# The Michelson-Morley Experiment as Evidence for Special Relativity

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Michelson & Morley's Interferometer experiment, 1887, appears to show that light travels at the same speed relative to any object, whatever speed that object itself is moving at. Light is split into two beams, to travel both across and along a framework moving at speed, then brought together again. No interference effect is detected, indicating that the light has taken the same time to travel along and across the framework even though one apparently involves a longer path than the other from the static viewpoint, due to the motion of the frame itself in one of those directions.

This 'null' result persuaded scientists of the time – and since – that light moves at the same speed in both directions relative to the frame, even though the frame is moving in one of those directions but not the other. Whilst this conclusion is very persuasive at a superficial level, it doesn't stand up to even fairly simple in-depth logical analysis.

It's agreed by every physicist from Einstein's time to present day (including Einstein himself) that an object moving at speed is contracted in its direction of motion by a clearly-defined factor – at least as measured by the static observer. This is an integral feature of Special Relativity (SR), it's also been proposed independently of SR (due to shortened molecular bonds) by three of Einstein's contemporaries: Larmor, Lorentz, FitzGerald – check out 'Lorentz-FitzGerald Contraction'. This makes sense, as there has to be an explanation for the M&M result from the static perspective.

The thing is, once that contraction is taken into account there's no mystery about M&M's result at all, nothing left to be explained; the maths work out perfectly with no special properties of light as proposed by SR. Those maths are given in detail below, there's nothing complicated about them; it's just straightforward high school (15/16 yr old) stuff.

The only question that's left hanging is: how is that in any way evidence for SR? For those who are determined to claim it as 'proof' of SR, there's another question: given that everyone agrees that contraction ***is*** happening for fast-moving objects as seen by the static observer, where's the evidence that this contraction ***isn't*** happening for an observer moving with that object? [*i.e.* that the object is different lengths for different observers – a bizarre claim that surely needs proof.]

This is a fairly crucial question. SR's 'explanation' for M&M's result includes length contraction "in the static frame", but it proposes that such contraction ***isn't*** happening "in the moving object's frame" (*i.e.* for an observer moving with the object). Since practical evidence is only available from the static frame (no-one has taken measurements whilst moving at ultra-high speeds), this is pure conjecture based on the assumption that SR is so. ***Assuming*** that SR is so leads to this result being accepted as evidence that SR ***is*** so – the perfect circular argument, and so no argument at all.

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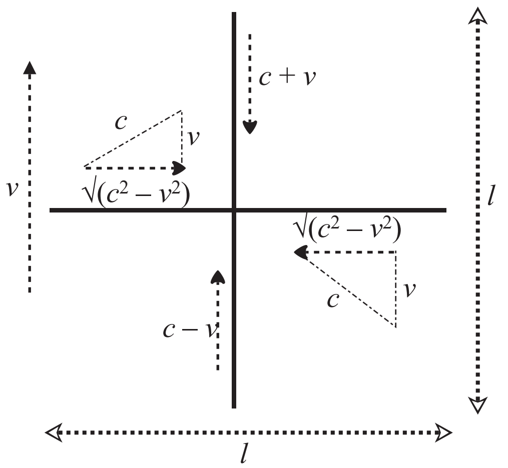
Let's consider two rods of equal length $l$, one oriented North-South and the other East-West, both mounted on a square board that's moving due North at speed $v$. Light runs from East to West along the 'horizontal' bar, then back again; at the same time light runs from South to North then back again along the 'vertical' bar.

[This is equivalent to light passing from the centre to one end, back to the other end then returning to the centre in each case.]

As the board moves due North, the path of the light travelling along the East-West rod will actually be a diagonal, since the rod itself is moving North as the light passes along it. The same will be true as the light on that rod returns to its Easterly end. Its speed in that diagonal direction is of course $c$, which includes a 'vertical' component $v$ – so the effective 'horizontal' component of speed will be $\sqrt{(c^2 - v^2)}$ in each direction, as shown in this diagram.




Meanwhile, as also shown in the diagram, the light running South-North-South will move over the board at a relative speed of $c - v$ on the upward path and $c + v$ on the downward path, since the board itself is moving with speed $v$.

The West-East-West light flow covers a distance of $2l$ across the board at a speed relative to the frame ('horizontally') of $\sqrt{(c^2 - v^2)}$. That gives a travel time of $\dfrac{2l}{\sqrt{(c^2 - v^2)}}$ . At the same time the North-South-North light flow covers distance $l$ 'up' the board at a speed across the board of $c - v$ followed by a distance $l$ 'down' the board at a speed across the board of $c + v$, taking times of $\dfrac{l}{c - v}$ and $\dfrac{l}{c + v}$ respectively. Adding those last two times we get $\dfrac{l}{c - v} + \dfrac{l}{c + v}$ , which add to give $\dfrac{2cl}{c^2 - v^2}$ total travel time up and back down the board.

From these results it's clear that travel time for the West-East-West light trip will be different from the time for the North-South-North trip – if the board measures the same in both directions. But here is where that contraction cuts in, in the direction of motion of the board. It's pretty well universally agreed that the board will be foreshortened in that direction by a factor $\sqrt{(c^2 - v^2)}/c$. So the light's travel time in that direction will be reduced by that same factor.

$\dfrac{2cl}{c^2 - v^2} \times \dfrac{\sqrt{(c^2 - v^2)}}{c}$ gives $\dfrac{2l}{\sqrt{(c^2 - v^2)}}$ – exactly the same as the travel time for the West-East-West trip.

Times along and across the moving board will coincide precisely, as in M&M's experiment – with no need at all for SR.