

RELATIVITY AND TIME SIGNALS

I would like to comment on the article by Essen on relativity and time signals in your issue of October 1978. I would like first to say that Dr Essen is quite incorrect in saying that "No one has attempted to refute my arguments." A number of refutations have been provided, over more than two decades, including for example a letter written by myself in *Nature* in 1957 of which I enclose a reprint. Furthermore, Dr Essen came himself to this Department in November 1968 and he and I debated the problem with an audience of students. During this debate I gave a detailed and calculated refutation of his thesis. The problem is not that there has been no answer to his arguments, but that he has failed to understand the answers which have been repeatedly given.

In each case the main discussion was concerned with the "twin paradox"; according to Einstein's theory of one pair of twins who remains on earth will have aged more by the time they meet than one who travels fast to a distant point and then returns. Dr Essen's statement that the Einstein theory implies that more ticks are transmitted than received by either Traveller or Stay-at-home, each of which has with him a clock ticking at a standard rate, is nonsense. One of the ways of refuting Dr Essen's arguments is to show that if Traveller goes at very high speed from earth to a distant point, turns round in a short period and returns at the same high speed, his clock will in fact have ticked fewer times than has the clock on earth which is operating throughout Traveller's journey. The fact that all ticks emitted by each individual are received by the other is the solid evidence for the asymmetry of ageing. There is of course no *a priori* reason for assuming symmetry of results; one twin has never accelerated and the other has suffered a major acceleration on starting and a major deceleration and re-acceleration at the goal. The asymmetry is clearly shown by an extreme example. If Traveller moved at such a speed that he took only an hour longer to reach Sirius (a distance of 12 light years from Earth) than a beam of light would have. Stay-at-home will observe his recession not just for 12 years + 1 hour but for an hour more than 24 years since Stay-at-home will see Traveller's arrival and deceleration 12 years, in earth time, after it actually occurred. Stay-at-home will watch Traveller's return from a distance of 12 light years for a period of only one hour since Traveller will arrive at earth only an hour behind the light emitted from Sirius at the time of his turnaround. If Traveller is broadcasting the ticks of his clock during his outward journey these will be returning to earth at a very much slower rate owing both to the Doppler effect and to the relativistic differences of the rate of the clocks. This slow rate will be observed by Stay-at-home for 24 years and an hour. During Traveller's return the rate of receipt of ticks on earth will be enormously greater but this very much greater rate will be observed for only one hour.

The observations of Stay-at-home's clock by Traveller, however, are quite different. From Traveller's point of view the amount of slowing down of the ticks from Stay-at-home's clock during the earth's recession from him will be identical with the slowing down observed by Stay-at-home during Traveller's recession. On Traveller's return, similarly, when he sees the earth approaching him rapidly Stay-at-home's



clock will appear to him speeded up by just the same amount as Traveller's clock had appeared to be speeded up as seen by Stay-at-home.

Now, whatever the time may be which is recorded by Traveller on his outward journey*, i.e., the time that it appears for him for Sirius to reach him, exactly the same time period will be recorded by Traveller for the earth to reach him on the return journey since at the moment of his deceleration when he is stationary with respect to Sirius and to earth, the distance away from earth will clearly appear to him identical with the apparent distance of Sirius from earth just before he started.

Accordingly, while Stay-at-home saw a slow tick rate for a very long time and a fast tick rate for a very short time Traveller sees the slow ticks and the fast ticks from earth for equal times and the total number of ticks received will therefore be very much greater. For ticks we can read heart-beats, and accordingly Stay-at-home and his clock must have aged more than for Traveller and his clock. It is easy using Einstein's equations to work out exactly both these times and the total number of ticks in each case but even without this it is evident that the experiences of the twins are not symmetrical and that there is no reason at all to suppose that they should have aged by equal amounts.

Finally, it should be pointed out that we have found experimentally that a fast moving particle which in the laboratory frame moves away at high speed and then returns will appear to age very slowly. π mesons that revolve in a big accelerator at speeds approaching that of light do, on the average, survive for a very much larger number of rotations and do show a half-life for decay very much longer than do similar mesons which remain more or less stationary in the laboratory. It is thus quite certain that

*38 hours. This time is easily calculated. All parties to the controversy – so far as I know – accept that objects moving fast with respect to an observer will appear to that observer to be reduced in length along the direction of motion – the Fitzgerald-Lorentz contraction. The amount of this is: $\sqrt{(1-v^2/c^2)}$ so that the case under consideration where $v=c(1-1/(12 \times 365 \times 24))$ or $v=9.5 \times 10^8$ c, the contraction is to $\sqrt{(1.9 \times 10^{-7})}$ or 0.0044 times the original length. Accordingly, while Traveller is in transit, the dimensions of the Universe along the earth-Sirius line is reduced by this amount and to him the earth-Sirius distance is only 0.0044×12 light years, or 38 light hours. Accordingly, Sirius which is approaching him at nearly the speed of light, will reach him in about 38 hours and earth will require a similar period to return to him after his retardation and re-acceleration.

the universe does not give a symmetrical answer to the twin paradox whatever Einstein or Essen may theoretically predict. Since I find no difficulty in calculating the increased half-life of the π mesons by using exactly the same Einsteinian formula as I would have in finding the age difference of the twins, I am also convinced that Einstein's theory is correct and Essen's theory is wrong.
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MEDIUM WAVE SPURIAE

After the medium-wave frequency changes on 23rd November 1978 I noticed an "extra" BBC Radio 1 signal on 720kHz; careful listening revealed that Radio 2 was in the background, obviously indicating an intermodulation product of some sort. A further spurious signal was discovered on 963kHz consisting of Radio's 1 and 3. The prime suspect was of course the receiver, but after various checks with attenuators and retuning, trying another receiver and getting other people to try with their own receivers in different locations, it seemed likely they were transmitted spuriae. This impression is reinforced by the fact that the two frequencies can be explained by simple intermodulation of the Brookmans Park transmitters:

$$720\text{kHz} = 2 \times 909\text{kHz} (R2) - 1089\text{kHz} (R1) \\ \text{and}$$

$$963\text{kHz} = 2 \times 1089\text{kHz} (R1) - 1215\text{kHz} (R3)$$

A telephone call to the BBC Engineering Information Department on 28th November indicated that they were well aware of these problems and that other people had reported them. I was told the problem stemmed from the fact the transmitters and aerial arrays were all new and that these unwanted interactions would be resolved as soon as possible. While I appreciate there may be considerable practical difficulties in curing this effect the fact remains that over two months later the spuriae are still being radiated. A second telephone enquiry to the BBC (E.I.D.) in mid-January revealed a very different attitude. While they were aware of the situation they had not been notified of it by any "official" body and until they were it was unlikely that anything would be done. This seems a somewhat regrettable attitude for two reasons. Firstly the signal on 720kHz especially is quite strong and the medium-wave band is sufficiently congested without spuriae of this magnitude. Secondly the BBC has always set extremely high engineering standards which are the envy of the world and it seems sad they should fail so noticeably in their country's own capital.

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The BBC comments:

The changes we made on November 23rd involved the commissioning of many new transmitters and aerial systems. At stations where several programmes are radiated at high power, it is not always easy to avoid combinations of this kind. We are now engaged in a tidying-up and fine tuning operation at all of our transmitting stations, in the course of which these two spurious emissions will be eliminated – or at least reduced to an acceptable level.