The wave equation, Lorenz force law and classical mechanics

Light	Sound
$c=\sqrt{\frac{1}{\epsilon_0\mu_0}}$	$v=\sqrt{\gamma\frac{P}{\rho}}$
Can propagate in vacuum. So the velocity is w.r.t. what?	Needs a medium. The velocity is w.r.t the medium (like air, water)

The ether frame is a hypothetical inertial frame in which the speed of light was supposed to be c

$$\vec{F} = q\left(\vec{E}+\vec{v}\times\vec{B}\right)$$

Velocity may be different in different intertial frames

So how is the force going to be same in all intertial frames?

Maxwell's equations are NOT invariant under a Gallilean transformation

What does :: Laws of physics are same in all intertial frames :: mean ?

Suppose Z = X * Y is a law of physics.

In an intertial frame (S) some one measures the quantitites to be X, Y and Z

In another intertial frame (S') one measures the quantitites to be X', Y' and Z'

S will find Z = X * Y

S' will find Z' = X' * Y'

Further S will be able to predict what X', Y', Z' will be measured in the other frame.

This is the job of the transformation equations.

In general X,Y,Z and X',Y', Z' will not be same.

What if time (or time interval) is one of the quantities ? For example half life of a radioactive substance.

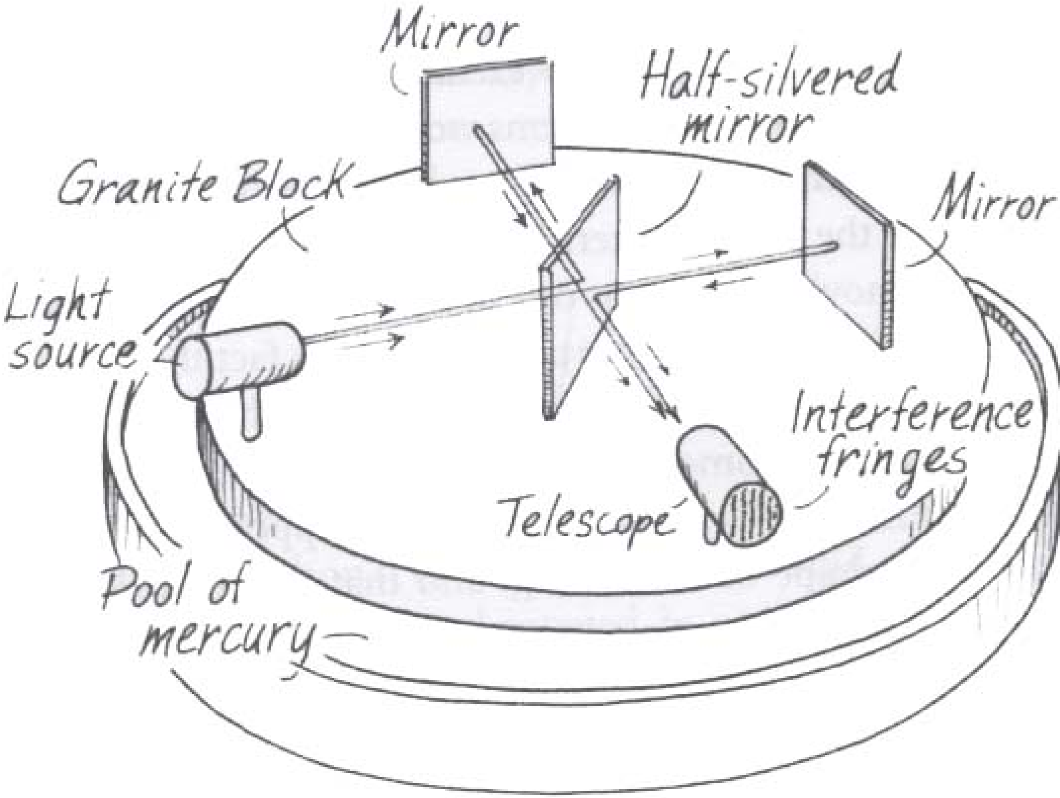
Time was thought to be universal....but that is NOT unambiguous.

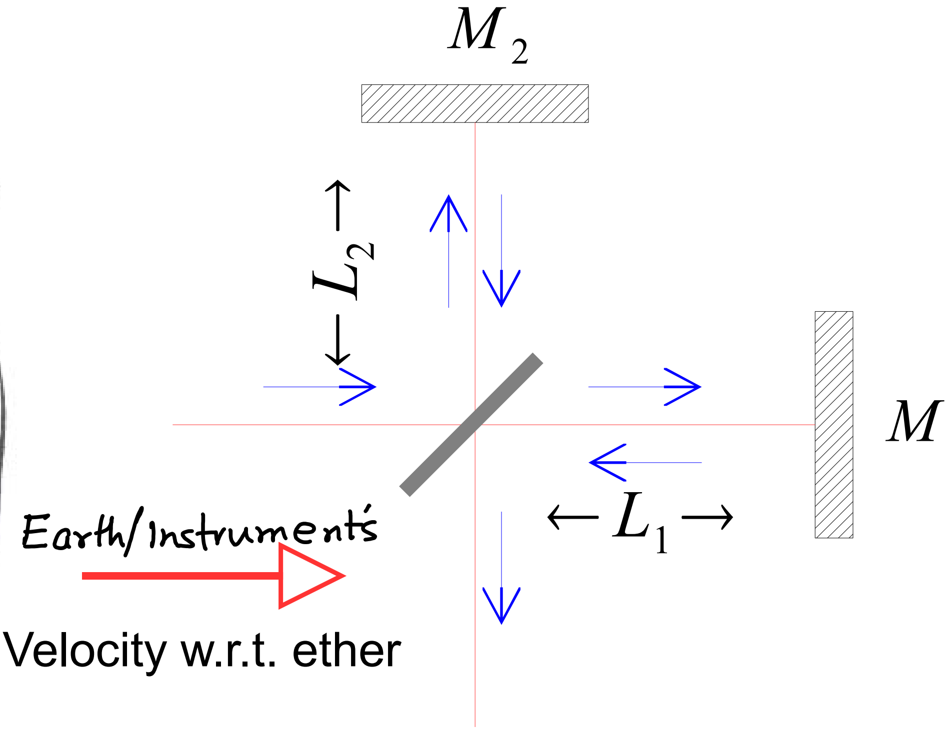
Newton : The universe HAS a clock.

Liebnitz : The universe IS a clock.

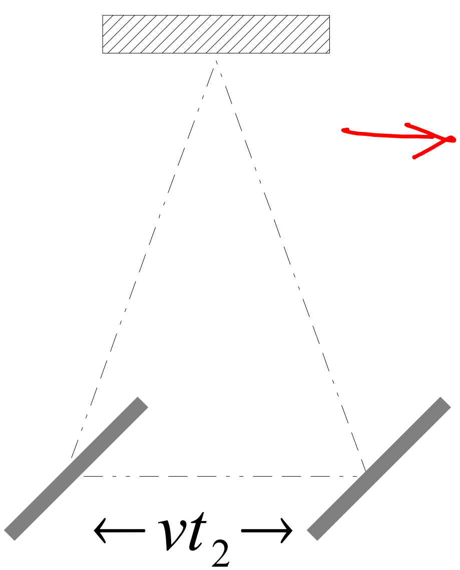
What is the difference ?

Michaelson Morley interferometer experiment



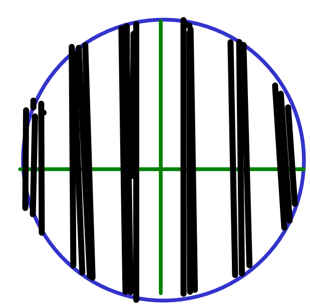


Observer
(fringes)



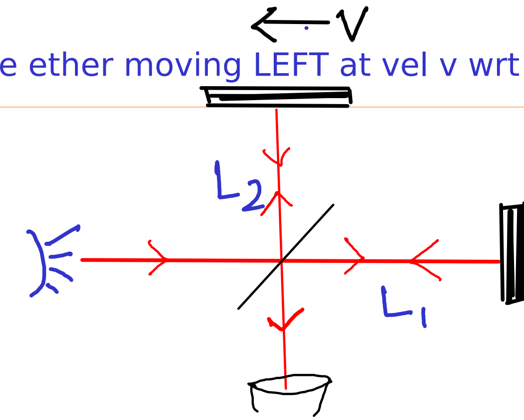
$\rightarrow$ V Instrument's speed wrt Ether

The reflection from M2
as seen by an observer
in the ether frame



Fringes

Michaelson Morley interferometer experiment: Assume ether moving LEFT at vel v wrt earth



To reach M_1 light takes : $\dfrac{L_1}{c-v}$

To come back : $\dfrac{L_1}{c+v}$

$$t_1 = \frac{2L_1 c}{c^2-v^2}$$

To reach M_2 and come back : $L_2^2 + \left(\dfrac{vt_2}{2}\right)^2 = \left(\dfrac{ct_2}{2}\right)^2$

takes $t_2 = \dfrac{2L_2}{\sqrt{c^2-v^2}}$

$$\Delta t = t_1 - t_2 = \frac{2L_1 c}{c^2-v^2} - \frac{2L_2}{\sqrt{c^2-v^2}}$$

Now turn the whole apparatus by 90°

$$\Delta t' = t_1' - t_2' = \frac{2L_1}{\sqrt{c^2-v^2}} - \frac{2L_2 c}{c^2-v^2}$$

$$\Delta t - \Delta t' = \frac{2(L_1+L_2)c}{c^2-v^2} - \frac{2(L_1+L_2)}{\sqrt{c^2-v^2}}$$

$\dfrac{(\quad)}{c^2(1-v^2/c^2)}$ $\qquad$ $\dfrac{(\quad)}{c\sqrt{1-v^2/c^2}}$

$$\approx \left(\frac{L_1+L_2}{c}\right)\frac{v^2}{c^2}$$

path diff λ
one fringe shift

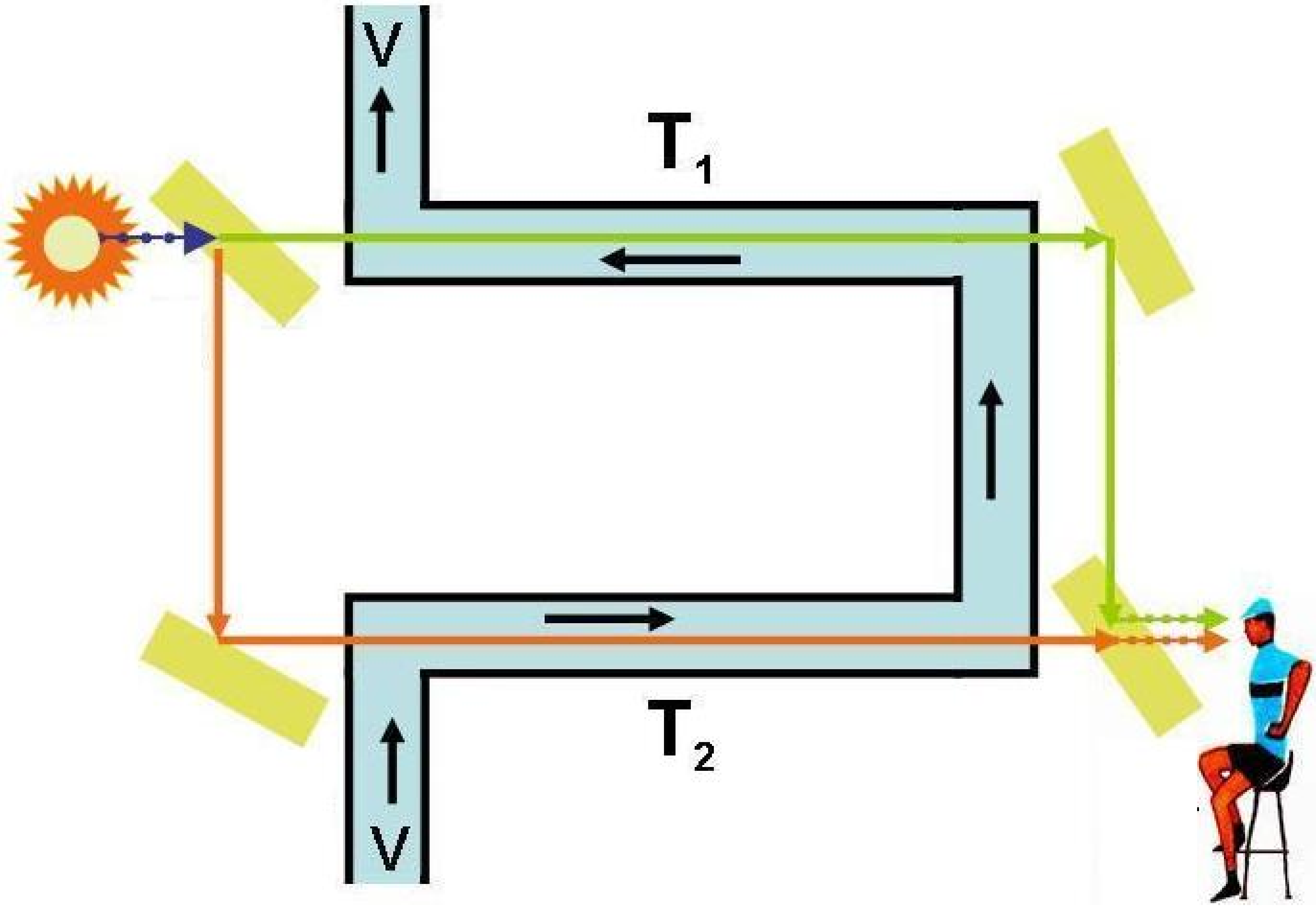
In experiment : $L_1 + L_2 \approx 22\,mt$: $\lambda = 500\text{nm}$

sensitivity 1/100 fringe : expect ~ 0.4 fringe shift for $\dfrac{v}{c} \approx 10^{-4}$

NO SHIFT was observed

$N = \Delta T / T$, $T = \dfrac{1}{\nu}$, $c = \nu\lambda$

Light in a moving medium : Fizeau



Fringe pattern changes when the flow is stopped

Infer the velocity of light from the fringe shift data

Light appears to be partially "dragged“ by the flowing medium.

$$v_{light} = \frac{c}{n} + v_{water}\left(1 - \frac{1}{n^2}\right)$$ Empirical