From the Editor

It's About Time

I confess that I have never been able to get my head round the theory of relativity. A newly-published book by N. David Mermin is what I have needed. He taught the subject for many years to nonspecialist students at Cornell University in the USA. This volume, entitled *It's About Time*, with the subtitle *Understanding Einstein's Relativity*, was published in 2005, the centenary year of the publication of Einstein's theory of special relativity.

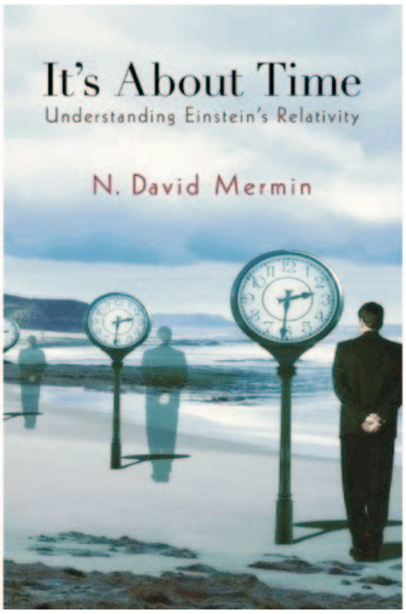
I could never grasp the underlying assumptions before reading this book. I am more at home in axiomatic mathematics like Euclidean geometry or group theory, which begins with a set of axioms or postulates and deduces things from them called theorems. What are the axioms of relativity theory? Mermin gives two.

The principle of relativity says that no phenomena have properties corresponding to the concept of absolute rest. In other words, all other things being equal, it doesn't matter how fast you are going if you are moving with fixed speed along a straight line.

The principle of the constancy of the velocity of light says that light in empty space moves with a velocity that is independent of the velocity of the body that emitted that light.

Using these, he brilliantly deduces, in a way even I can understand, how the rule for adding speeds u and v along the same straight line is not $w = u + v$ but

$$w = \frac{u + v}{1 + uv/c^2},$$



where c is the velocity of light. This makes it impossible to exceed the speed of light. He goes on to explain how two events can be simultaneous in one frame of reference, such as on a moving train, but not in another, such as standing on the track, and obtains the formula

$$T = \frac{Dv}{c^2}$$

for the difference in time between the two events in the track frame, where D is the distance along the track between the two events, v is the speed of the train, and c is our old friend the speed of light. Or, to turn it round, if two clocks are synchronized and separated by a distance D when at rest then, when they are moving at a speed v along the line joining them, the reading of the clock at the front lags behind the reading of the clock at the rear by this amount. The slowing-down factor of a clock moving with speed v is

$$\sqrt{1 - v^2/c^2}.$$

This is also the factor by which a stick moving at speed v in the direction of the line of the stick will shrink. As Einstein is famously quoted as saying 'At last it came to me that time was suspect'. It explains why sub-atomic particles decay much more slowly when accelerated in a particle accelerator; in their time, they are still decaying at the same rate.

One mind-blowing fact follows another. There is a *Doppler effect* in relation to time. For example, if a clock is moving towards you at speed v emitting a flash every second, then you will receive the signal every $\sqrt{(1 - v/c)/(1 + v/c)}$ seconds; if it is moving away from you at speed v, then you will receive it every $\sqrt{(1 + v/c)/(1 - v/c)}$ seconds.

My little grey cells were stretched beyond limit when I reached space-time geometry, $E = Mc^2$, and the brief introduction to Einstein's theory of general relativity, but I am grateful to Mermin for showing me that relativity theory is not the closed book I thought it was.

Reference

1 N. D. Mermin, *It's About Time: Understanding Einstein's Relativity* (Princeton University Press, 2005).