Reply to referee report #2

(SZABO: On the meaning of Lorentz covariance)

Taking into account of the referee reports, I have made important changes in the manuscript. However, there is no change in the main message of the paper. In this reply, I am reflecting to all of the referee's remarks and criticism, even if the corresponding passages have been rewritten or removed from the text.

> *"The main source of confusion is that it is sometimes thought that the Lorentz transformations, and the relativity principle, say something about what happens when a physical system that is at rest in system K is accelerated in such a way that it becomes at rest in another system K'. However, the Lorentz transformations say nothing about this. These transformations are only about the relations between systems that already were at rest in K and K', respectively; and that are in the same conditions as judged from their respective rest frames. ... It is not at all guaranteed, for example, that a measuring rod, when accelerated to velocity v, will become Lorentz contracted.*"

I think, the above passage expresses the most crucial point of the referee's position, and explains his or her disagreement with my claims.[1]

First, I would like to unpack the meaning of the referee's following sentence: "*These transformations are only about the relations between systems that* ***already*** *were at rest in K and K', respectively; and that are in the same conditions as judged from their respective rest frames.*" Let us postpone the investigation of the second part of the sentence, with respect to the problem of when the systems are 'in the same conditions' in two different reference frames, and focus on the meaning of the expression "*systems that already were at rest in K and K'*".

(a) Does it mean that the systems in question are such that they have been at rest relative to the corresponding frames for a long while and they have already unlearned the initial conditions, at least in some of their (equilibrium) properties,

[1] Note that this claim of Referee#2 is definitely in contradiction with the following statement of Referee#1: "*Certainly the Lorentz boost of a complicated system will be complicated. But just remarking that it is hard to analyze is no reason to doubt that it represents the original system set into uniform motion.*"

So one referee criticizes my position by saying that the Lorentz boost *always* describes the system set into uniform motion, while the other referee criticizes my claim by saying that it *never* does.

In contrast, my claim is that the situation is more complex: As it turns out from the examples in the manuscript, the Lorentz boost *sometimes* does correspond to the original system set into collective motion, *sometimes* does not, depending on how the system was actually set into motion and on the further details of the dissipation-relaxation processes.

and we consider the Lorentz transformations only for these equilibrium properties? If so, then why does the referee disagree with my entirely similar claim that the relativity principle is valid only for the equilibrium properties of dissipative systems?

(a) Notice that we do not need such a restriction with respect to the validity of Galilean principle of relativity. Consider an arbitrary motion of a system of classical particles in K:

$$t \mapsto \begin{pmatrix} \mathbf{r}_i(t) \\ \frac{d\mathbf{r}_i(t)}{dt} \end{pmatrix} \tag{1}$$

Set the same system, as a whole, into motion at constant velocity $\mathbf{V}$ relative to K:

$$t \mapsto \begin{pmatrix} \mathbf{r}_i(t) \\ \frac{d\mathbf{r}_i(t)}{dt} + \mathbf{V} \end{pmatrix} \tag{2}$$

The behavior of the collectively moving system (2), expressed—through the Galilean transformation—in the terms of space and time coordinates of K' has the same form as (1), no matter whether the system is in an "equilibrium state" or not, and no matter how long "the system has been moving together with K'"—if there is any sound meaning of this frasephrase at all, in general.

Let me turn now to the second part of the referee's statement. If I well understand the referee's position, it is claimed that one is always capable to know which state of the system (set of conditions) in K' corresponds to a given state of the system in K without performing the real (physical) acceleration of physical objects from one system into the other. This is however a methodological nonsense. If we want to regard Lorentz transformation (I mean just the transformation rule between the space and time tags measured in K and K') as an empirically confirmed hypothesis, we cannot avoid such an acceleration of the standard meter stick and the standard clock from K to K'.

Finally, let me briefly reflect to the referee's following remarks:

"Moreover, it also discusses examples that are irrelevant to the questions under discussion (like the transformation of the motion of a set of points that start simultaneously in K and not simultaneously in K′)."

I don't think that the examples were irrelevant. Although my final conclusion is different, my examples are practically nothing but the ones which were hotly discussed between 1959 and 1972 in the American Journal of Physics and which were also analyzed by Bell in his "How to teach special relativity". (In the new version of the manuscript I use explicitly these examples.)

As for the referee's example in the brackets, does the referee mean that the transformation of the initial conditions is "irrelevant" from the point of view of special relativity principle? If so, then—in conjunction with the fact that the Lorentz transformation changes the initial conditions in such a way that cannot be, in general, regarded as a simple 'setting into collective motion'—it means that Lorentzian relativity principle is valid only for those features of (dissipative) systems in which the system unlearns the initial conditions. Why does the referee then disagree with my entirely similar claim?

I hope that this reply made my position more clear and acceptable for publication—even if there have remained several points where the referee has different views.