

## LETTERS AND COMMENTS

**Reply to comment on ‘Lorentz transformations with arbitrary line of motion’****Chandru Iyer<sup>1</sup> and G M Prabhu<sup>2</sup>**<sup>1</sup> Techink Industries, C-42, phase-II, Noida, India<sup>2</sup> Department of Computer Science, Iowa State University, Ames, IA, USA

Received 7 February 2007, in final form 15 March 2007

Published DD MMM 2007

Online at [stacks.iop.org/EJP/28/L1](http://stacks.iop.org/EJP/28/L1)**Abstract**

We provide a short response to Tjiang and Sutanto’s comment on our paper ‘Lorentz transformations with arbitrary line of motion’. The reply clarifies our approach and some of the points mentioned in the comment.

The comment received from C Tjiang and H Sutanto is appreciated. We thank them for the interest they have shown in our paper and would like to add the following points to the discussion.

- (1) C Tjiang and H Sutanto have stated that we have applied equation (2), which is the equivalent of equation (3) of our paper, to the rod–slot problem. This requires some clarification. For the rod–slot problem we have applied equation (14) of our paper. Equation (14) of our paper has three parameters. C Tjiang and H Sutanto have expanded equation (3) of our paper, which has two parameters, to its three-dimensional version and the result has three parameters. If equation (14) of our paper is expanded to its three-dimensional version, it will have six parameters.
- (2) We have pointed out in figure 2 of our paper that when the two frames are in relative motion with the line of motion not coinciding with either axis, the axes of the frames cannot become parallel. The moving frame’s axes are observed to be non-orthogonal. In such a situation, realizing the condition of having the axes of S and S’ being parallel is a requirement whose fulfilment appears to be questionable. What we actually achieve in equation (3) of our paper is that the components of the unit vector along the line of motion take the same form in both S and S’.
- (3) It is well established in the literature that vector addition in relativity is non-commutative [1, 2]. For example, if we add  $\mathbf{u}_i + \mathbf{v}_j$  in that order and alternatively,  $\mathbf{v}_j + \mathbf{u}_i$  in that order, under relativity we get the combined velocity to have a magnitude of  $\sqrt{u^2 + v^2 - (u^2 * v^2 / c^2)}$  in both cases. But the angle that the line of velocity makes with the  $x$ -axis is different in the two cases [2].

- (4) This was our primary motivation in suggesting an alternative approach to using vector algebra. Our pedagogy has been to construct the transformation by first rotating the  $x$ - $y$  plane to align the  $x$ -axis with the line of motion, perform a conventional Lorentz transformation and then rotate back the  $x$ - $y$  plane according to the requirement of the 'moving' inertial frame in relation to the orientation of the object(s) co-moving with it. We felt that this approach resulted in ease of application to some problems.
- (5) The two-dimensional version has three parameters, namely,  $\phi$ ,  $\alpha$  and  $v$  given in equation (14) on page 189 of our paper. In the most general 3D solution, we have to rotate the  $x$ - $y$  plane, then the  $x$ - $z$  plane so as to align the  $x$ -axis with the line of motion. This involves two angular rotations. A conventional Lorentz transformation is performed at this point and so far we have three parameters. We presume that at this point (in the general case), the inertial frame has reached the required state of relative motion but the orientation of the axis is not according to its needs in relation to the orientation of the objects co-moving with it. Therefore, we have to rotate the coordinate planes according to the requirements of the 'moving' frame. This operation in 3D space in general requires three rotations of the coordinate planes. So we end up with six parameters in the 3D version in our approach, which renders the algebra more complex than the 2D version.

## References

- [1] Ungar A A 2001 *Beyond the Einstein Addition Law and Its gyroscopic Thomas Precession* (Dordrecht: Kluwer) pp xxiv-xxviii
- [2] Rhodes J A and Semon M D 2004 Relativistic velocity space, Wigner rotation, and Thomas precession *Am. J. Phys.* **72** 953

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