Interesting Physics
by Charles Kelly

Introductory physics courses teach that there are three fundamental quantities that are mutually independent: distance, time, and mass. This article describes a framework where distance is not constant and the three fundamental quantities are not independent from each other.

Distance carrier

The concept of distance is fundamental to geometry, physics, and human experience. The idea that "an inch may not be an inch and a meter may not be a meter" is unusual. Physicists describe some particles as force carriers. We can develop a similar concept: distance carrier. The basic concept of a distance carrier is that distance is not the same in every environment, for example within the nucleus of an atom, or within a black hole, or within a plasma.

We begin our discussion about distance carriers with an analogy to road markers along a highway. Road workers use their best effort to place mile markers along roadways. There may be errors in placement, but the workers strive to place the markers one mile from each other.

There is an external definition of one mile, which is separate from, and independent of, the placement of the road markers. If there is an error in placement of the road markers, this error will not affect the external definition of one mile.

Extending the analogy, suppose that there is a road toll that is based upon distance travelled. Further suppose that distance for the purpose of this toll is the number of road markers that you pass. In this case, it doesn't matter what the odometer in your automobile measures, the toll that you pay is based upon the road markers that you pass.

Now suppose that a malicious person moves the road markers. If he moves the road markers closer together, you will pass more markers and pay a higher toll. Conversely, if she moves the markers farther apart, you will pass fewer markers and pay a lower toll.

The road markers are an analogy to distance carriers.

Separate Observers

An interesting question about distance carriers is "why isn't the separation among distance carriers the same everywhere"? One answer is that distance carriers vary with their environments. For example, if it were possible to observe the inside of a nucleus of an atom, the observations about those internal distance carriers might be different from observations outside the nucleus. Other environments that might have different internal and external observations for distance carries include cold environments (near absolute zero), plasmas, and black holes.

Black holes present an interesting example. Black holes are an example of Einstein gravity fluctuations. They are sometimes described as a bowling ball on a rubber sheet. Applying distance carriers to these fluctuations we would say that the "road markers" have been moved, but that the distance between particles within the black hole has not changed. An external observer might say that the distance between particles has changed due to the gravity fluctuations. Stephen Hawking describes this phenomena as "extending two dimensions into three dimensions".

Particle Accelerators

A legacy description of particle accelerators is "atom smasher". These machines accelerate particles to velocities that approach the speed of light then smash the particles into each other. The purpose is to break the particles into components and observe the behavior of the components.

Using the terminology of distance carriers, the components experience one set of internal distance carriers while they are bound together within a particle, and experience a different set of external distance carriers after they are separated. The photographic and sensor data that are collected during particle accelerator experiments are based upon the "external" distance carriers. As described below, the data may measure different forces, fields, and masses than those that exist when the components of the particle are bound together.

Straight Lines

Introductory geometry courses teach Euclidean geometry. One of Euclid's postulates is that "the shortest distance between two points is a straight line". We adopt the principle that a straight line is a path between two (adjacent) distance carriers. Using this definition, internal and external observers might not both observe a straight line. This is almost a contradiction: a non-linear line.

The concept of a straight line is important within physics. For example, a gravitational force is calculated as the product of masses divided by the square of the distance between the masses. Implicitly, the distance between the masses is assumed to be a straight line.

This has interesting implications for the environments that we discussed above that may have different internal and external distance carriers. For example, suppose that the distance carriers within the nucleus of an atom are both curved and compressed (with respect to an external observer). In this case, the components of the nucleus might experience gravitational attractions that are both non-linear and stronger than those that would be calculated using distance carriers that are external to the nucleus.

Distance and Weight

Weight is the product of mass and gravity. As we discussed in the previous section, as the separation among distance carriers changes, gravity changes. Therefore, as gravity changes, weight also changes. Below we discuss how changes in the separation among distance carriers impacts mass.

Distance and Time

Einstein described how velocity impacts time. The popular version of his theory describes space travelers on a journey at a velocity that approaches the speed of light. When the travelers return to Earth, they are younger than the population because time moved more slowly in their space vehicle.

It is difficult to describe time without either an explicit or implicit reference to distance. The references include the movement of a pendulum, the rotation of a wheel, and the wavelength of an emission. The measurement of time changes as the separation among distance carriers changes.

The distance carrier approach to time is similar to the toll road analogy. In the analogy, cost changes with changes among distance carriers. Similarly, the measurement of time changes as the separation among distance carriers changes.

Control Equation

We have described how distance, time, gravity, and weight change as the separation among distance carriers changes. We can say that these quantities are not independent from changes among distance carriers. If they are not independent, we would like to evaluate their inter-relationships. We use a control equation to measure these inter-relationships.

One choice for a control equation is Einstein's famous equation:

$$E = mc^2$$

$$\begin{aligned} &where \\ &\quad E{:}\ energy \\ &\quad m{:}\ mass \\ &\quad c{:}\ speed\ of\ light \end{aligned}$$

A traditional interpretation of this equation is that mass and energy are inter-changeable. We can derive a distance carrier interpretation by recognizing that speed is equal to distance divided by time:

$$E = m\left(\frac{d}{t}\right)^2$$

$$E = m\frac{d}{t}\frac{d}{t}$$

We add subscripts to the equation (i for internal, and e for external):

$$\frac{t_e}{d_e}E = m\frac{d_i}{t_i}$$

Using this version of the equation, we can expand Einstein's interpretation and say that changes in energy are distributed among changes in mass, distance, and time. Examining the relationship between work and energy, we can write:

$$force\ x\ distance = Work = Energy$$

Distance carriers are involved twice on the left hand side of this equation. Distance carriers are used explicitly in the distance through which force is applied. Distance carriers are used implicitly in the definition of force.

Internal and External

We used subscripts in the final version of the control equation. These subscripts pertain to where measurements are taken. We can think of these as "inside" and "outside" a particular environment: nucleus, plasma, black hole, or cold environment. Our distance carrier framework says that these internal and external measures of distance, time, and mass do not have to be the same.

Distance Carriers and Dimensions

Rectangular coordinates are often used to analyze physical phenomena. These coordinates are an extension of the X-Y coordinates used in high school mathematics. Each axis in a rectangular coordinate system is at a right angle to every other axis.

We mentioned above that external observers might view a "non-linear line". Straight lines are the basis of rectangular coordinate systems; without straight lines, we can't develop rectangular coordinates.

Clothing presents an interesting analogy for distance carriers and dimensions. Weaving is analogous to rectangular coordinates and knitting is analogous to some coordinate systems based upon distance carriers.

Returning to our analogy of road markers, assume that there are two different types: blue and green. Truck travel is measured with blue road markers and passenger car travel is measured with green road markers. Green and blue markers that are evenly interspersed along the road correspond to weaving and markers that are "wrapped around each other" correspond to knitting.

For example, assume that an external observed sees three green markers arranged in a triangle and tree blue markers arranged in a triangle, and further assume that these triangles are partially overlaid upon each other. Also assume that an internal observer sees these markers arranged in two separate straight lines and one type of particles sees only green markers and another type of particle sees only blue markers. Each of these particles might be considered to be travelling in a straight line, perhaps at a constant velocity, in different directions from each other.

We can construct a special circumstance where these straight lines are perpendicular to one another. In this circumstance, the particles might not exert any force, or attraction, upon each other although an external observer sees these particles rotating near each other.

String theorists sometimes speak about "dimensions folding in on themselves". This could be similar to our blue and green triangles being knit together.

Final Word

I'm not saying that the distance carrier framework, or the selection of a control equation, is correct. I want to convey that the framework is interesting and it presents opportunities for analyzing physical phenomena, especially phenomena described in term of fields, which in turn are described in terms of distance.