

Week 7-9: Physics II – Einstein's Theory of Relativity

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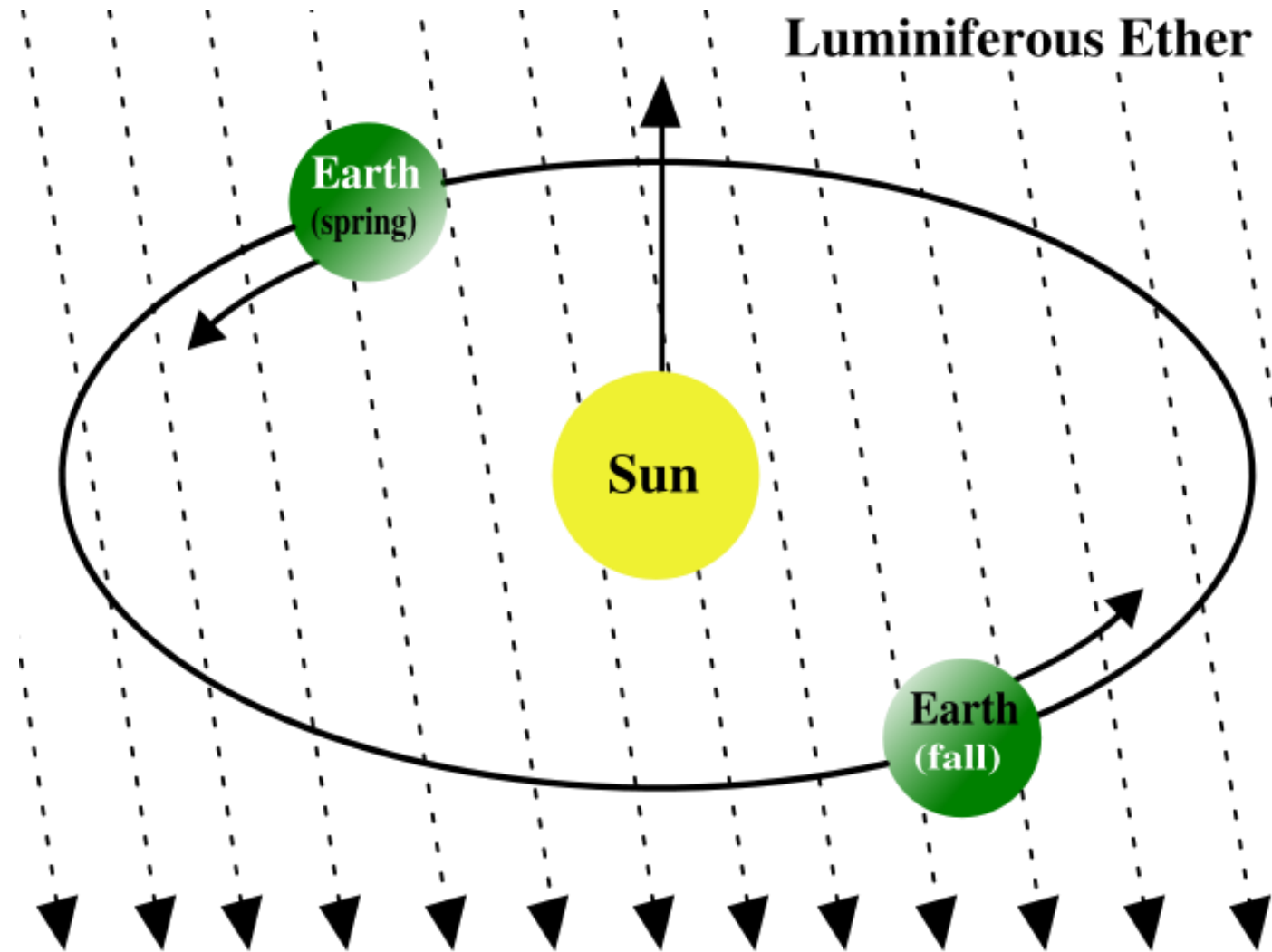
XJTLU

Outline

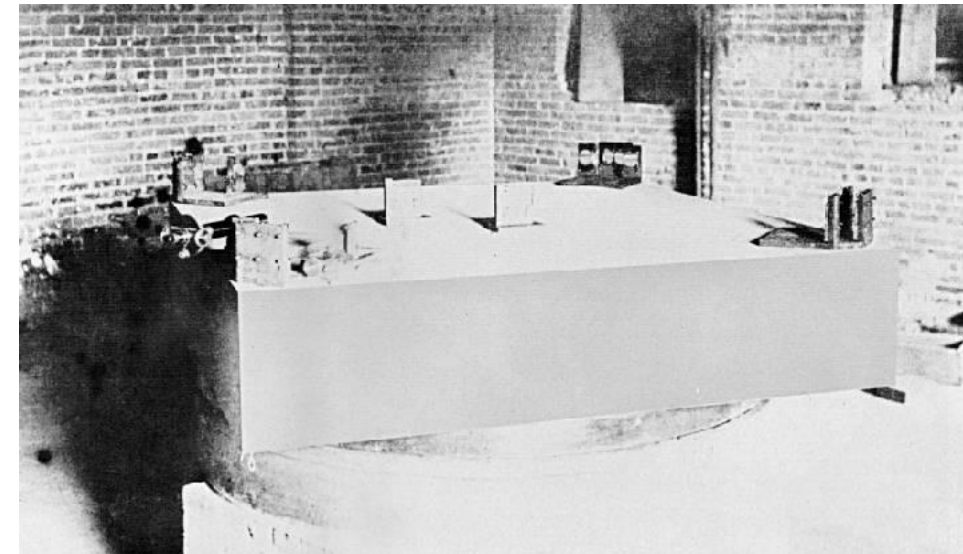
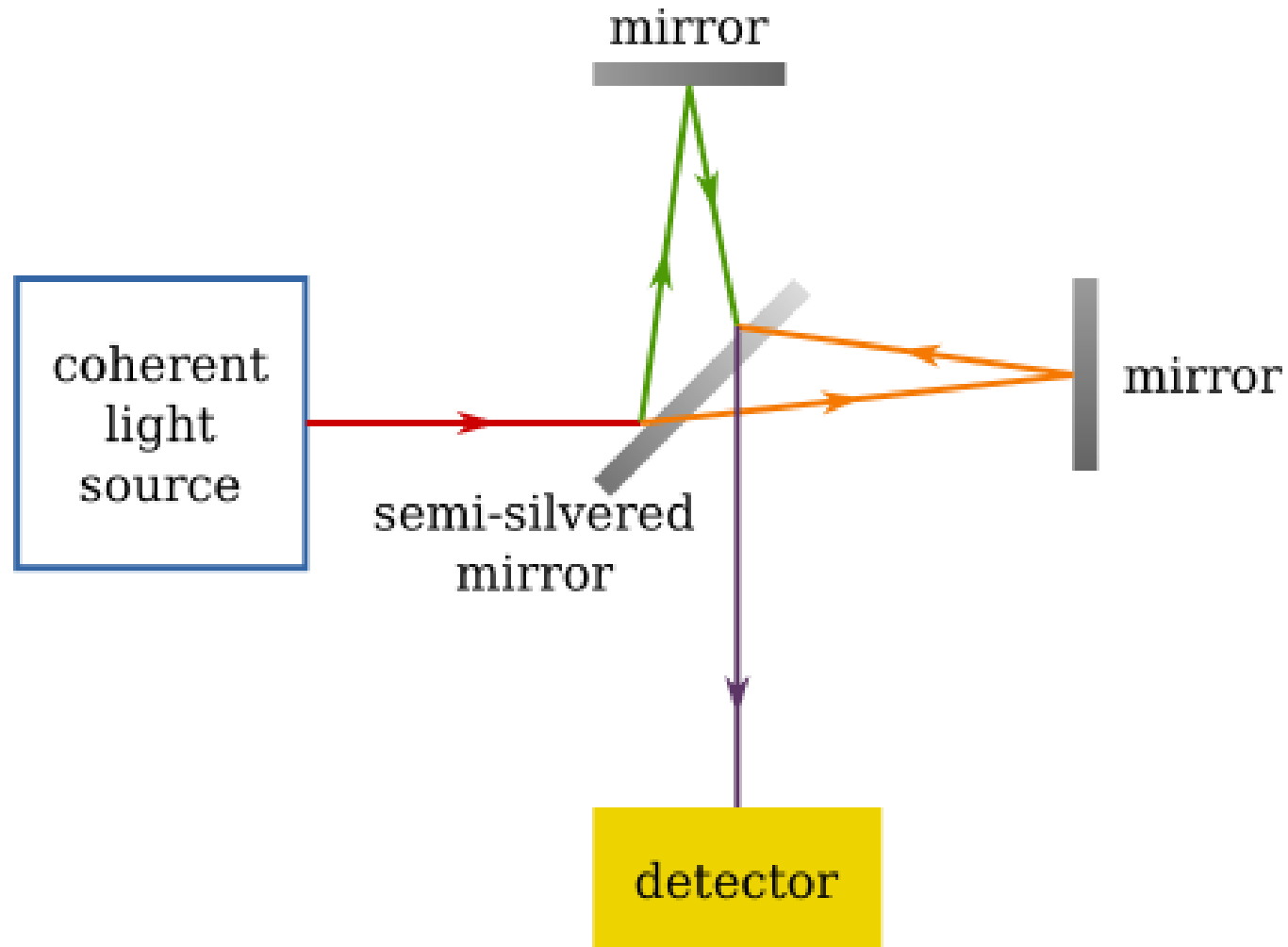
- Michelson-Morley Experiment
- Einstein's Special Theory of Relativity
- Einstein's General Theory of Relativity

Michelson-Morley Experiment

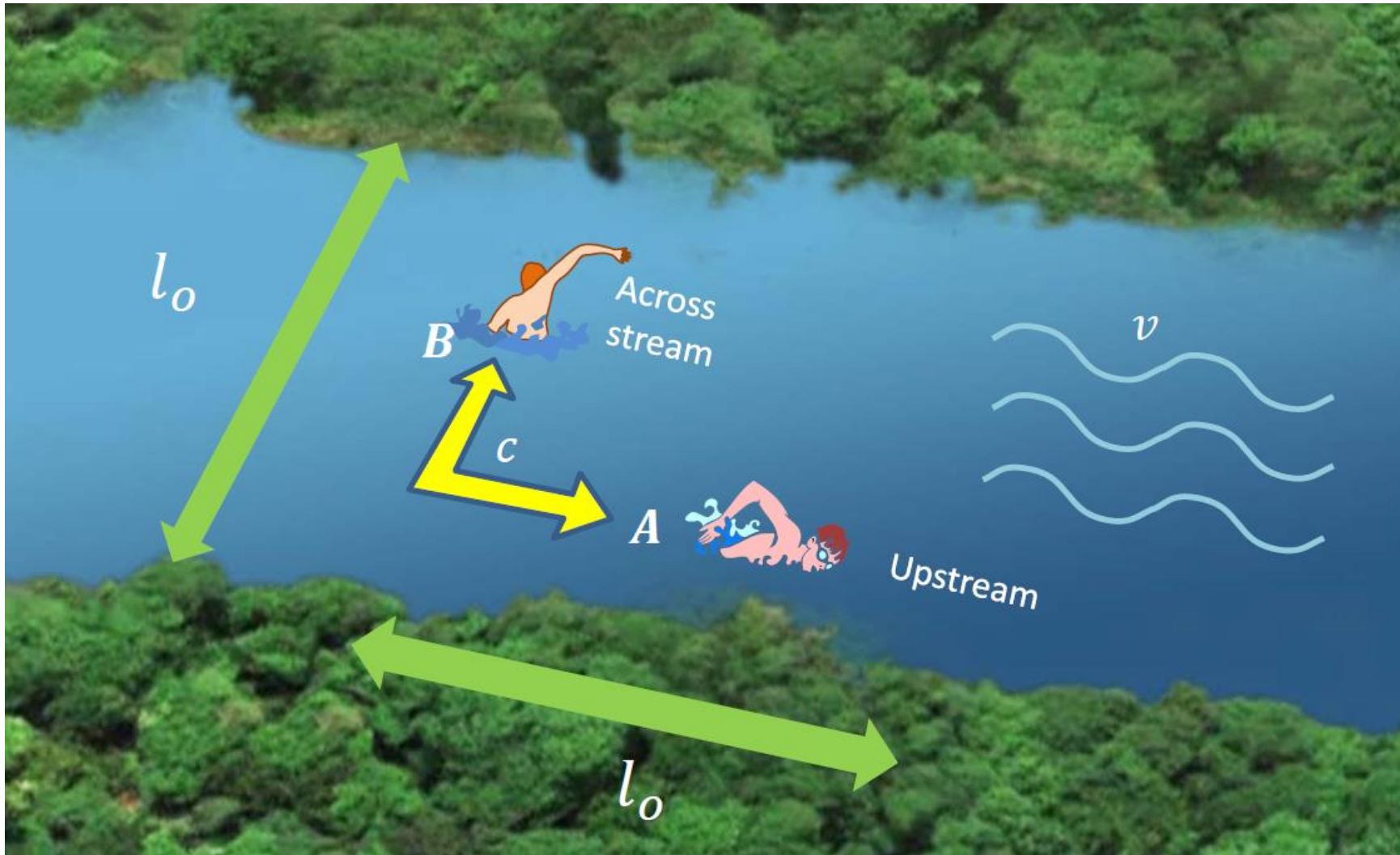
Luminiferous Aether



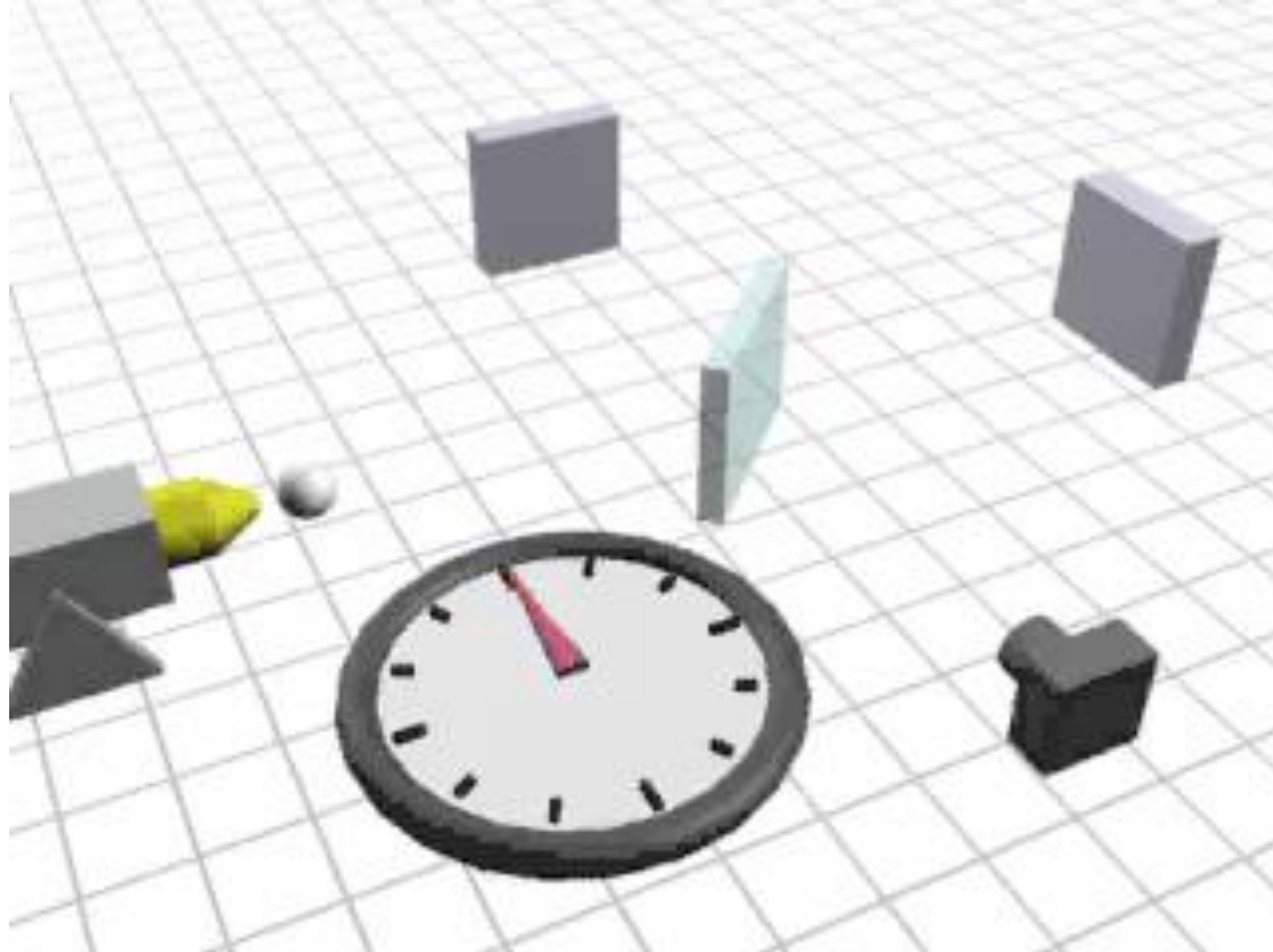
Michelson-Morley Interferometer



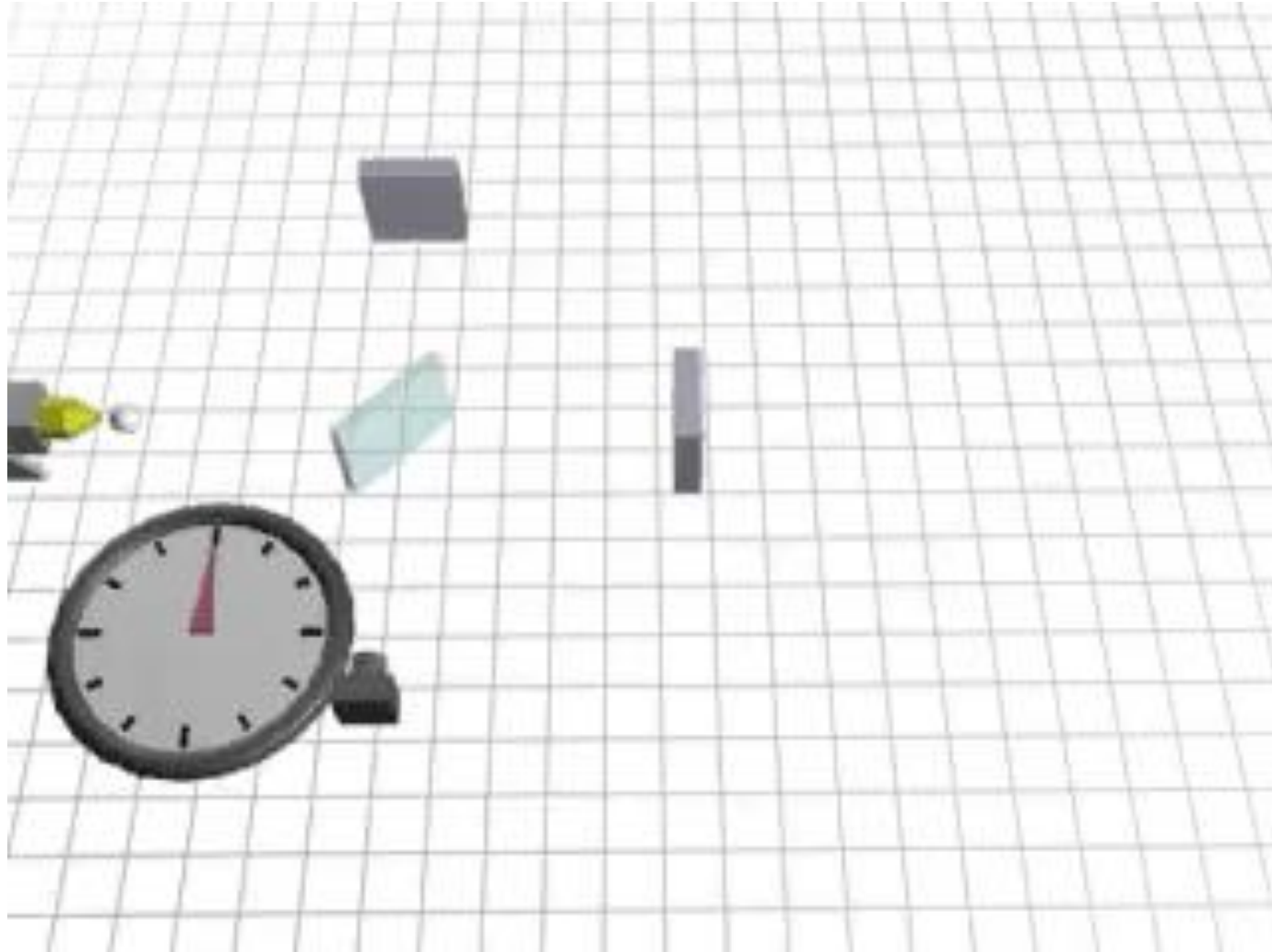
Michelson-Morley Interferometer: Two Swimmers



Michelson-Morley Experiment: Stationary in the Aether



Michelson-Morley Experiment: Moving through the Aether

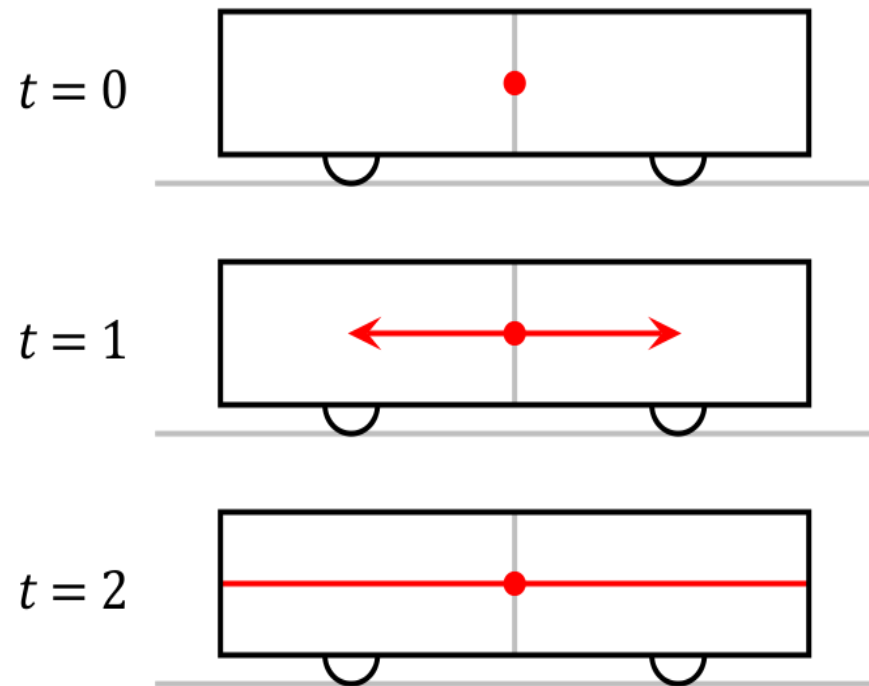


Einstein's Special Theory of Relativity

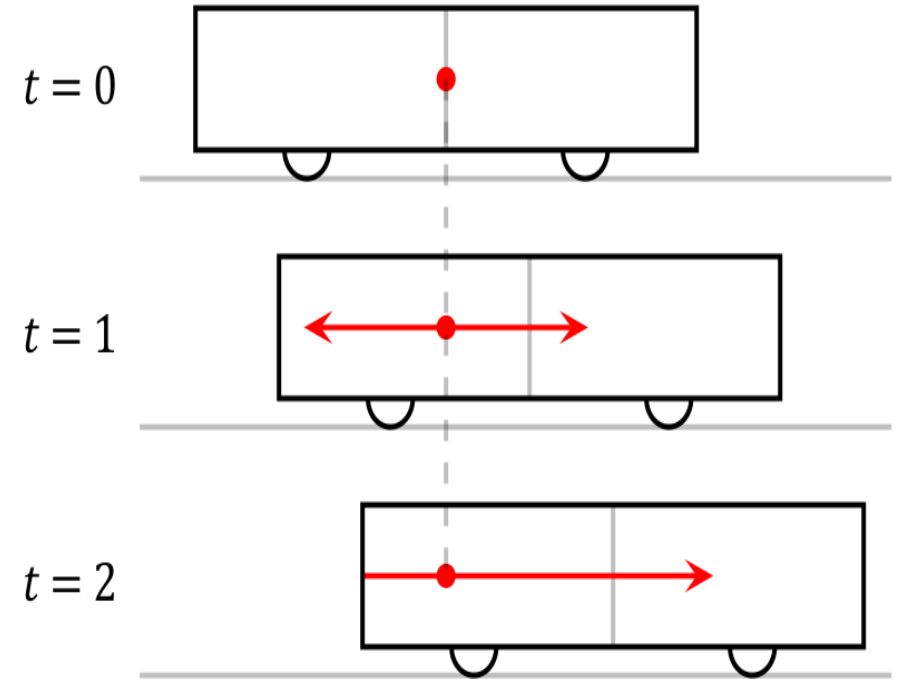
Two Postulates

- The laws of physics are the same for all observers in uniform motion relative to one another (***principle of relativity***).
- The speed of light in a vacuum is the same for all observers, regardless of their relative motion or of the motion of the light source (***constant speed of light***).

Relativity of Simultaneity

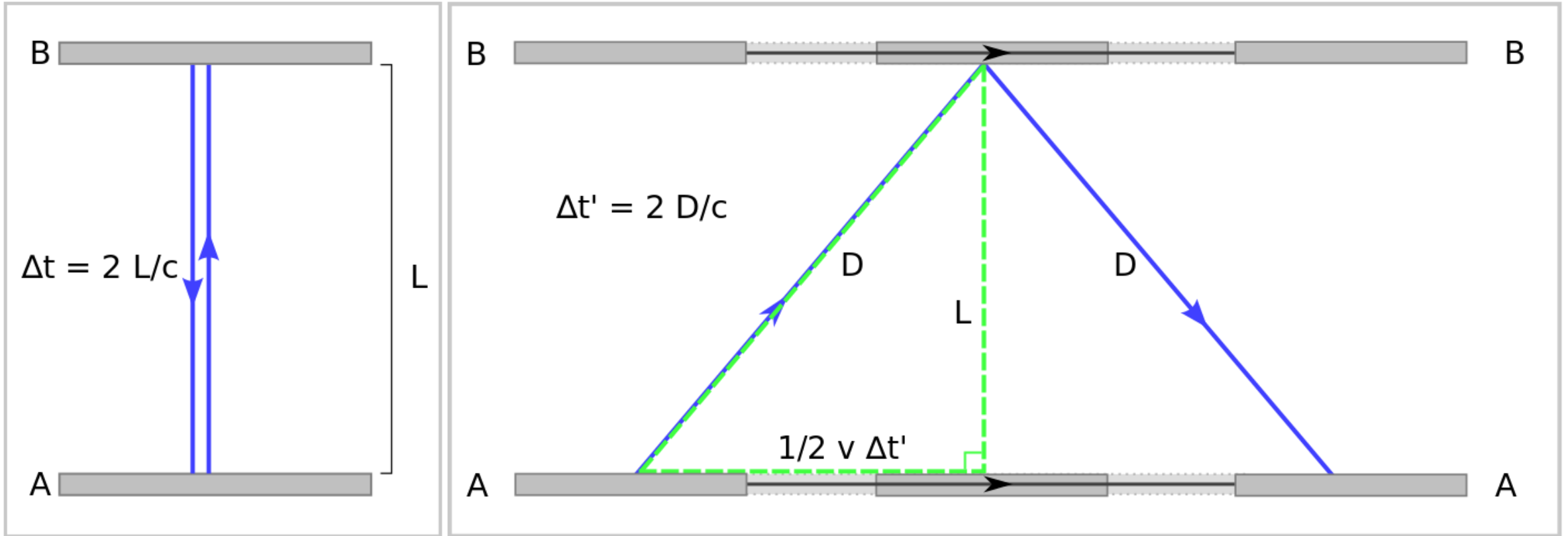


When you are inside the train



When you stand at the platform

Time Dilation

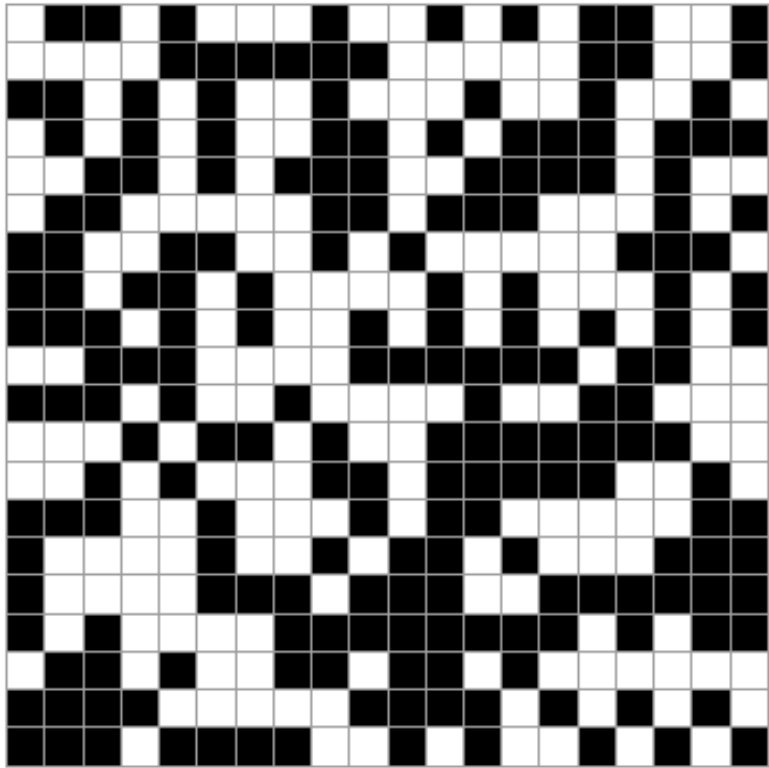


$$\Delta t' = \frac{\Delta t}{\sqrt{1 - \frac{v^2}{c^2}}}$$

Mass-Energy Equivalence

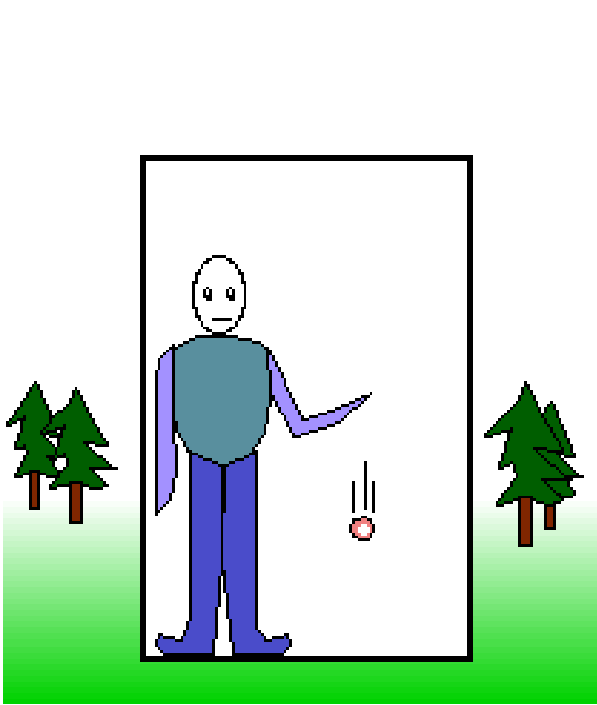
$$E = mc^2$$

Universe as A Cellular Automaton

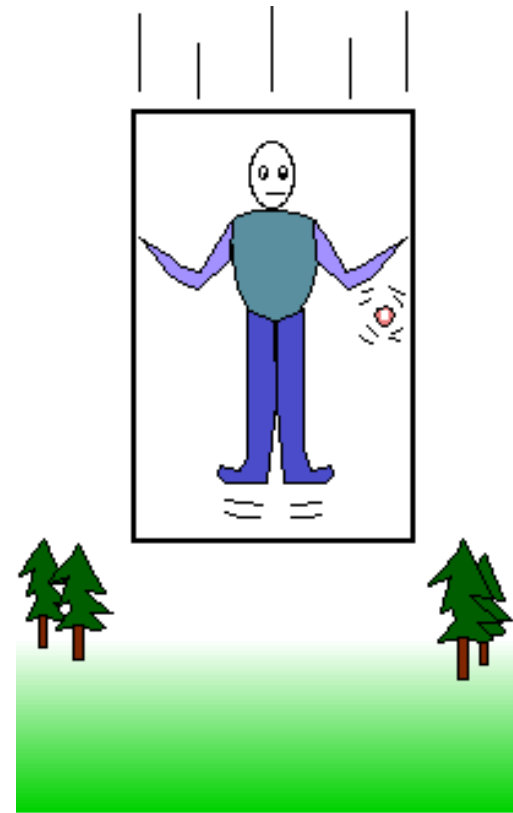
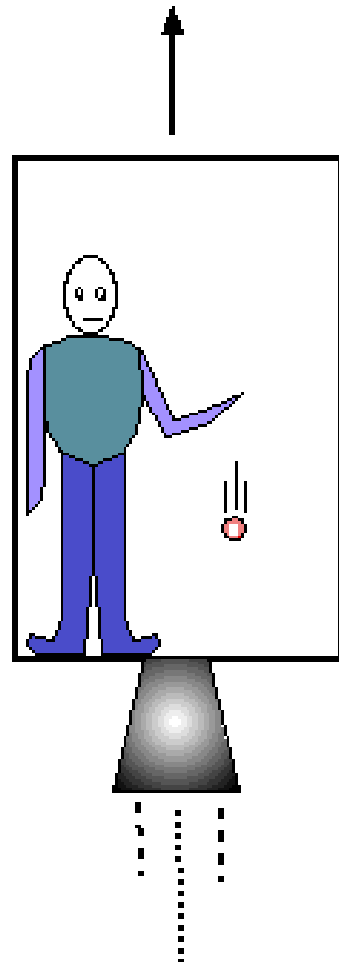


Einstein's General Theory of Relativity

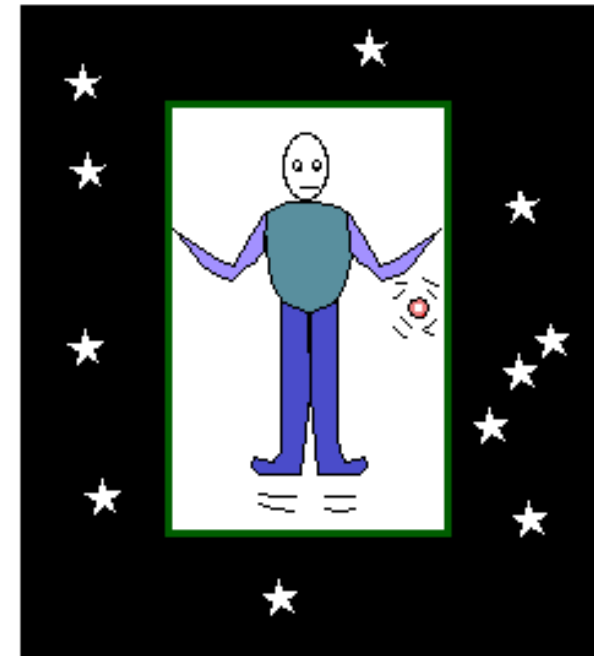
Equivalence Principle



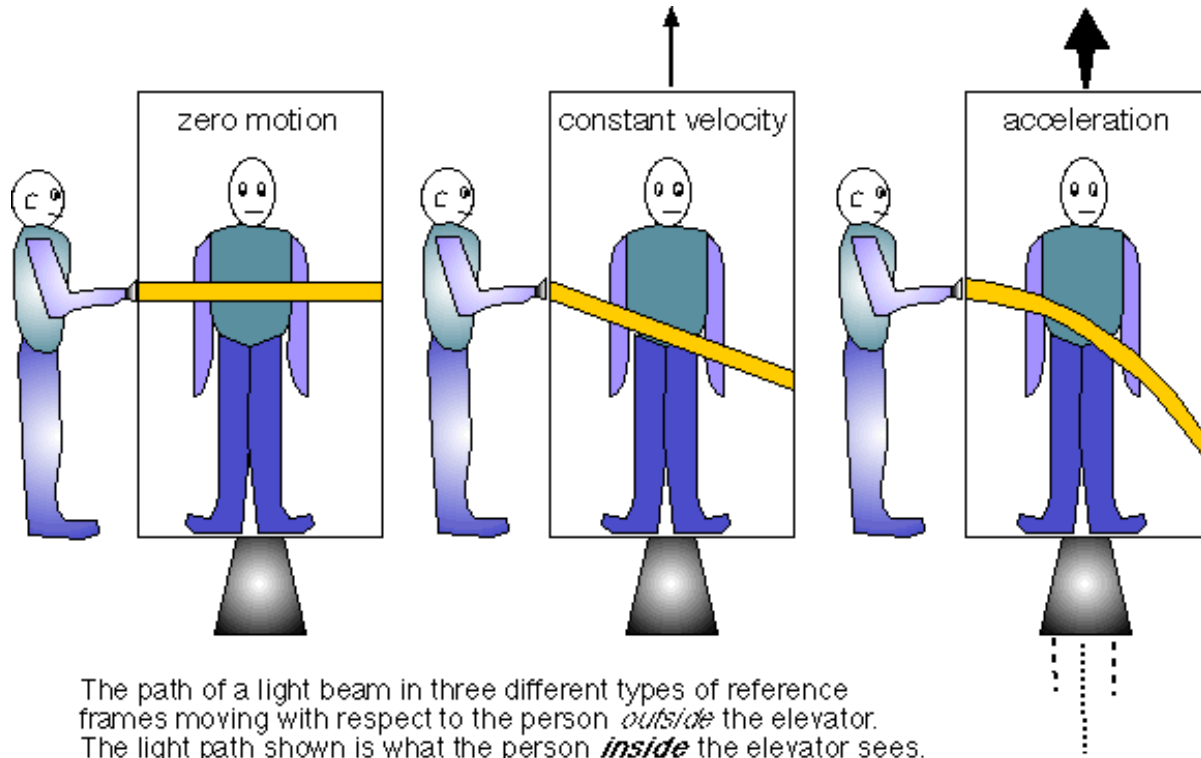
Things move the same way in a gravity field as those in a reference frame accelerating upward with the same magnitude.



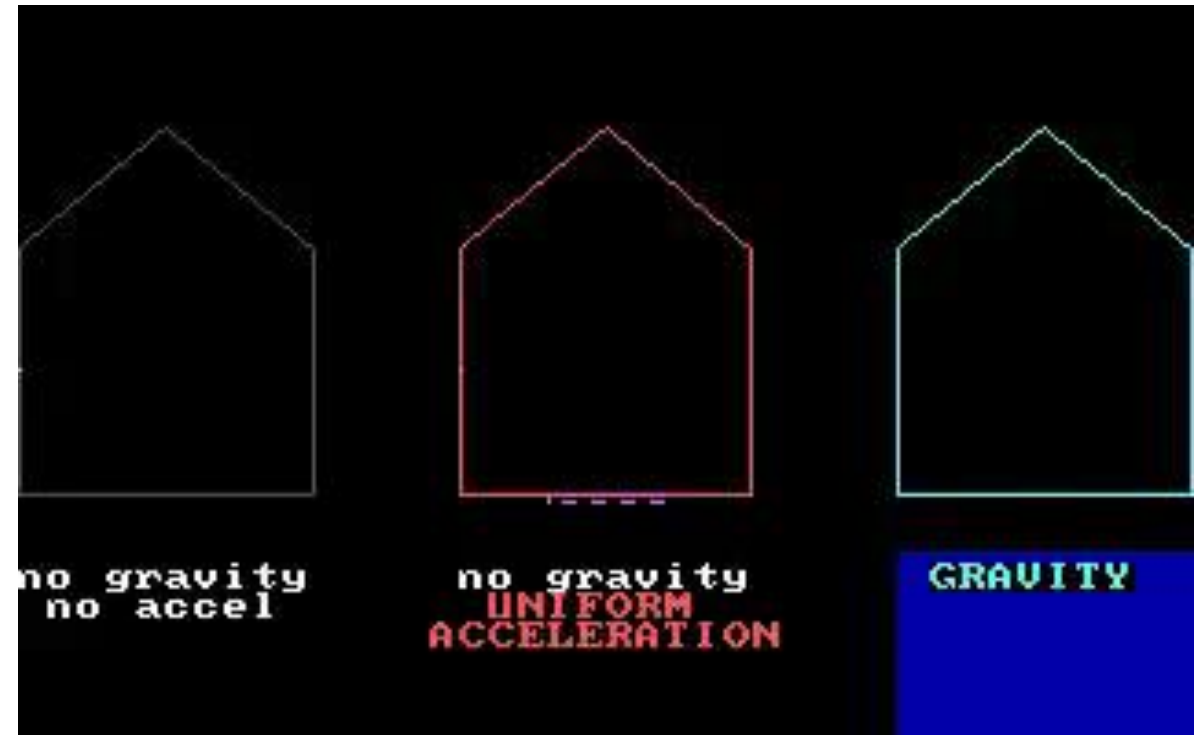
Things falling freely in a gravity field all accelerate by the same amount, so they move the same way as if they were in a region of zero gravity — “weightlessness”!



Light Paths under Gravity



The path of a light beam in three different types of reference frames moving with respect to the person *outside* the elevator. The light path shown is what the person *inside* the elevator sees. Under large acceleration, the beam of light will curve downward. It should also do that in a region of strong gravity.



Curved Spacetime

