Why did we spend so much time discussing swimming in a river?

Well, because this example explains the underlying concept of the Michelson-Moveley experiment – one of the "milestone experiment" in the history of physics.

Some facts:

- In the 1860s, a Scottish physicist, James C. Maxwell, discovered a set of four differential equations that completely describe the electric and magnetic fields. Based on these equations, he predicted the existence of electromagnetic waves.
- Soon, the existence of electromagnetic waves was confirmed experimentally by Heinrich HERTZ. Also, physicists realized that LIGHT is just an electromagnetic wave.
- For the XIX-century physicists it was clear that all types of waves need a MEDIUM for propagating.

  For instance, as you know, sound waves can propagate in media such as gases, liquids and solids. They cannot propagate in vacuum because there is no medium!

- But light can very well propagate in vacuum! (otherwise, how would we be able to see distant stars?) So, XIX-century physicists postulated the existence of "LUMINIFEROUS ETHER -

a hypothetical substance (weightless, colorless, odorless...) filling the entire universe, and acting as a medium for light propagation ("luminiferous" means "light carrying" in Latin).

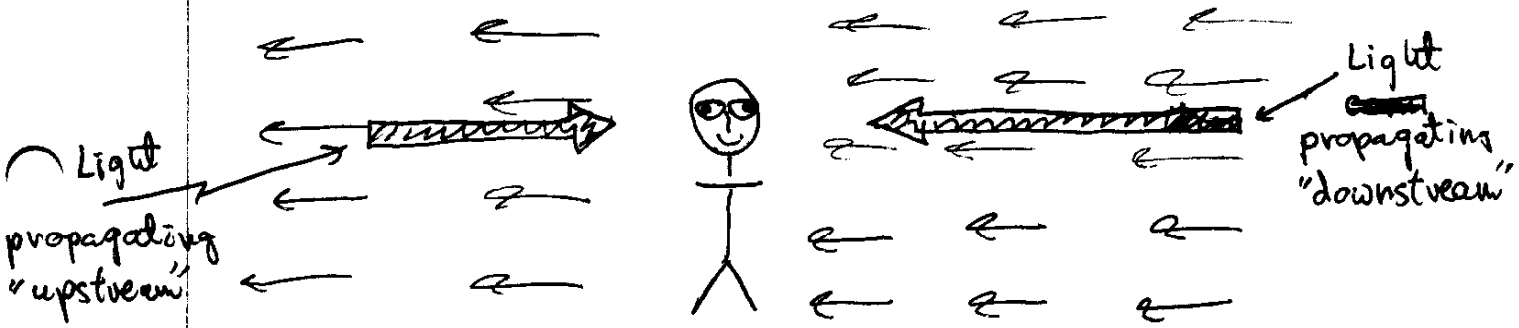
- Maxwell believed that the equations he discovered actually represented the <u>elastic properties</u> of the ether.

  (similarly, the equations describing sound waves are derived from the equations describing elastic distortions of solids).

- The "ether theory" seemed to be so well grounded that physicists overwhelmingly accepted Maxwell's explanation.

- In the closing decades of the XIX-th century, a large number of papers discussing the hypothetical properties of the hypothetical ether were published in scientific journals. One conclusion that emerged from those speculations was that the light propagation in ether should obey the principles of the classical (Galilean) relativity.

  Accordingly, if an observer were sitting in the middle of a "river of ether", light would behave like the swimmer in our example

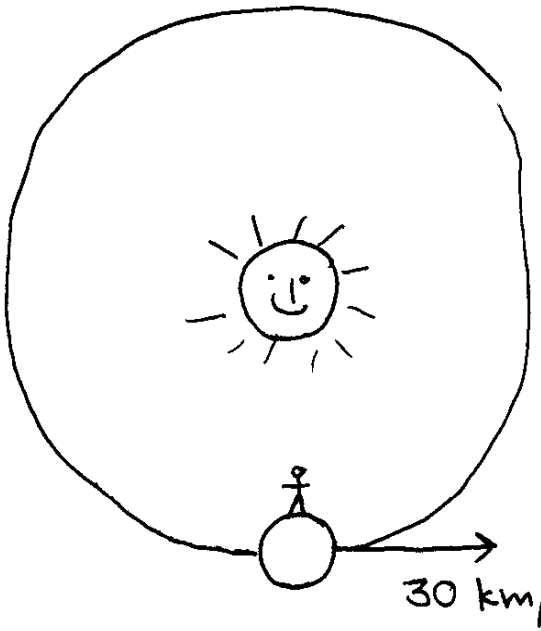


If the speed of light in stationary ether is **c** then the observer will see light propagating "downstream" with a $c+u$ speed, and light propagating "upstream" with a $c-u$ speed (where u is the "current speed" of the ether river).

Well, Michelson's idea was to test the above prediction experimentally.

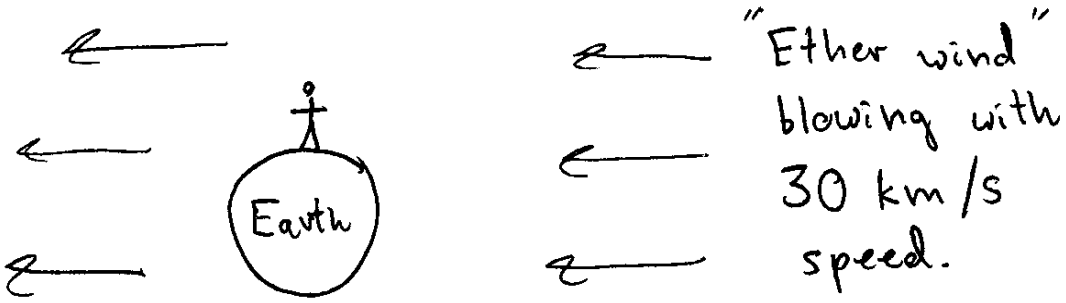
But where to find a suitable "ether river"?

No problem! – Michelson said. Earth is orbiting Sun with a velocity of 30 km/s



The solar system is immersed in ether, Michelson said.

So, the observer on Earth sees this situation as if he/she were sitting in the middle of an "ether river" (or "ether wind").



Michelsons idea was very simple: let's measure the difference of the speed of light propagating "upstream" and "downstream".

The experiment should yield a difference of 60 km/s

At Michelson's times, <u>direct</u> measurements were not yet feasible.

Michelson's idea was to use an ingenious <u>interferometry technique</u>.