Revisiting special relativity: A natural algebraic alternative to Minkowski spacetime

James.M.Chappell Nicolangelo Iannella, Azhar Iqbal, Derek Abbott

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Minkowski famously introduced the concept of the space-time continuum in 1908, merging the three dimensions of space with an imaginary time dimension $ i c t $, naturally producing the correct spacetime distance $ x^2 - c^2 t^2 $, and the results of Einstein's then recently developed theory of special relativity. As an alternative to a planar Minkowski space-time of two space dimensions and one time dimension, we replace the unit imaginary $ i = \sqrt{-1} $, with the Clifford bivector $ \iota = e_1 e_2 $ for the plane that also squares to minus one, but which can be included without the addition of an extra dimension, as it is an integral part of the real Cartesian plane with the orthonormal basis $ e_1 $ and $ e_2 $. We find that with this model of planar spacetime, using a two-dimensional Clifford multivector, the spacetime metric and the Lorentz transformations follow immediately as properties of the algebra. This also leads to momentum and energy being represented as components of a multivector and we give a new efficient derivation of Compton's scattering formula, and simple derivations of Dirac's and Maxwell's equations. Based on the mathematical structure of the multivector, we produce a semi-classical model of massive particles, which can then be viewed as the origin of the Minkowski spacetime structure and thus a deeper explanation for relativistic effects. We also find a new perspective on the nature of time, which is now given a precise mathematical definition as the bivector of the plane.

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