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Answer to "Information Flow, Causality, and the Classical Theory of Tachyons"[1]

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We briefly answer the comments in "Information Flow, Causality and the Classical Theory of Tachyons" by Basano.

Let us briefly answer the comments by Basano (1977) in this journal. Although "Extended Relativity" (see, e.g., Recami and Mignani, 1974; Mignani and Recami, 1975) seems to allow us to solve any causal paradoxes with both usual particles and tachyons (Pavšič and Recami, 1976, 1977; Caldirola and Recami, 1977), nevertheless a number of paradoxes are continuously proposed. In particular, as another answer to a previous paper by Basano (1976), we have already showed (Pavšič et al., 1976) that tachyons possibly do not imply any causality violations even in macro-physics. However, Basano (1977) claims that our procedure leads to new, different paradoxes. We are going to show that such presumed difficulties do not exist.

We agree with the discussion in Sections 1 and 2 of Basano (1977), where only his definition (3) represents our view. Let us notice the following, however: (i) If an observer A' programs a "tachyon exchanger" P to operate "in a certain way," a priori another observer A can see P to operate in a different way (with tachyons), since only laws and not descriptions (Recami and Mignani, 1974) must be covariant in special relativity. (ii) Our recent works are not in contrast with what the classical theory of tachyons "has been maintaining for years," since we still do maintain that the names "source"

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and "detector" are observer-dependent; but this does not preclude that, when A exchanges tachyons with A', both A and A' (but not other observers!) can agree on which is source and which is detector; in particular, if, for simplicity, A and A' are at rest one relative to the other, in the laboratory we may put forth a description that you can consider as "privileged" but that is not Lorentz invariant. (iii) Our demonstration that two macro-objects A, A' can exchange only tachyons with impulses such that those tachyons appear as emitted by A and absorbed by A' (or vice versa) to both observers A and A' is not a formal trick, since that demonstration was actually derived from the four-momentum conservation law. Here we are assuming that macro-objects do not change their rest-mass during tachyon absorption.

Let us now confine our attention to motions along x, and first choose A as the reference frame. Then, if a macro-object A' moves with subluminal speed u relative to the macro-object A, due to four-momentum conservation A' can absorb tachyons emitted by A only if the tachyon speed V satisfies the necessary (but not sufficient) condition

$$uV < c^2 \tag{1.1}$$

and in such cases—as is well known—no paradoxes arise.

Let us come to the point: i.e., let us suppose that (with respect to A) the tachyons T emitted by A do not satisfy equation (1.1):

$$uV > c^2 \tag{1.2}$$

so that they are not absorbed by A' but proceed beyond A' [until absorbed by another, farther detector B, whose speed w will satisfy a condition of the type (1.1)]. Incidentally, let us remember that in the classical theory of tachyons (cf. Recami and Mignani, 1974) it is always necessary to take proper account of both source and detector, since, if A sends tachyons to B, there always exist frames such that it is B that sends tachyons to A and, in particular, "critical" frames always exist which observe A, B as connected through an instantaneous, symmetrical exchange. Let us also recall that every body at rest, having mass M, a priori can absorb only tachyons or antitachyons with rest masses m and speeds V obeying the equation

$$|V| = (1 + 4M^2/m^2)^{1/2}$$

Now, if we consider A' as the new reference frame and apply the suitable (subluminal) Lorentz transformation, then from condition (1.2) it follows that quantities $M_{A'}$ and m are such that

$$|V'| \neq (1 + 4M_{A'}{}^2/m^2)^{1/2} \tag{1.3}$$

so that A' (in his own rest frame) will correctly realize that he cannot absorb the antitachyons under consideration, or, rather, the initial hypothesis that (e.g. in the frame A) A' cannot absorb tachyons means that (Pavšič and Recami, 1976)

$$|\mathbf{p}| \neq (m/2M_{A'}^2)(m|\vec{P}| + [(\mathbf{P}^2 + M_{A'}^2)(m^2 + 4M_{A'}^2)]^{1/2})$$

where from it directly follows—in the frame A'—the inequality (1.3).This is enough to definitely show that no paradoxes of the kind raised by Basano (1977) exist even when observing the process from A'; in other words, it is not true that A' will not be able to decide whether to absorb tachyons T [which, actually, appear to A' as antitachyons $\bar{T}$ emitted by B with negative speed V' and absorbed by A (cf. Pavšič and Recami, 1977)].

Further details are already contained in Pavšič and Recami (1977).

Let us add that we prefer not to use the terminology in Basano (1977), since in extended relativity it is traditional to call "transcendent" (with respect to a frame F) only tachyons endowed with infinite speed with respect to F; when tachyons overtake and bypass the infinite speed, they simply start appearing as antitachyons traveling in the opposite direction, as explained in detail elsewhere. Lastly, we want to emphasize that, in any case, the definition of "transcendent tachyons" proposed by Basano (1977) is actually linked to the velocity of tachyons T or $\bar{T}$ (for instance, relative to a certain frame F) and to the velocity of A' (relative to the same F), and not to the velocities of A and A' as claimed in (Basano, 1977).

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