Using Electromagnetism to Understand Special Relativity

When you encounter Einstein's Theory of Special Relativity, you can become amazed at the flexible nature of space and time. After all, we count on the certainty of space and time in our analysis of force and motion.

We are confident that the rules of force and motion don't change as long as we are in a reference frame that is in uniform motion. And then, there is electromagnetism.

With electromagnetism, we have the electric force due to charge, and the magnetic force due to moving charge. You may see a problem, when you consider the following case.

In this case, two electrons are traveling side-by-side at a constant speed in a straight line. What forces do they feel? There is a combined electric repulsive force and a magnetic attractive force. However, in the reference frame moving with the electrons, there is only the repulsive force. How do we resolve this?

There is a way of calculating the force from a moving charge force by tinkering with the space and time scales (Lorentz transformations) and treating the charge as stationary. This procedure also provides a way to maintain the rules of electromagnetism in a uniformly moving reference frame. These relativity rules for electricity propagate to other aspects of physics.

The length of a physical object is maintained by the electromagnetic forces between the elements of its structure. The change in length due to the electrodynamics of motion could be difficult to calculate. However, all electrodynamic effects can be calculated from the above change in scale. This calculation propagates to the length of the object.

A typical time measurement device depends on the elasticity of a clock spring. The inter-atomic forces in a metal are electrical in principle and subject to the electrodynamics of motion. The behavior of a clock spring in motion is also subject to Lorentz transformations.

All of our timing devices depend on electromagnetism and are subject to motion.

Our sense of time depends on the biochemical activity in our brain. The physics of chemistry is electrical in principal and also is subject to Lorentz transformations.

So, the rate that things happen in a moving reference frame changes because of electrodynamics. What about "real" time?

The "real" space and time that feels static to most people, is an unrealistic approximating idealization. Practical space and time that refers to the size of things and how fast things happen, turns out to be relative. The surprise here is that the relativistic effects of electricity applies equally to all other physics such as the nuclear force.