"Proof" of the constant speed of light

First off, while it's a bit unconventional to do so, I will be restricting myself to the MKS units system. That is, measures are taken in units of metres, kilograms, and seconds.

We will begin this analysis by assuming that the classical Maxwell equations are valid. These equations were empirically deduced, to quote my undergraduate E&M professor, "by men in drafty castles, wearing smelly wigs, rubbing bits of cat against bits of glass." They are:

$$\begin{array}{ll} \vec{\nabla} \cdot \vec{D} = \rho & \vec{\nabla} \cdot \vec{B} = 0 \\ \vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} & \vec{\nabla} \times \vec{H} = \vec{j} + \frac{\partial \vec{D}}{\partial t} \end{array} \tag{1}$$

Now, for reasons that will become clear we are interested in the propagation of light in a vacuum. So, it is sufficient to consider these equations in a vacuum, so called "free space." In free space, the following relations hold:

$$\begin{array}{ll} \rho = 0 & \vec{j} = 0 \\ \vec{D} = \epsilon_0 \vec{E} & \vec{H} = \frac{1}{\mu_0} \vec{B} \end{array} \tag{2}$$

Where ϵ_0 and μ_0 are fundamental physical constants describing properties of the vacuum in MKS units.

Substituting these values in to equations 1 yields:

$$\begin{array}{ll} \epsilon_0 \vec{\nabla} \cdot \vec{E} = 0 & \vec{\nabla} \cdot \vec{B} = 0 \\ \vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} & \vec{\nabla} \times \vec{B} = \epsilon_0 \mu_0 \frac{\partial \vec{E}}{\partial t} \end{array} \tag{3}$$

We can combine the bottom two equations to produce:

$$\vec{\nabla} \times (\vec{\nabla} \times \vec{E}) = -\epsilon_0 \mu_0 \frac{\partial^2 \vec{E}}{\partial t^2} \tag{4}$$

Exploiting the fact that $\vec{\nabla} \cdot \vec{E} = 0$ allows us to write this as:

$$\vec{\nabla}^2 \vec{E} = \epsilon_0 \mu_0 \frac{\partial^2 \vec{E}}{\partial t^2} \tag{5}$$

This is just a wave equation for the electric field, and represents a wave whose speed of propagation is $\frac{1}{\sqrt{\epsilon_0 \mu_0}}$.

All this was just to arrive at the following observation: if the we are to believe Maxwell's equations, we are forced to conclude that the speed of light is a function solely of the two parameters ϵ_0 and μ_0. These two parameters are physical constants describing the properties of the vacuum.

If we now assume that the laws of physics are constant for observers moving with fixed but different velocities, then we have to conclude that the speed of light itself is a constant for these different observers. This conclusion has been verified experimentally in the negative results of searches for the "luminiferous ether."