Albert Einstein - Early Years:

Born: 14 March, 1879 in Ulm, Germany, a German Jew. Didn't talk till he was three.

Family involved in the German electrical industry. Business failed and they were forced to move to Italy.

Dropped out of school before getting his certificate and so couldn't go to University.

At the second attempt, in 1895, he passes entrance exam to Technical School in Zurich.

Never attended lectures! Involved with revolutionary socialists!

In 1900, graduated without recommendation - went to Swiss Patent Office where he worked until 1905. Between 1895 and 1905 developed Special Theory of Relativity.

Special Relativity.

In 1831, Michael Faraday showed that the motion of a magnet could induce an electric current in a wire $\Rightarrow$ electricity and magnetism are related.

By 1864 James Clerk Maxwell had formulated a complete mathematical description of the electro-magnetic force in the famous "Maxwell's Equations".

These suggested that electromagnetic fields should radiate as a wave through space at the same speed as that of light.

Heinrich Hertz confirmed this experimentally in 1886.

Effectively, optics incorporated into the theory of electromagnetism. Light is an electromagnetic wave.

The Ether.

Fundamental question of late 19th century physics - how did light travel through space?

Classical wave theory $\Rightarrow$ waves require a medium - the ether.

Maxwell $\Rightarrow$ electromagnetic wave travels at constant speed which depends only on properties of medium.

Perhaps Maxwell's equations of electromagnetism could only be simply applied by an observer at rest with respect to the ether?

Therefore could Earth's motion with respect to the ether be detected?

But Michelson-Morley experiment (1887) did not detect this motion!

Einstein's breakthrough (1905-1906).

Newtonian Principle of Relativity - an observer in a closed train cannot determine the velocity of the train.

But electromagnetism $\Rightarrow$ ether fills train
$\Rightarrow$ measure speed of light relative to observer
$\Rightarrow$ determines the constant velocity of train.
$\Rightarrow$ contradicts Newtonian Relativity

(Note that, in another sense, Maxwell's equations *do* obey Principle of Relativity, at least for small velocities. eg induced current only depends on relative movement of magnet and coil.)

But constant light speed for a given medium remains a problem for Newtonian Relativity.
$\Rightarrow$ ether is a preferred, absolute frame for applying equations of electromagnetism.

Einstein $\rightarrow$ Principle of Relativity is paramount.

No observer in a closed train compartment should be able to determine the velocity of the train.

Considered observer travelling at speed of light with a mirror.

Principle of Relativity:

$\Rightarrow$ No observer could be allowed to "catch up" with light.

$\Rightarrow$ Every constant velocity observer should see light travelling at the same speed.

$\Rightarrow$ In general, all physical laws should be “invariant” for constant velocity observers.

Einstein's Special Theory of Relativity.

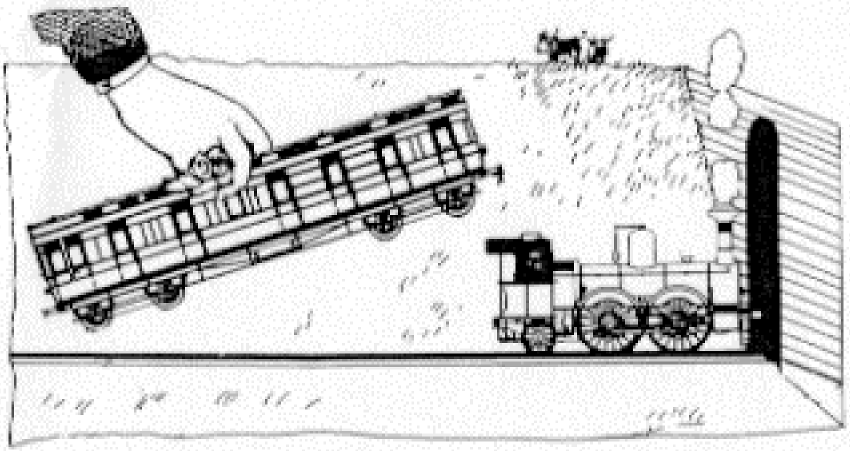
Since Velocity = Distance/Time, to keep velocity of light constant , require observers moving with different velocities to measure different times (and different distances).

Huge implications!

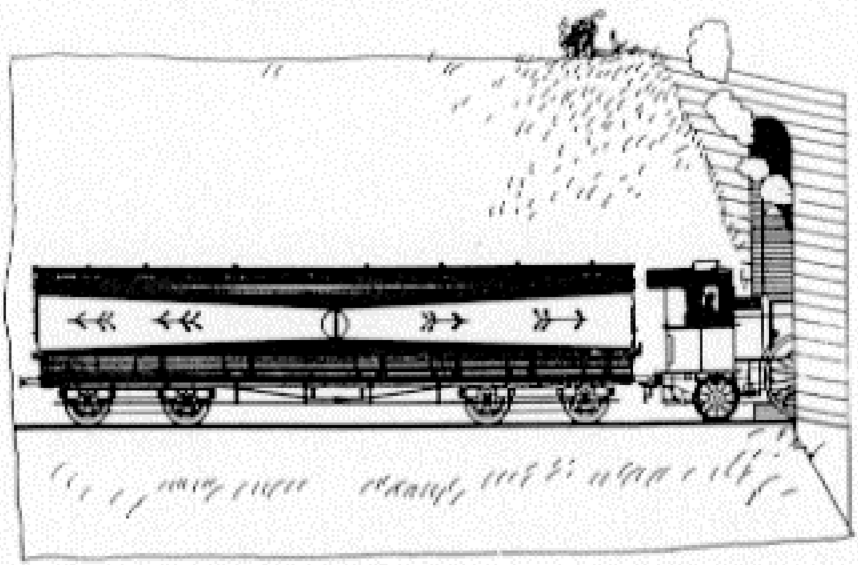
⇒ observer on railway embankment and observer in railway carriage will not agree on which events are simultaneous!

⇒ they also disagree on distance between the events - space+time become mixed up.

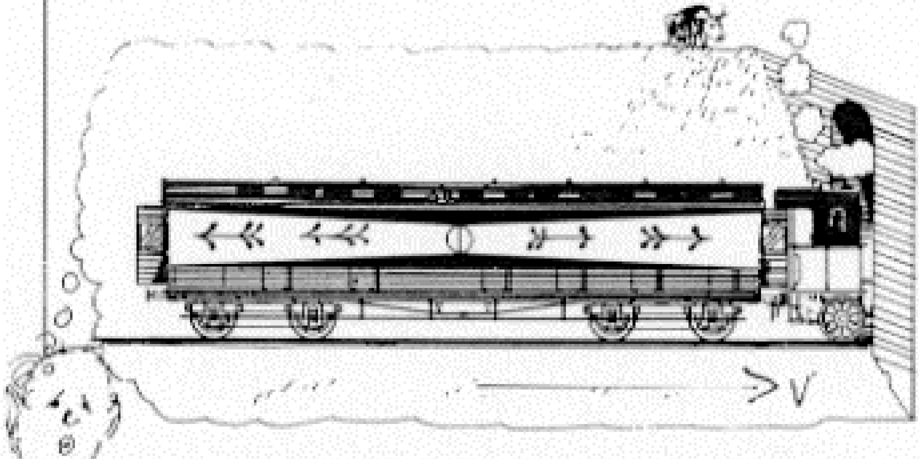
Now we can put them together. Let's have a passenger car too, Mike.



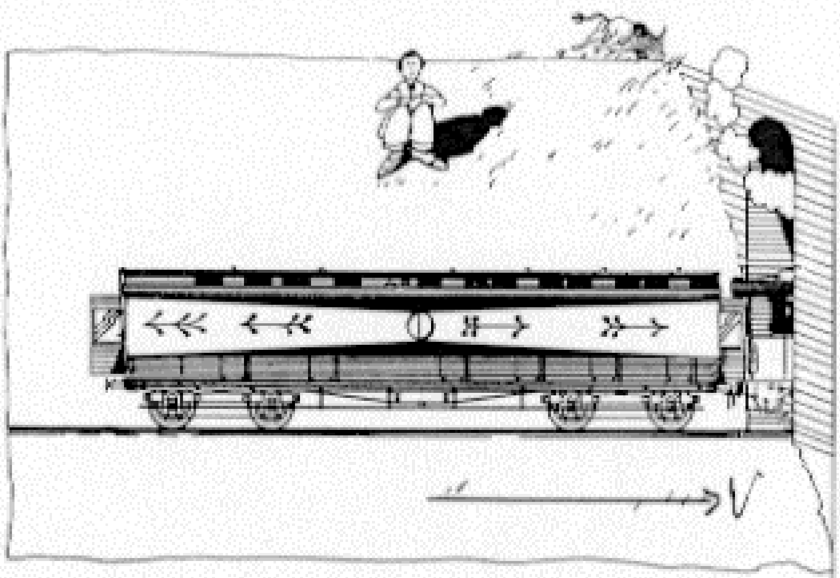
There. Now imagine that someone in the centre of the passenger car holds a device which can send out a beam of light in the forward direction and at the same time a beam of light in the backward direction.

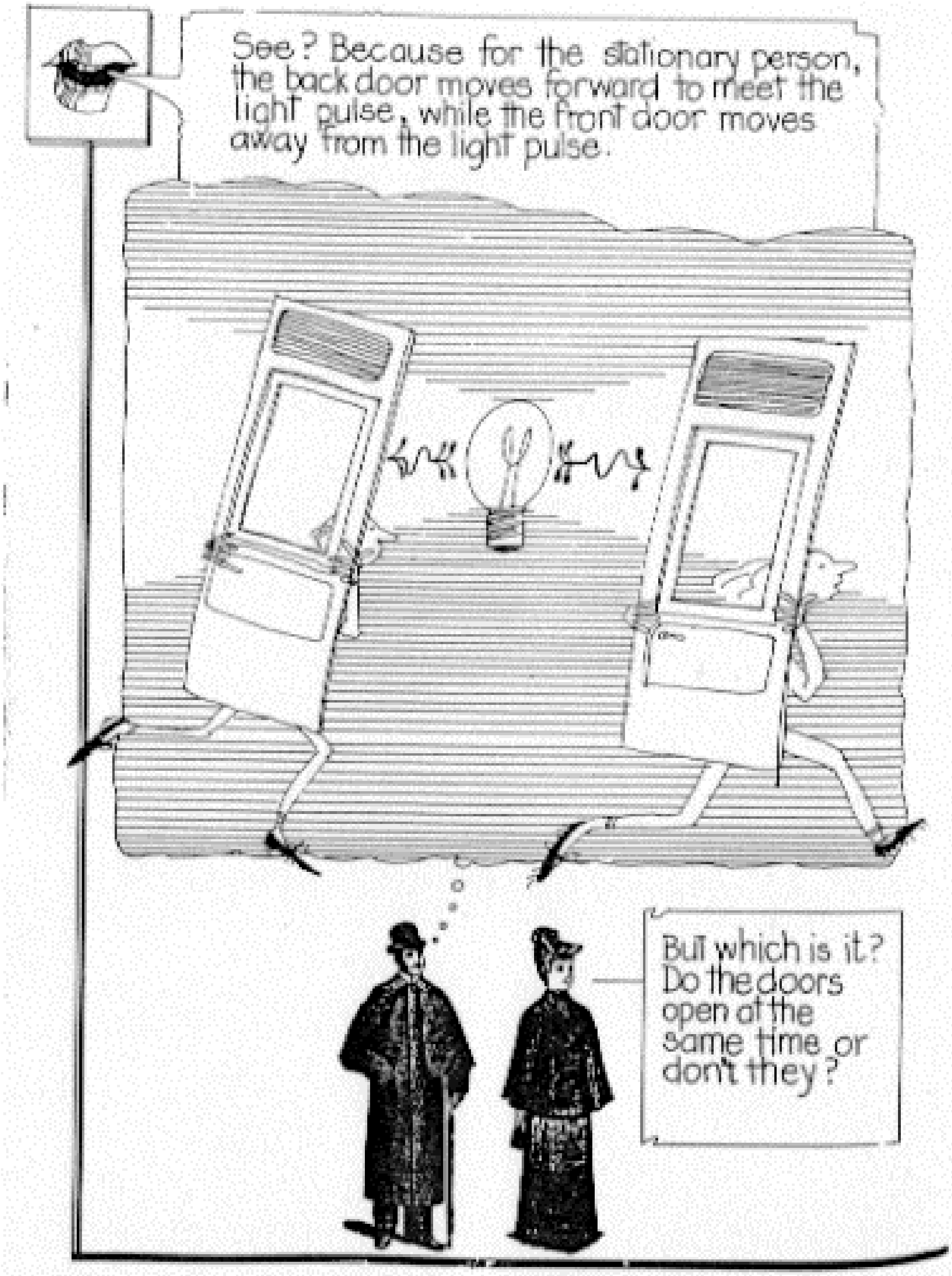


And we further imagine that the front door and back door can be opened automatically by the light beams.



Then to the person holding the device the doors of the passenger car will open simultaneously. But to a person on the embankment, Albert argues, the back door will open before the front door!




See? Because for the stationary person, the back door moves forward to meet the light pulse, while the front door moves away from the light pulse.
But which is it? Do the doors open at the same time or don't they?

Absolute vs. Relative.

Seems Special Relativity helps Leibniz rather than Newton. Time and distance now relative and depend on the speed of the observer.

However, Special Relativity's great achievement is to remove the need for the ether as an absolute frame for electro-magnetism.

So Special Relativity simply restores the Newtonian situation - all constant velocity observers are equivalent for mechanics *and* electromagnetism.

But question of what defines the constant velocity, inertial, observing frames is still open! (Newton vs Mach).