Answer to Professor Mückenheim

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1. In his formulas (1), (2) and (3) Prof. Mückenheim does not reckon with some important relativistic effects, which causes that his argument and conclusion lack cogency in a relativistic situation. Because being "parallel" and, therefore, also "orthogonality" and "projection" are not independent of the inertial system considered (see below), it is necessary to give a more detailed analysis than my opponent does.

2. Consider figure 1 in which the x, y and ict axes have been drawn. Arrow P moves relativistically at a velocity v in the x-direction and also at an infinitesimal velocity in the y-direction $(1 - \frac{v^2}{c^2})^{1/2} = 1/2$. If A is the back end and B the point of P the worldlines of A and B are ACA_2 and BDB_2, respectively. If in the inertial system $S(x, y, o, t)$ of the wall plus opening with edges C and D ($CD = 50$ cm) P is continuously situated parallel to the wall, A will pass C (in the y-direction!) *at the same moment* (for S) at which B passes edge D (in the y-direction) because in S the length of P is P's rest length 100 cm times $1/2$, that is, 50 cm. For what would be the meaning at all of AB being shortened to 50 cm and AB also being in a position parallel to the wall – that is, to CD – if we could *not* say that at the same time at which A is at C, B is at D? In turn, this implies that AB can pass CD *in the y-direction* at that common moment. (At the moment of passage (viz. $t = 0$) A and B both satisfy $y = 0$ in S).

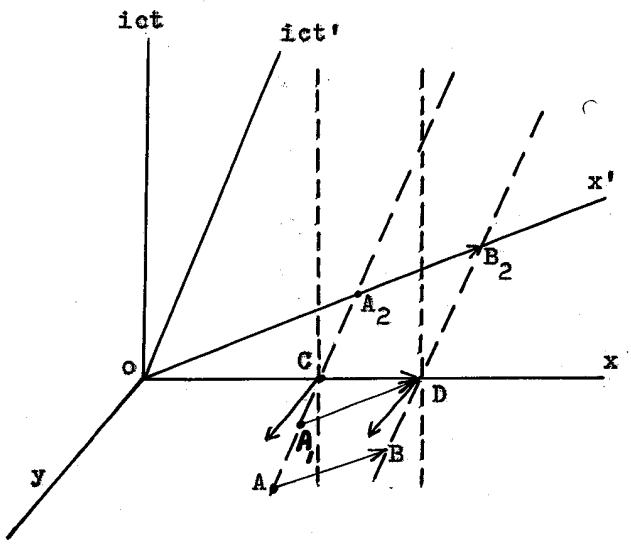

Figure 1. Diagram of the behaviour of the arrow with respect to opening CD.

3. An important point making the above formal relativistic argument also acceptable to our intuition and imaginative faculty is the following. Consider the course of events from the standpoint of an observer O at rest with respect to arrow P in its inertial system S', and at his time $t' = 0$, which we take to be the moment at which point B passes D in the y-direction (in our direction). Then, at $t' = 0$, A did not yet arrive at point-event C of its worldline (that is, A did not yet arrive at the wall) because it is only at A_1 since A_1 and D are simultaneous in S' and as drawn in figure 1. For O back end A has yet to cover section A_1C of its worldline before arriving at C, at which A passes the wall, *after* point B did so at D. During the period in which A progresses from A_1 to C, aperture CD moves some distance to the left for O so that A can indeed pass via C : its worldline passes C in both S and S', of course.

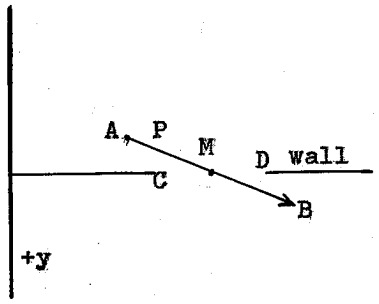

Figure 2. Sketch of the "now" situation for observer O travelling with arrow P, at half-way during P's passage.

4. Figure 2 can elucidate the situation further. It sketches how it is experienced by O at the moment (for him) at which the centre M of AB passes the aperture in the y-direction. Then, B did already pass edge D, but A did not yet so with respect to C. During the *finite* period for O in which AB passes CD in the y-direction, and that corresponds to the period in which A covers A_1C in S, CD is rapidly moving to the left for O. This explains how "his" AB of 100 cm can indeed pass CD that for him is only 25 cm because of the factor $(1 - \frac{v^2}{c^2})^{1/2} = 1/2$.

Mind here that an S-observer could only see P's front and back end *simultaneously* pass D and C, respectively, (in the y-direction) because his idea of simultaneity is different from $O's$. For O the two passages are not simultaneous point-events. In figure 2, C and D as drawn are simultaneous for O, as A and B and the whole plane $x'y$.

5. Finally note that the additional movement of P also in the y-direction causes that as soon as AB is parallel to the wall and to CD for an S-observer it is *not* parallel to the wall for O in S' *in consequence of the difference as regards simultaneity between* S *and* S'. By the way, we see from this how such difference plays a very realistic role in how an S-observer and an S' one experience the course of events.

(Manuscrit reçu le 12 janvier 1992)