synchronise time measurements made at places which are remote from each other?

In real life the remote synchronisation of clocks is achieved quite successfully and without any difficulties, and anyone concerned with practical chronometry can only wonder why it is necessary to see complications where there are none. But Einstein is not disturbed by the facts of practical chronometry. He proposes his own theoretical method as to how remote clocks should be synchronised, and this method is then declared by him to be the only acceptable definition of simultaneity. His method or definition is given in the form of a thought experiment in which observers exchange light signals.

Einstein's thought experiment expounding his definition of simultaneity requires two observers, two clocks, and the communication of signals with the aid of light rays. An observer A determines the time value at the point A of space by reading a clock which is positioned *in the immediate proximity* of A. Another observer B determines in an identical manner the time value at point B. In order to arrive at *a common "time" for A and B we establish by definition that the "time" required by light to travel from A to B equals the "time" it requires to travel from B to A* (Einstein). If a light signal is emitted at the instant 4 from A and reflected at the instant 7 from B, it will return to A at the instant 10 so that 7 - 4 = 10 - 7. Einstein does not find it necessary to add anything more, to provide any details of clocks and signal transmission, or to examine any theoretical and practical implications of his time concept. But he is nevertheless convinced he has the right to assume *that this definition of synchronism is free from contradictions*, and that it adequately solves the problem of simultaneity.

One of the strange features of special relativity is its embarrassing lack of physical content. Possibly as a substitute for the non-existent empirical basis Einstein frequently introduces thought experiments during crucial stages of his argumentation, and the procedure for the synchronisation of remote clocks is an example of such "experiment". Confident that he has successfully completed his task, Einstein concludes his description with the following words: *Thus with the help of certain imaginary physical experiments we have settled what is to be understood by synchronous stationary clocks located at different places.* Two things in this conclusion must be criticised. The first is the use of the term "imaginary physical experiment". Either an experiment is physical or it is imaginary. In this case we are dealing with an imaginary experiment, and the issue should not be clouded by intimating that it is equivalent to a physical experiment. The word "experiment" alone is able to lead people astray who are not aware that a thought experiment is really all thought and no experiment. It is inappropriate to reinforce its potential to mislead by adding "physical". Secondly, an imaginary experiment cannot *settle* anything in physics. It can assist in explaining something, it can embellish and reinforce a rational argument, or it can indicate a possible way to deal with a physical problem. But it cannot *settle* the problem, and it cannot enrich empirical knowledge. Its end result is not a scientific fact, but an assumption which has still to be proved. In other words, thought experiments suffer from distinct limitations and are not to be considered in any way equivalent to practical tests. This has to be remembered every time we are confronted with one of Einstein's thought experiments. However, if the limitations are taken into account, there are no compelling reasons why thought experiments could not be occasionally used in logical argumentation and analysis.

Irrespective of the value of thought experiments, it is difficult to see what will be achieved by adopting Einstein's synchronisation procedure. There are, however, several good reasons why it should not be accepted. For instance, why should the meaning of simultaneity depend on light signals, and only on light signals? And what is the exact method of observing clocks and transmitting light signals? Considerable doubt must be expressed about the validity of Einstein's division of synchronisation processes into two kinds: "local" and "remote". Where exactly does "local" synchronisation end and "remote" synchronisation begin? The meaning of "remote" in Einstein's argument is certainly not equivalent to "extra-terrestrial", as is usually assumed. Einstein's remoteness is quite clearly connected with the visual inability of one observer to see a clock and an event, or two adjoining clocks, together. Without doubt, a state of remoteness in the Einsteinian sense exists if, for instance, two clocks are one kilometre apart. Now it is possible to arrange a number of clocks in a line which is one kilometre long so that any two adjoining clocks can be synchronised by one observer in accordance with Einstein's prescription for local time. Therefore, if any two adjacent clocks can be synchronised on the basis of local time, all clocks in the line can be synchronised on the same basis. This shows that not only can two clocks which are "remote" be synchronised without light signals, but that the distance between the two clocks can be potentially extended to any required value so that, in effect, Einstein's "local time" would become identical with Newton's universal time.

If Einstein is permitted to advance a thought experiment in order to provide a definition of simultaneity which is necessary for his theory, then it is only fair and proper to give consideration also to a different thought experiment in order to see that there is nothing wrong with the classical concept of simultaneity and that a theoretical definition of it can be given. This definition is as follows: (a) two clocks are synchronous if their readings coincide when they are visually inspected together by one observer; (b) in a line of clocks in which any adjoining pair is synchronous all clocks are synchronous; (c) if a line of synchronous clocks is thought of as established between two points at which events occur, events which are observed together with coinciding clock readings are simultaneous. This definition can be strengthened by assuming rings and networks of clocks instead of lines. By converting open-ended lines into closed rings, and rings into networks, complete and error-free synchronisation of all clocks can be achieved. All places in the universe will be covered by a synchronous chronometric network in which there is theoretically no room for non-synchronous time measurements and non-simultaneity.

However, it should really not be necessary to use thought experiments to counter Einstein's definition of simultaneity. It must be understood that the definition in itself is not invalid, but inconsequential. It acquires significance only for a person who believes in Einsteinianism and uses it in conjunction with the Einsteinian conceptions of time and motion of light. Within this metaphysical framework the definition enables the drawing of particular conclusions in the subsequent stages of the argument, and these conclusions represent the central core of the theory of special relativity and are contrary to traditional and well-established principles of physics. If the time required for light to travel from one place to another is taken into account, Einstein's definition, although trivial, is formally correct. But the point is that Einstein does not permit travelling time to be taken into account because he has decreed that time apart from clock readings synchronised in accordance with this prescription does not exist. Einstein's definition of simultaneity can be understood only in terms of his rejection of the universal time concept which is still one of the cornerstones of physics. The definition is physically meaningless and should be confined strictly to the realm where it belongs, namely to metaphysics.

In addition to the objections already mentioned Einstein's definition of simultaneity suffers from a lack of credibility because of inherent contradictions in its presuppositions. One of the conditions required to be met in order that light signals in two directions can be considered as a reliable method to synchronise clocks is the existence of rigid Newtonian space. But does Einstein really accept rigid Newtonian space? He does not openly say so in his 1905 paper, but there can be no doubt that he has reservations about it. In view of his negative attitude to such properties of space as rigidity, homogeneity, etc., how does Einstein know what happens to a light ray during its journey from one observer to the other and back? How does he know that effective synchronisation of remote clocks by light rays is achievable under non-Newtonian conditions? And why should we accept his word?

Another presupposition is the existence of standard time in order to measure and give meaning to the velocity of light. It has been demonstrated without any doubt, and within terrestrial laboratories, that light is physical motion. And what is more, it is cyclical or periodical motion. This means that light can be used as a clock. According to Einstein the periodical motion of a clock is the basis of our understanding of time, and if this is the case, then the motion of light represents, or is corresponding to, time-flow. Consequently, the motion of light from one place to another must be necessarily connected with a time-flow. But Einstein explicitly denies that there is any time-flow associated with light rays during the synchronisation process. We are permitted to allocate something called time to the motion of clock hands, but we are not permitted to allocate it to the motion of light, although this motion may be measured by a perfect photon clock inherent in it. Einstein wants his cake, and wants to eat it as well.

Practical chronometry is not afflicted with any problems or difficulties as far as the establishment and keeping of a standard time is concerned, and no empirical evidence has ever been produced indicating that the principle of the constant and universal time-flow is breaking down or that it is not fully and unconditionally applicable in any part of the world. Neither within terrestrial, nor within cosmic dimensions have any synchronisation difficulties been encountered. Within the terrestrial chronometric network time measurements can be made and synchronised by various means with a precision which is sufficient for any practical and scientific purpose. The most accurate devices, atomic clocks, measure time intervals which are less than a millionth of a second, and these time intervals are synchronised by radio signals and oscillographs. The terrestrial chronometric network can be extended into outer space as far as necessary, and clocks in space vehicles can be synchronised without any difficulties. The travel time of signals is certainly taken into account.

There is neither a theoretical nor a practical basis for Einstein's assumption that the concept of universal simultaneity is doubtful and that a reconciliation of spatially separated time measurements is necessary in order to "define" it. It is Einstein who is required to produce evidence in support of real, as opposed to apparent, non-simultaneity if he expects his claims to be taken seriously. However, it is intrinsically impossible to produce any convincing physical evidence either for or against non-simultaneity because the comparison of clock reading can only disclose the relative coincidence and state of perfection of their mechanisms. It cannot disclose whether there is anything called simultaneity or non-simultaneity hiding behind those mechanisms if we limit ourselves to purely empirical criteria. Simultaneity is intimately associated with time, and not time measurement. As part of the concept of time it is an unanalysable element located at the interface of physics with metaphysics. It cannot be conclusively proved or disproved solely by physical operations. It requires a rational justification in addition to the evidence from physical reality.

Despite the shallow and unrealistic nature of Einstein's discussion of simultaneity relativists do not tire to extol the depth of vision and the admirable "operationalism" allegedly manifested in the Einsteinian approach. Eddington was the first who saw relativity as an outstanding example of the philosophy of operationalism at work, and in the introduction to his *Mathematical Theory of Relativity*, published in 1923, he spelled out the essential thesis of this philosophy: *A physical quantity is defined by the series of operations and calculations of which it is the result.* Bridgman, the principal advocate of operationalism, praised Einstein's operational methodology on numerous occasions, but his praise was later mixed with a considerable dose of criticism. More recently Bondi found it necessary to exhort some wayward members of the profession: *We must abandon the elementary concept of one universal time. We must return to the basic idea that any quantity in physics is defined by the method of measuring it.* Although serious objections have been raised, operationalism still remains a popular belief system among physicists. It is epitomised in the "rule", which is entirely metaphysical, that only those things in physics are to be considered meaningful and incorporated into the body of knowledge which can be measured or computed in accordance with a set of explicitly stated operations, either physical or mental.

Operationalism requires that hypothetical considerations be realisable in practice in order to be acceptable. Imaginary experiments should be actually performed and yield the results which are claimed to be demonstrated by them. Is anyone using Einstein's method to synchronise remote clocks? Has anyone made a practical effort to show that Einstein's method is fully "operational" and does not presuppose a number of non-operational concepts? The answer to these questions is negative. Nobody has bothered to perform or use Einstein's experiment and test its effectiveness and practical compliance with the canons of operationalism. Yet Bridgman asserted that *Einstein recognised that in dealing with physical situations the operations which give meaning to our physical concepts should properly be physical operations, actually carried out.*

Einstein's operational prescriptions are incomplete and insufficiently explicit. One of the fundamental weaknesses in his argument is the absence of a definition of a clock, either operational or non-operational. He speaks vaguely in terms of clock hands, which appears to refer to a certain type of clock only, and he does not provide an objective method of comparing two clocks, or a clock with an event. The synchronising is effected by the subjective assessment of a human observer, it happens in his mind, and this is hardly an acceptable method in terms of the philosophy of operationalism. Furthermore, the details of the procedure associated with the transmission of light signals are not described, and the procedure requires the human element again and an assumption that signals are not distorted or interfered with during transmission. A physicist cannot recreate Einstein's imaginary experiment. Too many things have to be added, improvised or assumed. And even if he succeeds in performing something along the lines of Einstein's prescription, the result would not prove anything about simultaneity or demonstrate that this method of defining it is useful or necessary.

Einstein's definition of simultaneity is not a convincing example of operationalism in action. Even less so are other facets of special relativity. In fact, Einstein has on most occasions shown a complete disregard for the thesis that a physical quantity should be defined by the method of measuring it. An excellent opportunity to apply this thesis presented itself when he introduced the constancy of the velocity of light into his theory. Do we find anywhere in Einstein's work an operational definition of the concepts of velocity, constant velocity, velocity of light? Instead of proceeding from a firm empirical basis where it is obviously possible to do so, Einstein uses a metaphysical device. He postulates the concepts he needs. A postulate is an a priori assumption or, in terms of the philosophy of operationalism, a meaningless gesture. A complete lack of operational methods is a characteristic feature of other parts of special relativity and particularly also of general relativity.

Einstein uses the motion of light in order to synchronise the motion of clocks, but neither the former nor the latter is properly defined, nor is the concept of motion in any way operationally established. For the definition of motion Einstein would need a clock, and for the definition of a clock Einstein would have to analyse motion. We have before us a typical circular argument which cannot be resolved by operational definitions alone or by purely empirical means. The only way out of this dilemma is by assigning physical meaning to a common, primary, simple, elementary, unanalysable and qualitatively unique principle to both clocks and motion. And this is what has been done and what has proved immensely successful and absolutely indispensable in measuring physical quantities and describing physical reality. The unique qualitative principle is known as time. Metaphysically speaking time is an a priori concept. Why should time be acceptable a priori and not Einstein's clocks and Einstein's velocity of light? The answer is simple: clocks and the velocity of light are not primary and elementary operational devices, quantities or concepts. They are not simple. They are compounds of analysables and unanalysables. They can be, and are, physically and conceptually dissectible into simpler entities, and the simpler entities can be used to define or to construct practically all physical quantities.

With the postulation of time physics comes face to face with metaphysics. But this is unavoidable and there is nothing wrong with it as long as the ultimate concepts are genuinely no further analysable in terms of empirical methods. Technically speaking, Einstein's approach is the same. He has also reached the interface with metaphysics by introducing postulates, indeterminate devices called clocks, and undefined actions by observers called synchronisations. But, in fact, his postulates, devices and actions are still far away from the real interface with metaphysics. And the result is that Einstein is offering a metaphysical approach where physical methods are still valid and necessary. If anyone wants to believe, and the emphasis is on belief, that Einstein's unanalysables are plausible and physically sound, so be it. But the belief must be genuine and consistent, and not arbitrary and spasmodic. It must be associated with an undeviating and complete eradication of the concept of universal time from physics. Has this happened? Have relativists displayed any desire to remove the concept of time from their conceptual framework? Have they practised what they preach? The answer is no. Absolute physical time has remained completely unaffected by relativistic metaphysics. The whole of mechanics, nay physics, is still solidly based on the a priori concept of constant and immutable time, and Einstein and his followers have used and are using it continually. It should no longer be necessary to repeat that Einstein's light postulate and definition of simultaneity are meaningless without the concept of absolute time.

To say that time does not exist, but time measurement does, is either an empty phrase or a contradiction. The numbers which represent clock readings always have a specific quality attached to them prior to the measurement. Clocks do not produce pure numbers which are subsequently interpreted or classified. A clock is constructed and used with a specific and clear objective in mind before any measurements are made, and once measurements are made they do not require any interpretation. Meaning is assigned to all phases and factors involved in a measurement because without assigning meaning there would be no point in carrying out the measurement. The physicist does not read clocks in order to discover or synthesise the concept of time, but to determine quantitative points in time whose existence has already been accepted.

The result of a measurement is never a pure number. It is a number of something. In the case of clocks it is an instant of time, and the quantity of time between two instants is an interval or a duration of time which is conventionally measured in seconds. Einstein has no hesitation in using the time unit designated "second". He is thus indicating that he is accepting the aprioristic meaning assigned to clocks and clock readings, namely that they measure constant and immutable time. It is quite improper to pretend that they measure nothing, or perhaps velocities, or something else. Clocks are instruments constructed and used for the explicit purpose to provide a sequence of identifiable subdivisions in the flow of Newtonian time. Clocks can be of various types and precision levels, but this does not alter their purpose or affect the nature of time. On the contrary, it lends additional support to the general applicability of the Newtonian concept. Absolute time has been so effective and reliable, as well as inescapable, in science and our lives that it is plainly not enough for Einstein to come along and to say that he does not believe in it. An entirely different approach and a considerable amount of hard evidence is required in order to convince us of the irrelevance of the absolute time concept and the need to discard it.

Up to this point Einstein's argument dealt with the synchronisation of two stationary clocks, that is, with clocks in a state of rest relative to each other. A new twist is introduced into the problem of synchronisation by considering a stationary and a moving clock. It must be understood that Einstein's train of thought is already attempting to proceed on a track which is different from that of classical physics. It is supposed to be consistent with his two postulates and his definition of simultaneity. Although Einstein's language appears to be using the same vocabulary as the language of classical physics, the meaning of some words and phrases may be different and one has to be aware of it. For instance, Einstein has changed the status of time from a priori to a posteriori. But he continues to use the word "time" as if nothing has happened. Only when we explicitly separate time from motion or clearly imply that time is elapsing without any motion taking place, will the relativist point out that we have got our facts back to front. We are not permitted to assign either distances or times to signal journeys or to assume that Einsteinian systems require space and time in order to exist.

When we deal with a stationary situation, the effects of Einstein's definition of clock synchronisation coincide with classical physics because transmission times and distances in both directions are, in actual fact, equal. If, however, one of the two systems is stationary and the other in motion, then, according to Einstein's rule, the clock in the moving system cannot be synchronised with the clock in the stationary system, but the clock in the stationary system can be synchronised with the clock in the moving system. If both systems are in motion, clocks cannot be synchronised. The reason for this strange behaviour of simultaneity is the peculiar formulation of Einstein's prescription and his blanket prohibition of analysing the signal paths and the velocity of the moving system in terms of rigid space and universal time.

If we try to apply Einstein's prescription to two systems in relative motion, each with one clock attached to it, we are faced with a fundamental difficulty. According to the relativity postulate it should not matter which of the two systems is in motion and which is at rest. But the prescription cannot be used unless the state of motion or of rest of each participating system is specified. Instead of the symmetrical and reciprocal relationship between two systems demanded by the relativity postulate, the imposition of Einstein's simultaneity rule leads to an asymmetrical and non-reciprocal relationship. The rule says that *the "time" required by light to travel from A to B equals the "time" it requires to travel from B to A* (Einstein). In order to comply with this condition when two clocks are in a non-stationary relationship the clock reading associated with signal emission must be effected by a stationary observer and the clock reading associated with signal reflection will then be done by a moving observer. If the clock associated with the observer who initiates the synchronisation procedure by light signals is not stationary, the forward and return journeys of the signal represented by the clock readings will not be equal, and this means that Einstein's prescription cannot be complied with. Einstein does not enlighten us as to the consequences of an inability comply with his prescription. Three interpretations are possible. Either it means that a state of non-simultaneity exists for the moving observer, but not for the stationary one, or the theory just does not apply in the same way as it does not apply to accelerated motion, or the situation is relativistically meaningless and therefore non-existent. Of course, all three interpretations are absurd, but Einstein remains silent on this point.

In order to use his synchronisation prescription in respect of systems in motion and produce his "proof" of remote non-simultaneity, Einstein has to perform the following contortions: (a) break his own relativity postulate and use a Newtonian non-symmetrical situation in which one system is resting in absolute space and the other is moving in relation to it; (b) base his argument on two systems which are not co-ordinate systems he talks so much about, but rigid distances of two points, i.e. lines presented as rods or bars in order to give them a physical appearance; (c) assume that the axes of the two systems are physically overlapping, i.e. that the moving system is parallel to the stationary system and in actual physical contact with it; (d) apply his synchronisation procedure for adjoining clocks to technically "remote" clocks and stretch its meaning so that it becomes applicable to two clocks or a clock and an event "at the same place" when one of the two things is stationary and the other moving; (e) introduce, despite the close contact of the two rods, the peculiar and entirely hypothetical method of "viewing" the length of the moving rod in the stationary system; (f) provide observers with blinkers and instruct them to interpret light paths as either times or distances; (g) reveal that one particular light path in the wholly fantastic and contradictory set-up is to be interpreted as length contraction; and finally (h) break his own light postulate by making the velocity of light additive when it suits him.

All these ingredients can be found in Einstein's second thought experiment, the rod experiment, which, in contrast to the first thought experiment, is completely fictitious. It cannot be carried out at all and has no connection with practice and physical reality. The synchronisation of clocks by light signals can be considered as a quasi-physical procedure, and it is at least possible to execute some synchronisation of clocks by light rays in reality. The rod experiment, however, is pure pseudo-science and unadulterated fantasy. The "viewing" of measurements in the other system, for instance, is an Einsteinian invention which belongs to the realm of fiction. However, it is accorded a decisive role in special relativity, despite the fact that Einstein does not make even the slightest attempt to describe his method and to show that it is, even in a very remote way, a possible and practical method and not just a fairy tale. Unfortunately, the rod experiment, and not the Lorentz transformation or anything else, represents the central core of the whole relativistic edifice and it is, therefore, necessary to look at the experiment in detail.

In the first act of the rod experiment the length of a Newtonian *stationary rigid rod* is measured *by a measuring-rod which is also stationary*. The result of this measurement is called the "length of the rod in the stationary system". In the second act *uniform motion of parallel translation with the velocity v* is imparted to the rod together with the measuring-rod along the longitudinal axis of the rod. During motion the superobserver, who cannot be anyone else but Einstein himself, *measures the length of the rod directly* *by superimposing the measuring-rod, in just the same way as if all three* (i.e. the rod, the measuring-rod and the observer) *were at rest*. The result of this measurement is called the *"length of the rod in the moving system"*. Einstein says that in accordance with his relativity postulate the length of the rod in the moving system must be equal to the length of the rod in the stationary system. Of course, the two measurements are considered equal also in Newtonian physics. The equality of the length measurements is not questioned. What is questioned is the use of the designations "stationary" and "moving" without defining them and providing a reference frame for them. And, of course, in actual life rods cannot move in the way described by Einstein and measuring-rods, clocks and observers cannot be attached to them. A proper physical environment, which is indispensable, is missing in this case. For these reasons alone the "experiment" is, in principle, a fictitious story.

In the third act Einstein's great invention, the "viewing" of measurements in the other system, comes to pass and the mystery of length contraction is revealed. Clocks are set up along the whole length of the stationary rod, but not so close that they could be synchronised by the visual inspection method. They must be synchronised by the remote synchronisation method in order to be able to show different times. *By means of stationary clocks set up in the stationary system* and synchronised by light signals Einstein's observer *ascertains at what points of the stationary system the two ends of the rod to be measured* (i.e. the moving rod) *are located at a definite time*. There is a trick involved in this operation. The prescribed use of the remote synchronisation method within the stationary rod presupposes the existence of non-simultaneity, i.e. the consequence to be "proved" is postulated as an implicit assumption. But Einstein is not embarrassed by any petitio principii, he thrives on them. By measuring the light path between two clocks in the stationary system corresponding to the front end of the moving rod at the instant of light emission and to the rear end of the moving rod at the instant of light receipt, and interpreting this light path, measured in clock readings, as length, Einstein makes his observer "discover" that *the length of the moving rod in the stationary system* is shorter than the length of the moving rod in the moving system measured in the second act. Einstein thus introduces, in the course of an entirely imaginary procedure, a physical phenomenon, namely length contraction, which is at a later stage of the argument announced to be the physical effect of his transformation, a mathematical formula which is derived from a peculiar interpretation of the rod experiment in which the same effect is read into hypothetical measurements by a hypothetical observer using a hypothetical method.

In the fourth act of the rod experiment clocks are placed at the two ends of the moving system *which synchronise with the clocks of the stationary system* as a result of the use of the visual inspection method. At this stage things are liable to become confused if we do not exactly distinguish observers at certain places in both systems, what they "view" in their own and the other system, and what clock readings they use to draw their conclusions. In actual fact, the conclusions can only be drawn by a superobserver who is looking at the whole situation from outside and who is specifically selecting and arranging his observations in such a way that he must draw the conclusions he wants to draw. The sequence of implicit inferences is as follows: (a) there are several clocks in the stationary rod, synchronised by the light ray method; (b) clocks at the ends of the moving rod are synchronised by the light ray method; (c) if the clocks in the moving rod are compared with clocks in the stationary rod which are "at the same place", using the visual inspection method, it will be found that the stationary clocks are not running synchronously from the point of view of the moving rod. Einstein triumphantly declares: *Observers moving with the moving rod would thus find that the two clocks were not synchronous, while observers in the stationary system would declare the clocks to be synchronous. So we see that we cannot attach any absolute signification to the concept of simultaneity.*

It is needless to say that Einstein's conclusion is completely arbitrary, misleading and unfounded. It rests entirely on the belief that time is not universal and that the length of a moving object sustains a mysterious and unexplained change along its axis of motion when observed from a stationary position. Physical causes and a physical environment are excluded from any consideration, but the physical effects of the two beliefs must be considered as real. The measuring-rod and the observer travelling with the moving rod are also contracted when "viewed" by the stationary observer, but within the moving system the contraction is either non-observable or non-existent. One cannot help noticing the analogy between Einstein's belief system incorporated in his rod experiment and the set of ideas expressed in the Lorentz-Fitzgerald contraction hypothesis.

In fact, if the essential features of the Michelson-Morley experiment are combined with the Lorentz-Fitzgerald explanation and described from the point of view of a hypothetical outside observer who is resting in absolute space, we have a replica of the essential features and explanation offered by Einstein in his rod experiment. The Earth is Einstein's moving system and the moving rod is the longitudinal arm of the Michelson-Morley apparatus. The Michelsonian observer knows that his system is moving, but when he tries to measure his motion with the aid of light, he does not obtain the expected result. The Lorentzian observer then explains to him that this is due to length contraction in the direction of motion which exactly counterbalances the expected result. The Einsteinian superobserver combines the Michelsonian and Lorentzian viewpoints by positioning himself outside the moving system in absolute space and "observing" the length contraction. The explanation, epitomised in the Lorentz factor, is the same.

Relativists frequently assert that the Einstein contraction and the Lorentz contraction are qualitatively different because Lorentz and Fitzgerald operate within the classical framework of absolute space and time and Einstein supposedly does not. Despite all the protestations and statements to the contrary, Einstein operates in this instance and whenever he finds it necessary just as much within the classical framework of absolute space and time as Lorentz and Fitzgerald. The Einsteinian stationary observer in the rod experiment is based solidly on absolute space, the motion of the moving rod is related to absolute space, and the composition of the velocities of light and the moving system is expressed in units of absolute space and time.

Einstein's beliefs are embodied in two equations which are meant to reflect the conclusion reached in the final act of the rod experiment. The first equation says that the period of time, in terms of clock readings in the stationary system, between signal emission simultaneous with the front end passage of the moving rod and signal reflection simultaneous with the rear end passage of the moving rod is equal to the presumably contracted length of the moving rod divided by the velocity of light minus the velocity of the moving rod. The second equation says that the period of time between signal reflection and signal return to its original point of emission is equal to the presumably expanded length of the rod divided by the velocity of light plus the velocity of the moving rod. These are two strange equations. One peculiar feature of them, which has already been alluded to, is that they express the observations of a superobserver which is not supposed to exist in the theory of relativity. They summarise results if observers in the stationary system synchronise their own clocks by the remote method and then synchronise their clocks with the clocks in the moving system by the visual inspection method, and if observers in the moving system synchronise their own clocks by the remote method and then try to synchronise them with the clocks in the stationary system by the visual inspection method. In other words, Einstein is using the remote method to reconcile local time, and the local method to reconcile remote time. The time relationship within the systems is one of remote time, and between the systems it is one of local time. This is exactly the opposite of what relativists actually teach.

The equations indicate that the significance of the rod experiment revolves around unilateral light path interpretations made by observers in the two systems. The stationary observers "view" a length contraction in the moving system, and the moving observers "view" a time dilation in the stationary system. This, in itself, is an illegitimate procedure because it is non-reciprocal and clearly violates the relativity postulate. But this is overlooked, and the length of the rod used in the equations is *the length of the moving rod—measured in the stationary system* (Einstein). In other words, the moving rod is presented as a contracted or expanded rod. In this way a hidden, subjective and unsupported presupposition is introduced into the mathematical apparatus of relativity and made an integral part of what becomes later its "physical" meaning.

Finally, the length of the moving rod is divided in the first equation by the difference, and in the second equation by the sum, of two velocities: the velocity of light and the velocity of the moving system relative to the stationary system. Here again the situation is described in terms of what can be seen only by a superobserver. The forward journey of a light signal in the moving system proceeds in the opposite direction to the motion of the system and, from the stationary observer's point of view, the value c–v is allocated to the combined velocity. The return journey of a light signal proceeds in the same direction as the motion of the system, and the value c + v is allocated to the combined velocity. This is again and quite clearly an illegitimate procedure. The aditivity, or subtractivity, of the velocity of light contradicts the empirical evidence of the Michelson-Morley experiment and violates Einstein's own light postulate which says that the velocity of light is independent of its source. Under no circumstances is an Einsteinian observer permitted to measure or use velocities in which the velocity of light is combined with the velocity of its source. Yet Einstein does exactly that without blushing. Such disregard of empirical evidence and inconsistent application of principles on the part of any other physicist would be severely objected to and condemned. But Einstein is not only let off without even a slight reprimand, he is praised for his "deep insights".

The rod experiment does not offer any metaphysically worthwhile, empirically meaningful or mathematically promising ideas leading to a potential enrichment of knowledge. When all is said and done, the whole contents of the rod experiment can be reduced to a physically not uncommon situation in which two motions of different magnitude interact in a particular way: one motion proceeds steadily in one direction, while the second motion is periodically changing its direction and is at the same time remaining associated with the first. In Einstein's scheme the steady motion is that of the moving rod and the reversing motion is that of the light signal within the moving rod.

There are several instances in which the two-motion situation has achieved "historical" fame, for instance: (a) Fizeau's experiment to determine the velocity of light in a moving liquid; in this experiment the constant motion was that of light and the reversing motion was that of the liquid, and (b) the Michelson-Morley experiment; in this case the constant motion was the motion of the Earth and the other motion was the motion of light. A paper by Voigt, published in 1887, which has been mentioned earlier as one in which the Lorentz factor makes his first known appearance, also deals with two motions. The constant motion is represented by a radiating surface, while the reversing motion is the wave propagation in an elastic medium. Perhaps it is also worth mentioning that the two-motion situation sometimes arises in high school physics when the problem is to determine the time required to swim a specific distance upstream and downstream in a flowing river, or across the river. In all these cases the physical circumstances are very similar and the solution of any problems associated with two motions does not present any difficulties.

The so-called "contradiction" between the two Einsteinian equations will disappear if we recognise that they represent nothing more than the separate reverse and advance sections of a secondary motion which is associated with a steady primary motion, and that the Lorentz factor which can be derived from the situation has a perfectly Newtonian explanation.

Einstein's rod experiment appeared in 1905, but it was not easy to understand and, in particular, it was unrealistic and unconvincing. In his later expositions of relativity Einstein replaced the rod experiment with the train experiment. To demonstrate that two events which are simultaneous in one system are not simultaneous in another system, which is in a state of motion relatively to the first, Einstein uses two strokes of lightning, or two light flashes, and two observers located exactly halfway between the flashes, one on a moving train and the other on the non-moving embankment next to the train. Einstein says that the observer on the embankment will perceive the two flashes simultaneously, while the observer on the moving train will experience the same flashes successively. The flash coming from the direction in which the train is moving will be seen by the train observer first. In Einstein's opinion this thought experiment adequately illustrates the point that what is simultaneous for a stationary observer is non-simultaneous for an observer in motion, and vice versa.

If Einstein's train experiment illustrates anything at all, it can only be one thing, namely that in the assessment of perceived phenomena a differentiation is necessary between what is real and what is apparent, and that some sense impressions, particularly when considered in isolation from an integrated sequence of events, are not a reliable guide to what is actually happening. The problem is, of course, not a critical one and can be easily overcome by using the power of reasoning. We all know, for instance, that lightning and thunder rarely coincide as far as our sense impressions are concerned. A simple reasoning, however, indicates that this is only an apparent effect resulting from the different velocities of light and sound. Einstein's train experiment does not in any way prove, demonstrate or support the assumption that universal time, and therefore universal simultaneity, does not exist or that there is even the slightest doubt concerning its existence.

The train experiment is not only ineffectual as far its intended purpose is concerned, it is also logically and empirically invalid. A human observer in the train could not possibly perceive the flashes successively unless, of course, the train were travelling with a speed of the order of 100,000 km per second or the flashes were 100,000 km or so apart. This is due to the fact that the human senses cannot distinguish durations which are less than about one-tenth of a second. Relativists may say that this is not a valid objection and that there are instruments which could measure considerably shorter periods. Certainly, there are instruments, and the instruments would measure not only the exact times when the flashes are received with great precision, but also compute the speed of the train in relation to the light sources by analysing the Doppler effect and provide much more information. Without fail, and without any human limitations and optical illusions, they would determine the exact times when the flashes occurred and tell us objectively whether they were simultaneous or not. The only restriction which would have to be accepted would be the technically attainable level of chronometric precision. So what does Einstein's train experiment establish or exemplify? Nothing which is even slightly contrary to classical physics.

It is not only the physical interpretation of the train experiment which is wrong and must be seriously challenged, Einstein's methodological approach is equally bad. It is slipshod and non-scientific. For instance, how does the observer on the train exchange information with the observer on the embankment? Without such exchange and a confirmation that the two are referring to the same event, or sequence of events, the fact that there is a difference in the sense impressions of the same flashes will never come to light. How do the observers know where they are located in relation to the flashes? If the procedure is to produce the desired effects on the two observers, they must somehow know that they are halfway between the flashes. Otherwise, they will adopt different interpretations. The observer on the embankment will say: I have perceived the flashes simultaneously, therefore I must be halfway between them. And that is all he would conclude. It is also almost certain that the observer on the train, should he really perceive two successive flashes, would quite correctly argue that they must be non-simultaneous, and they would really be non-simultaneous. He does not require much physical training in order to conclude that the probability of any two simultaneous flashes producing the effect he is experiencing is practically equal to nil. Can the train experiment under these circumstances be considered as methodologically sound? Yet, incredibly, Einstein believes that his procedure *supplies the physicist with the method by means of which he can decide by experiment whether or not both lightning strokes occurred simultaneously*. Einstein is obviously preaching to the converted, and they do not require plausible reasonings or proper physical procedures.