See also: https://www.youtube.com/watch?v=pTn6Ewhb27k (Derek Muller's Veritasium)
https://www.youtube.com/watch?v=ff0aofh6urU
http://henk-reints.nl/astro/HR-speed-of-light.pdf

Measuring the *speed of light* by sending it to a mirror $@d$ that reflects it back, how Einstein described it in "Zur Elektrodynamik bewegter Körper" (1905).

We'll use: $\zeta c =$ "emitted speed of light"
in http://henk-reints.nl/astro/HR-Hubble-Lemaitre-slideshow.pdf
is derived ζ should equal the light source's
Doppler factor as "observed" by the mirror,
but we will use that only in 2nd instance.

and: $\eta c =$ returning speed of light.

Einstein: $\boldsymbol{c = \frac{2d}{\Delta t}}$ (Zur Elektrodynamik bewegter Körper)

hence: $\Delta t = \frac{2d}{c}$

Mirror's velocity: $v,\ \beta = \frac{v}{c}$ ($v = \frac{\partial d}{\partial t}$ is positive if distance increases)

Way out: $\Delta t_0 = \frac{d}{\zeta c}$

way back: $\Delta t_1 = \frac{d}{\eta c}$

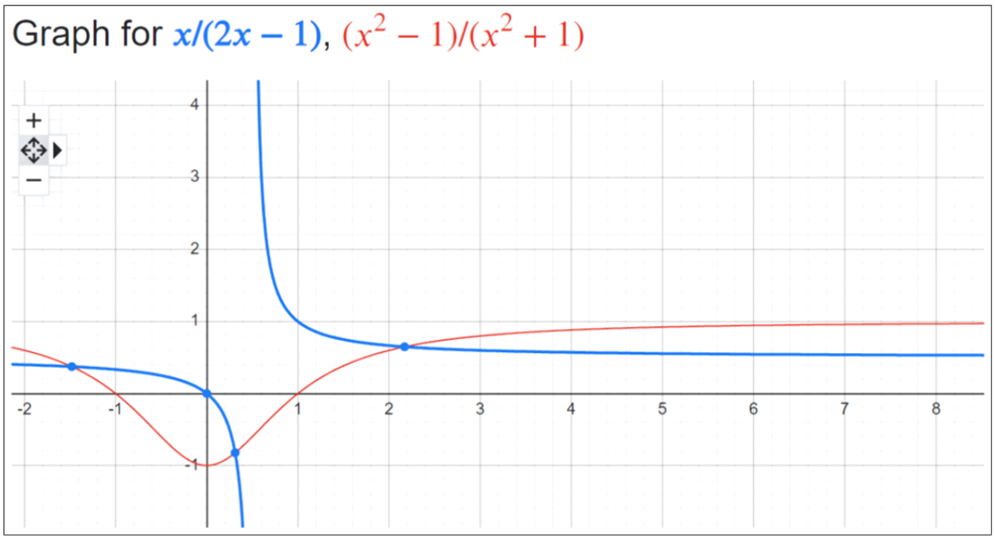
Total: $\Delta t = \Delta t_0 + \Delta t_1 = \frac{d}{\zeta c} + \frac{d}{\eta c} = \frac{\eta c d}{\eta c \zeta c} + \frac{\zeta c d}{\eta c \zeta c} = \frac{\eta c d + \zeta c d}{\eta c \zeta c} = \frac{(\eta+\zeta)d}{\eta \zeta c}$

Obviously: $\frac{2d}{c} = \frac{(\eta+\zeta)d}{\eta\zeta c} \therefore \frac{(\eta+\zeta)}{\eta\zeta} = 2 \therefore \eta + \zeta = 2\eta\zeta$

$\therefore \zeta = 2\eta\zeta - \eta = \eta(2\zeta - 1)$

yielding: $\eta = \frac{\zeta}{2\zeta - 1}$ (requirement to render c as the back & forth average speed of light).

eta and beta as function of zeta (x in the graph, hor. axis):



Please note: negative zeta is malarkey. (graph made by Google).

For the curve of β, ζ is presumed a moving object's Doppler factor.

Doesn't the blueshift part ($0 < \zeta < 1$) look weird, especially the asymptote at $\zeta = \frac{1}{2}$? And wouldn't a negative η be rather senseless? Wouldn't this already indicate the whole concept of two speeds of light is bunkum? We have not yet made use of ζ being equal to the mirror's Doppler factor (only for graphing the β curve).

For any meaningful measurement, one should always use non-moving stationary equipment that is pleonastically standing still at one point in space without displacement, i.e. having: $\beta = 0 \therefore \zeta = \sqrt{\frac{1+\beta}{1-\beta}} = 1$, yielding: $\eta = \frac{\zeta}{2\zeta - 1} = 1$, so there is no net Doppler effect and with $\zeta = \eta = 1$ we have one single speed of light in both directions. Now we *did* use $\zeta =$ mirror's Doppler factor, as aforementioned.

Presuming $v \ll c$, we can use the Classical Doppler effect in good approximation. We'll have to multiply the Doppler factors that apply to each one-way journey.

Way out, mirror "observes": $\frac{\nu_{\text{mir}}}{\nu_{\text{src}}} = \frac{\zeta c - v}{\zeta c} = \frac{\zeta - \beta}{\zeta}$

way home, mirror acts like source, we observe it: $\frac{\nu_{\text{obs}}}{\nu_{\text{mir}}} = \frac{\eta c}{\eta c + v} = \frac{\eta}{\eta + \beta}$

Their product equals: $\frac{\nu_{\text{obs}}}{\nu_{\text{src}}} = \frac{\zeta - \beta}{\zeta} \cdot \frac{\eta}{\eta + \beta} = \frac{\eta(\zeta - \beta)}{\zeta(\eta + \beta)}$

Total Doppler factor: $\xi := \frac{\nu_{\text{src}}}{\nu_{\text{obs}}} = \frac{\zeta(\eta + \beta)}{\eta(\zeta - \beta)}$ (the reciprocal thereof)

we had found: $\eta = \frac{\zeta}{2\zeta - 1}$

yielding: $$\xi = \frac{\zeta\left(\frac{\zeta}{2\zeta-1} + \beta\right)}{\frac{\zeta}{2\zeta-1}(\zeta - \beta)} = \frac{\left(\frac{\zeta}{2\zeta-1} + \beta\right)}{\frac{\zeta-\beta}{2\zeta-1}} = \frac{(2\zeta-1)\left(\frac{\zeta}{2\zeta-1} + \beta\right)}{\zeta - \beta} = \frac{\zeta + \beta(2\zeta - 1)}{\zeta - \beta} = \frac{\zeta - \beta + 2\zeta\beta}{\zeta - \beta}$$

WolframAlpha:

Taylor @$\beta = 0$: $$\xi = 1 + 2\beta + \frac{2}{\zeta}\beta^2 + \frac{2}{\zeta^2}\beta^3 + \frac{2}{\zeta^3}\beta^4 + \mathcal{O}(\beta^5) \qquad \text{[A]}$$

Classical Doppler effect with just one speed of light:

$$\frac{c+v}{c} \cdot \frac{c}{c-v} = \frac{1+\beta}{1-\beta} = 1 + 2\beta + 2\beta^2 + 2\beta^3 + 2\beta^4 + \mathcal{O}(\beta^5) \qquad \text{[B]}$$

Relativistic:

light source's mirror image seems to distantiate itself

at a velocity of: $\frac{2\beta}{1+\beta^2}$ (relativistic velocity addition)

rel. Doppler: $\sqrt{\frac{1 + \frac{2\beta}{1+\beta^2}}{1 - \frac{2\beta}{1+\beta^2}}} = \sqrt{\frac{1+\beta^2+2\beta}{1+\beta^2-2\beta}} = \sqrt{\frac{(1+\beta)^2}{(1-\beta)^2}} = \frac{1+\beta}{1-\beta}$ same as classical!

Obviously, either [A] or [B] is correct, or both are equal, implying $\zeta = 1$. Correctness of [A] would still yield just one and only one correct value of ζ, or would ζ depend on β? And how plausible would $\zeta \neq 1$ be when looking at these equations?
Would measurements confirm correctness of [B], then we're there: $\boldsymbol{\zeta = 1 \therefore \eta = 1}$.
I do not know if for example radar guns for speed measurements (as used by the police in many countries) are accurate up to the 2nd order. Fact is that there can be just one $\{\zeta, \eta\}$ pair matching reality and to me, $\{1{,}1\}$ seems the most plausible.

In what I can find about Doppler measurements of satellites, I see no anomalies. Especially GPS is *very* accurate! See http://henk-reints.nl/astro/HR-speed-of-light.pdf for a bit more about GPS, which effectively ***does*** measure the *one-way speed of light* in all directions and it ***does*** have an accuracy within 8 metres (in 95% of open-field measurements)!

As mentioned above, it should also be that: $\zeta = \sqrt{\frac{1+\beta}{1-\beta}} \therefore \beta = \frac{\zeta^2-1}{\zeta^2+1}$ (which is relativistic, hence exact)

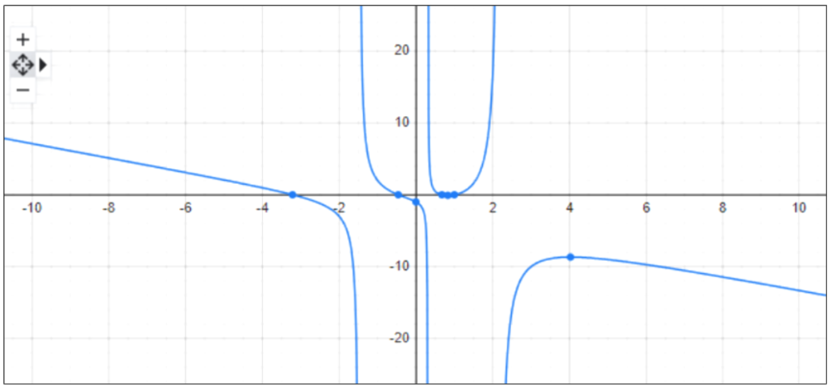
yielding:

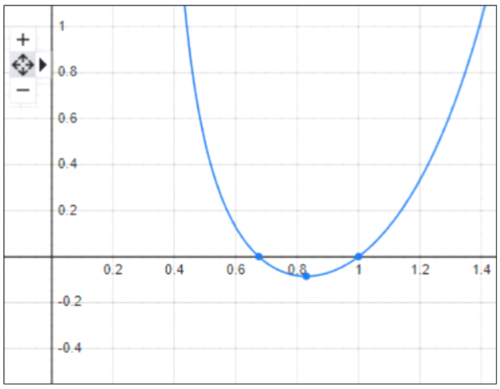
$$\frac{\nu_{\text{src}}}{\nu_{\text{obs}}} = \frac{\zeta+(2\zeta-1)\beta}{\zeta-(2\zeta-1)\beta} = \frac{\zeta+(2\zeta-1)\frac{\zeta^2-1}{\zeta^2+1}}{\zeta-(2\zeta-1)\frac{\zeta^2-1}{\zeta^2+1}} = \frac{\zeta(\zeta^2+1)+(2\zeta-1)(\zeta^2-1)}{\zeta(\zeta^2+1)-(2\zeta-1)(\zeta^2-1)}$$

$$= \frac{(\zeta^3+\zeta)+(2\zeta^3-\zeta^2-2\zeta+1)}{(\zeta^3+\zeta)-(2\zeta^3-\zeta^2-2\zeta+1)} = \frac{\zeta^3+\zeta\ +\ 2\zeta^3-\zeta^2-2\zeta+1}{\zeta^3+\zeta\ -\ 2\zeta^3+\zeta^2+2\zeta-1} = \frac{3\zeta^3-\zeta^2-\zeta+1}{-\zeta^3+\zeta^2+3\zeta-1}$$

It should also be that: $\frac{\nu_{\text{src}}}{\nu_{\text{obs}}} = \zeta$ (actually the premise of the current derivation).

Difference would be: $\frac{\nu_{\text{src}}}{\nu_{\text{obs}}} - \zeta = \frac{3\zeta^3-\zeta^2-\zeta+1}{-\zeta^3+\zeta^2+3\zeta-1} - \zeta = \frac{(1-\zeta)(\zeta^3+3\zeta^2-\zeta-1)}{\zeta^3-\zeta^2-3\zeta+1}$





WolframAlpha:

Taylor @$\zeta = 1$: $(\zeta-1) + 3(\zeta-1)^2 + (\zeta-1)^3 + 3(\zeta-1)^4 + \mathcal{O}((\zeta-1)^5)$

with $z = \zeta - 1$: $z + 3z^2 + z^3 + 3z^4 + \mathcal{O}(z^5)$

In 1st order, the difference equals z, yielding a factor of 2 w.r.t. Doppler effect already being z !

Roots: $\zeta \in \{\mathbf{1},\ \sim 0.67513,\ \sim -0.46081,\ \sim -3.2143\}$

Please remember the usage of the classical Doppler effect, which only applies to $\zeta \approx 1$. Together with the weirdness of the graph, $\zeta \ll 1$ or $\zeta \gg 1$ makes no sense at all and $\zeta < 0$ is malarkey. This leaves $\zeta = 1$, meaning that the mirror is not moving, i.e. $v = 0$. And it yields $\eta = 1$ and then the speed of light definitely is the same in both directions.

* * * * *

YOUR brainchildren are wrong, not the cosmos!

(My intention was to use *brainchild* as a pejorative term!)