Comment on "Misconceptions Regarding Conventional Coupling of Fields and Particles in XFEL Codes"

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We make some observations regarding a paper by Gianluca Geloni, Vitali Kocharyan and Evgeni Saldin (2016 Misconceptions Regarding Conventional Coupling of Fields and Particles in XFEL Codes, DESY 16-017, ISSN 0418-9837).

In an outstanding paper [1], Geloni, Kocharyan and Saldin address the problem of the consistency between the assumption of a special system of reference and Special Relativity (SR) that has been defended in our previous works [2-17]. Indeed they write in the introduction of the paper that "One might be inclined to think that the concept of absolute simultaneity necessarily violates relativity, but this is not right. Minkowski space-time can be described equally well from the point of view of any spread time through space: the standard and non-standard clock synchronization reveals no deep facts about Minkowski space-time and special relativity; it is rather, a trivial consequence of general covariance". We partially agree. They continue "We may use language as we want and define a meaning for the names "synchronization", "simultaneity" and "speed" in many different ways. Reality is independent of the names we use to describe it. What really matters is that one makes sure that none of these words is used in some context and interpreted in a different one" p.5 [1]. The underlined text (our underlining) is a direct copy of a text written by us and published in our previous article "The Principle of Relativity and the Indeterminacy of Special Relativity", p. 46 [10]. However the authors failed to referred this previous work and misinterpret our affirmations, developing a conventionalist interpretation that has been explicitly rejected in this previous article. Indeed we explicitly affirm in the abstract [10] "Einstein special relativity corresponds to a simple and very elegant solution to this problem, allowing the study of relative motion without any concern with the study of absolute motion, wich is considered to be surperfluous. A large number of researchers have discussed this question, mostly within the *conventionality* of simultaneity thesis. The typical formulation of this thesis provides some new physical insight and points out the problem, but does not solve it. In contrast, it often leads to a labyrinth of difficult language wich is herein clarified". However at [1], it is affirmed differently. "In contrast, conventional coupling of fields and particles in accelerator physics codes is based on the use of results of particle tracking treated according to the absolute time convention. Here lies the misconception that led to the qualitative disagreement between theory and experiment". Absolute time convention? What the authors means about this statement? Qualitative disagreement between theory and experiment with conventionality?

At point 2 of [1] it is discussed the "conventionality in distant simultaneity". This of course has been introduced by Einstein [18, 19] and was criticized at [2, 12, 14 -16]. As usual language is fundamental to formulate the problem. We defend in our previous works that the notion of simultaneity is not a convention. Two events of two spatial points are simultaneous if they occurred at the same instant. And for the same point, eventually, we need only one clock to define simultaneity of two events. Of course if we have two clocks, the same instant, the same time, usually means that the clocks mark the same number, they are synchronized. Or the "same instant", simultaneity, usually means two different times if the clocks are desynchronized. At the same point. If we are not careful enough conventionalism can leads indeed to a labyrinth of difficult language. The implicit assumption is that we use synchronized clocks to define simultaneity and this is a convention that we accept. Operationally there is no difficulty to implement this convention for the same point as Einstein has pointed out. But this is not mandatory and this is what standard SR do, without explicating so. Indeed at the same point we can have two clocks, a Lorentzian clock and a synchronized clock. Einstein's simultaneity maintain the criterion of simultaneity with desynchronized clocks (Lorentz clocks) distant apart, the reading of the clocks marking the same number. This criterion, naturally, originates a huge terminological confusion. With this criterion if we are not aware of the meaning of what we are doing or saying the world can be seen as a bizarre world where paradoxes happen everywhere. Like the Motion Paradox [16, 20]. Or the Twin Paradox [13, 14]. All kind of paradoxes emerge (by the way this is not specific with SR since we can classically define with desynchronized clocks "simultaneity" with the reading of the clocks marking the same number as it happen in "Summer Time" change of hour, originating eventually a prejudicial confusion when we are not aware of the change of the hour). However what is emphasized in the standard special relativity formulation is the difficulty to implement for two spatial distant points synchronized clocks. Indeed SR is a theory that admits the existence of a frame where the one-way speed of light is isotropic that we call Einstein´s frame (EF) [6-8] (of course we can give other names, like Lorentz frame or Electromagnetic Field Frame but Einstein's frame seems full of physical meaning to acknowledge the problem of conventionalism and the acceptance of the existence of a physical reality, the courageous and beautiful idea of Einstein). We show earlier that this frame is unique. In this frame, since the one-way speed of light is c (the two way speed of light in every frame in vacuum), Einstein synchronization method is effective and the clocks at two separated points are synchronized. For another frame moving in relation to this frame the one-way speed of light is not c in all directions [15] and, therefore, Einstein´s method is no more effective. Therefore we obtain clocks desynchronized, Einstein´s synchronization is a desynchronization. With the same token, with these clocks, we obtain Einstein's simultaneity not simultaneity, since we define Einstein´s simultaneity with the same convention that we use for defining simultaneity – the Lorentzian clocks marking the same time (the same number) since we use the same time (the same number) with clocks desynchronized [16, 20]!

The concept of simultaneity can also be conceived in another way. Classically when a rod S´ with length l moves longitudinally through the x axis of a frame of a rod S [15, 16] we know that the extremities of the rod pass simultaneously by two points of x-axis. If we have at this two points two chronometers resected at 0 (or any other equal numbers) at a distance l when the extremities of the rod S´ pass by them the two chronometers can be activated and we obtain two clocks synchronized, if they are marking the same number [15]! This approach to conceive synchronization is equivalent to sending a signal with "infinite speed" between the chronometers [15]. This simple idea is the most primitive

notion of simultaneity that Special Relativity does not ruled out contrarily what is usually affirmed by standard formulation [13-16]. However the introduction of aether by Maxwell leads to the Fitzgerald-Lorentz contraction of the rod S´. Therefore the rod moving does not have any more the original length l in frame S. The length change with the speed in relation to EF. This is what SR preview and the operational difficulty only can be solved by the detection of EF. It is not a theoretical problem, it is an experimental problem as we explain in two recent articles [15, 16]. This cannot be solved by conventions, by manipulative language. Indeed, since Einstein´s synchronization is only effective in one frame, for another frame we don´t have the common time of the clocks at two different points [10]. We don´t know the common time. Therefore we don´t know the trajectory of the events. Our example of the F1 car criticizing the experimental work of Greaves et al. [17] perhaps help to elucidate what we mean – the trajectory of a F1 car with "speed" constant all along the track with Lorentzian-like clocks and the trajectory with synchronized clocks. Since simultaneity has a clear physical meaning, Einstein´s simultaneity has also a clear physical meaning and this physical meaning is different from the former. Therefore we don´t agree that "A convention is something wich has no physical relevance" p. 7 [1]. It is, contrarily, crucial to understand what we are saying and doing. And we don´t agree also with "According to the thesis of conventionality of simultaneity, simultaneity of distant events is a conventional matter, as it can be legitimately fixed in different manners in any given inertial reference frame" [1]. But we agree that "simultaneity", simultaneity and Einstein´s simultaneity are well defined, they are two concepts of "simultaneity" and can be legitimately fixed in two manners in any given inertial frame – We may use language as we want and define a meaning for the names "synchronization", "simultaneity" and "speed" in many different ways. Reality *is* independent of the names we use to describe it. What really matters is that one makes sure that none of these words is used in some context and interpreted in a different one [10]. We completely agree in this context [18].

"In order to measure the one-way speed of light one has first to synchronize the clocks. A clock deadlock appears if one synchronize the clocks by assuming that the one-way speed of light is c. The one-way speed of light measured with these clocks, that is the Einstein speed of light, will always be c: this is because the clocks have been set assuming that particular one-way speed in advance, it cannot be otherwise" p. 3 [1] – this is our thesis published in several previously works [7 (p.86), 10 (p.41)] based on the key concept of Einstein speed introduced by us [6-10] but the authors failed once again to reference this previous works of ours, particularly [10] that they know but not refer as we describe previously in this comment. Therefore we don´t agree that the speed of light is just a matter of convention [15] because the speed of light only depend of the distance and the rhythms of the clocks and the distance and the rhythms of the clocks has clear physical meaning and don´t depend of synchronization. This is a misconception that has originated the "relativity of simultaneity" when used out of the context, origin of several paradoxes particularly the Twin Paradox, a "never ending chronic scientific confusion" [13, 14, 21]. Perhaps now the statement "The conventional nature of distant simultaneity in special relativity is not to be confused with the relativity of simultaneity. Clearly, the conventionality of simultaneity within a single inertial frame is quite distinct from the relativity of simultaneity" p. 7 [1] can be understood. What is the context the authors are referring? Simultaneity is not relative [2-16, 20]. Einstein´s simultaneity is relative because Einstein´s simultaneity only is simultaneity in one frame, EF. This is the origin of "A Motion Paradox from Einstein´s Relativity of Simultaneity" that explains well this problem [16, 20]. But perhaps it is worthwhile to refer our explanation about clock

rhythms and time readings addressed in previous papers [12] where the physical meaning of time dilation is stated in the resolution of the twin paradox [13, 14].

The Galilean transformation has been introduced at p. 8 of [1] following another previous work that is now referred [8]. But the formal character of the transformation is emphasized in this our work [8] and has been introduced only after the introduction of the IST transformation with clear physical meaning. The crucial point is that we introduce in our previous works an intrinsic desynchronization with $t'_L = t' - v_1\, x'/c^2$, where t'_L is the Lorentz time and t' is the synchronized time at x' and v_1 is the absolute speed of S´ [1, 2-16].

From the IST transformation

$$x' = \frac{x - v_1\, t}{\sqrt{1 - \frac{v_1^2}{c^2}}} \qquad (1)$$

$$t' = t\sqrt{1 - \frac{v_1^2}{c^2}} \qquad (2)$$

Introducing at x' a Lorentzian clock t'_L we obtain from (1) and (2)

$$t'_L = t' - v_1\, x'/c^2 = t' = t\sqrt{1 - \frac{v_1^2}{c^2}} - v_1\left(\frac{x - v_1\, t}{c^2\sqrt{1 - \frac{v_1^2}{c^2}}}\right) = \left(t - \frac{v_1}{c^2}\, x\right)/\sqrt{1 - \frac{v_1^2}{c^2}} \qquad (3)$$

$$x' = \frac{x - v_1\, t}{\sqrt{1 - \frac{v_1^2}{c^2}}} \qquad (4)$$

$$t'_L = \frac{t - \frac{v_1}{c^2}x}{\sqrt{1 - \frac{v_1^2}{c^2}}} \qquad (5)$$

We obtain Lorentz transformation wich shows the consistency of special relativity with EF, as expected.

Robert B. Laughlin, Nobel Laureate in Physics, endowed chair in physics, Stanford University, had this to say about ether in contemporary physics, (https://en.wikipedia.org/wiki/Aether_theories):

It is ironic that Einstein's most creative work, the general theory of relativity, should boil down to conceptualizing space as a medium when his original premise [in special relativity] was that no such medium existed [..] The word 'ether' has extremely negative connotations in theoretical physics because of its past association with opposition to relativity. This is unfortunate because, stripped of these connotations, it rather nicely captures the way most physicists actually think about the vacuum. . . . Relativity actually says nothing about the existence or nonexistence of matter pervading the universe, only that any such matter must

have relativistic symmetry. [..] It turns out that such matter exists. About the time relativity was becoming accepted, studies of radioactivity began showing that the empty vacuum of space had spectroscopic structure similar to that of ordinary quantum solids and fluids. Subsequent studies with large particle accelerators have now led us to understand that space is more like a piece of window glass than ideal Newtonian emptiness. It is filled with 'stuff' that is normally transparent but can be made visible by hitting it sufficiently hard to knock out a part. The modern concept of the vacuum of space, confirmed every day by experiment, is a relativistic ether. But we do not call it this because it is taboo.[9]

Without the notion of Einstein's speed and intrinsic desynchronization it is difficult to understand special relativity, particularly the meaning and scope of the Principle of Relativity [10]. Einstein postulate of the invariance of the speed of light is easily accepted and seems not contradictory with the postulate of the existence of EF, where the speed of light has the value c independently of the velocity of the source. If the speed of light is c in the frame of the source than the speed of light in relation to EF must be a result of a vectorial addiction admitting that the vacuum has no effect, a particle-like reasoning has expressed [1] about Bradley reasoning about aberration. But this is conceptually wrong [21]. Therefore it is important to solve any problem in the Einstein frame transposing to the other frames using the IST coordinates and the Lorentzian coordinates. This is a trivial problem solving technique that standard special relativity avoid to use because it is taboo.

As previously affirmed the most primitive conceptualization of simultaneity can be achieved by a rod moving in relation to a frame through an axis if we assume that it cannot be otherwise – the extremities of the rod pass by two locations of the axis at the same instant. This classical notion also subsist in relativity and therefore the determination of the one-way speed of light is conceived and must be experimentally implemented. The difficulty to experimentally implement this conceptualization is a result of the indeterminacy of special relativity [10], the assumption that the two-way speed of light in the EF, although experimentally verified in vacuum is not enough to solve the problem of the localization of the two extremities of the rod, the localization of the rod. And, as pointed out by Iyer and Prabhu several years ago, it is important to experimentally verify the non-equivalence of the inertial frames [22]. The equivalence of the frames however can be considered in a restricted sense [10, 23]. However as Chandru Iyer points out in the comment of our article about the meaning and scope of the Principle of Relativity [10, 23] "To generalize the above observations, one may state that to express the composition of a physical transformation as a combination of discrete processes is a natural endeavour of physics. When such a composition is non-commutative and offers different alternatives, a preferred order of composition is implicit".

In our previous works based on these postulates we conciliate the analysis of Einstein based on a Principle theory with the Lorentz-Poincaré approach and recently several works points out the importance of this discussion about the foundations of Relativity and Quantum Mechanics [13-16, 18, 25-47].

"It is beyond doubt that different types of clocks synchronization simply provide time coordinates to describe the same reality. In addition, the words "time", "speed" and "simultaneity", wich we use to attribute a precise physical meaning, actually refer to different notions when different types of clocks are used. Since different descriptions made with various types of clocks, are mathematically equivalent, this latter issue is mainly a question of language. Nonetheless it is an important one and likely to originates several misunderstandings because the physical concepts underlying each of these

descriptions are quite different. Debates around the LCLS beam splitting experiment are related to the problem of using the same word to designate different concepts. For this reason it is of major importance to know what kind of clocks one ends up after performing synchronization", p.11 and 12 [1]. These are the "Conclusions" of [1], a direct copy of a text written by us and published in our previous article " The Principle of Relativity and the Indeterminacy of Special Relativity" p. 40 and 41 [10] where the underlined text (our underlining) substitute "Many disputes and hot debates around special relativity" and "internal synchronization". However the authors failed, once again, to reference this our previous work of ours. And we agree that "internal synchronization" must be substituted by synchronization since it is not difficult to realize that internally "synchronized" clocks are Lorentzian clocks as we explain at p. 41 [10].

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