Foreword to part I
Special relativity

Physics is very interesting. There are many, many interesting theorems. Unfortunately, there are no definitions.

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Part I, Special relativity contains in chapter I the maths for the physics we discuss in the chapter which follows it. We will give motivations in physics for why we are introducing these mathematical ideas. The reader whose maths is basic can notice an equation is there, then ignore it and continue with the text. Many mathematical works can be read in this way.

Special relativity is a theory relating time and space and describes how time slows down when an object speeds up and how its measuring rods contract. It is both a set of ideas which can be expressed mathematically, and a theory of physics which describes measurements in experiments. Our objective in Part I is to extend the ideas on which special relativity is based, and to go into a level of detail unusual in an introduction to the subject in testing whether or not these ideas match reality.

In special relativity we relate two coordinate systems, called frames, moving with uniform velocity v with respect to each other. If the first frame has a time coordinate t and three space coordinates x, y and z, and the second frame has a time coordinate t' and space coordinates x', y' and z', then special relativity relates t in a formula involving the velocity v with t', x', y' and z'.

A particle of light called a photon travels with a velocity represented by the symbol c. Then if we want to relate t and x, y and z together they must be measured in the same units, because if a formula A = B describes a physical state or process, then the quantities in which A is measured will match the quantities in which B is measured. We can measure with respect to distance if we wish. Then c is measured in units of $\frac{[\text{distance}]}{[\text{time}]}$ so that ct is measured in units of [distance]. This means we must always use ct in our formulas when we are using x, y and z.

The formulas in special relativity relating time in the first frame with time and distance in the second frame, and distance in the first frame with time and distance in the second frame are known as *Lorentz transformations*. When the origin in which the coordinate systems are measured is shifted these are called *Poincaré transformations*. The Lorentz transformations relate time in the first frame in a formula which combines both time and space in the second frame, and distance in the first frame in a formula also with time and space together in the second frame. For this reason we often use the term *space-time* in our discussions of special relativity.

Using the units we have already described, these transformations have a remarkable feature – between the (ct, x, y, z) frame and the (ct', x', y', z') frame we have

$$c^2t^2 - x^2 - y^2 - z^2 = c^2t'^2 - x'^2 - y'^2 - z'^2, \qquad (1)$$

so this expression is an invariant under the coordinate transformations of special relativity which we denote by s^2. We call s the *line-element*.

We will discuss recent and historical experimental results and relate them to the opinions of ‘weak and strong dissidence’, followed by our ‘non Lorentz inference’.

Weak dissidence accepts the Lorentz transformations of special relativity, but as discussed by John Bell [Be87], lifts the philosophical requirements. This may be rephrased as selecting a reference frame which is stationary, as was done by Lorentz, or in more mathematical terms as appending a base point or origin coordinate to the vector space which floats without an origin in the relativistic interpretation. Both mean the same thing.

Strong dissidence looks at the experimental data for relativity and claims a nearly stationary coordinate system in the presence of large gravitational mass, so that the contraction given by the Lorentz formula does not happen. We have been surprised that the experimental data on global positioning system (GPS) satellites confirms this hypothesis. This is not the standard interpretation. Strong dissidence may or may not claim a nonrelativistic coordinate system beyond the detectible range of matter. Modern data indicate relative variations of the speed of light as less than 10^{-17} near large amounts of matter.

In terms of the measurement of the transmission of light, which is an electromagnetic phenomenon, we will revisit the experiments of Michelson and Morley, Miller at Mt Wilson, Sagnac, Silvertooth, ? Australia, and the COBE satellite data. We will also perform experiments ourselves, which are not expensive in an electronic age compared with their cost for earlier experiments. We will design a meteorological balloon flight to measure these effects in terms of the height above the Earth's surface, carrying optic fibre cable loops as in the Australian experiment.

Thus we have a further testable hypothesis, suggesting that a moving frame locks velocities as if it were stationary in the presence of bulk matter, at a Michelson-Morley interferometer mirror. Our claimed reason is that this might be inferred as a result of the Miller experiment, described in chapter II.

We mention that there are two versions of strong dissidence. The first describes the situation in terms of potentials, the second resurrects a word we will spell as the ether. The differential equations these define are different. In the first, the potential is covariant, the differentials are order preserving, but in the second the ether is a hydrodynamic model and contravariant, or order reversing. Einstein's principle of covariance states that the laws of physics are covariant. All commonly adopted models of the current era conform to this principle.

In recent work Jim looked at the Lorentz transformations as he had done in the work *Vector Algebra*, and their derivation using quaternions. Amazingly, although he got out a related transformation equivalent under an interpretation system to the Lorentz transformations for the time component by this means, he did not retrieve the Lorentz transformations for the space component, but something else. Our current view is that the Lorentz transformations are permissible, and so are our own. The new transformations separate out the space and time transformations so that they are unmixed in terms of space and time respectively. The Lorentz transformations on the other hand always mix space and time transformations. Since the equations for the interval obtained from space and time is an invariant in both approaches, our claim is that these two types of transformation are equivalent, and represent the same physics.

It is also the case that in the rest frame of a moving observer, if, say, his ruler is expanding (which would not normally happen), then the Poincaré transformations assume Galilean transformations rather than relativistic ones for this ruler.

What then is the status of the Lorentz and Poincaré transformations describing special relativity? Consider the Michelson-Morley experiment. This looks at a stationary reference frame (velocity **0**) and another frame moving with velocity **v** with respect to the first frame.

In the moving frame there is an interferometer with light at velocity **c** at right angles to **v** interfering with light at velocity **c**′ in the same direction as **v**. The Lorentz and Poincaré transformations do not relate four velocities, **0**, **v**, **c** and **c**′. There is a factor v/c in the equations, so this should relate the time and space in the stationary frame to the time and space in the second frame. The theoretical fudge used in the explanation of the null result of the Michelson-Morley experiment assumes that **c** and **c**′ are equal to **v**, whereas there are four frames, one with velocity **0**, one with velocity **v** and two with velocity **c**. The Lorentz transformations do not refer to four frames, but two, and indeed cannot describe the **c** frame which leads to infinities.

One of our long-range objectives is to describe relativity in terms of mathematical objects called novanions given in [Ad15], chapter V. These are interpreted as having a relativistic structure and conserve number, except at t = 0 (time zero for the universe) when number is not conserved so t = 0 is a fixed and not a floating coordinate.

Essential to our physics is the twofold correspondence or duality between the states of the model and the observer-based interpretation of the model. Observers exist not only as people- or things-in-themselves, but also as a consequence of the novanionic universal model. Thus the existence of observers as physical objects implies that the variables they use are provided by the theory, but what the observer may interpret as a measurement may be expressed in the theory in a different way.

An example is in order. This is provided with more introductory detail in chapter I.

Consider the quaternion model. The quaternions are mathematical objects we will explore in chapter I. They contain a scalar component and three quaternion imaginary parts. We will use the scalar component to describe time and the three imaginary parts to describe distances. The algebraic description of a quaternion using the matrix intricate representation of chapter I or in chapter III of *Superexponential algebra* [Ad15] is

$$a1_1 + bi_1 + c\alpha_i + d\phi_i, \qquad (1)$$

having one scalar part 1_1, and three quaternionic imaginary parts, where i is $\sqrt{-1}$, and α and ϕ satisfy $\alpha^2 = \phi^2 = 1$, with $\alpha \neq \phi$, $\alpha \neq 1$, $\phi \neq 1$. Representing this as is more usually given as

$$a1 + bi + cj + dk,$$

in chapter I we will see that

$$(a1 + bi + cj + dk)(a1 - bi - cj - dk) = a^2 + b^2 + c^2 + d^2, \qquad (2)$$

where (2) is the square root of the determinant, a measure of the four dimensional volume or hypervolume, of the quaternion matrix.

In special relativity we deal with the line element

$$s^2 = a^2 - b^2 - c^2 - d^2, \qquad (3)$$

where a = ct, c is the speed of light, t is the time and b, c and d are the space components.

Form (3) is not form (2) unless we provide an interpretation of equation (2) as

$$s^2 = a^2 - (ib)^2 - (jc)^2 - (kd)^2, \qquad (4)$$

where $i^2 = j^2 = k^2 = -1$. Thus (4) is (2) in the quaternion model, but the observer embedded in the model sees the model quantity b as ib observationally, since she is composed of space components represented by ib, jc and kd.

Let us project, in other words select variables in terms of a component, along the axis (ib) for the observer. Using the intricate representation this is along i_1. Then using the mathematics of chapter I, for instance the projection along a different component (jc) is

$$i_1(\alpha_i)c = -\phi_i c, \quad (5)$$

where

$$(-\phi_i)^2 = -1. \quad (6)$$

Thus the distance at right angles to i_1 in the model is projected to be minus the distance at right angles to both these distances by the observer. So what the observer sees is not what the model tells us is there.