variable speed of light theories
https://en.wikipedia.org/wiki/Variable_speed_of_light
I may never fully understand theoretical physics/astrophysics and don't know what the answer is to
https://en.wikipedia.org/wiki/Variable_speed_of_light - about gravitational constant G and the Finestructure constant.
Why can't you go faster than light? Fermilab 2017
https://youtu.be/A2JCoIGyGxc

Quantum Gravity: How quantum mechanics ruins Einstein's general relativity Arvin Ash Oct 2020
https://youtu.be/S3Wtat5QNUA

When theory conflicts with observation then observation prevails. We have solid observation for time dilation, viewed the further we are from any mass, so "varying in space or time" is a fact, though it isn't clear to what extent this occurs outside of our solar system or galaxy. GPS satellite adjustment for time dilation is quite interesting, and highly suggestive of significant time difference outside the solar system.
I've done all I know how to thus far, and defer to phDs for building on other questions raised. My ADD prevents me remembering enough theory to master others physics questions, i'm out of my depth on theoretical physics.

$$v_{ph}=\frac{1}{\sqrt{\mu_0\mu_r\epsilon_0\epsilon_r}}$$

https://en.wikipedia.org/wiki/Maxwell%27s_equations - is the speed of light (i.e. phase velocity) in a medium with permeability mu0, and permittivity epsilon0. In a vacuum, vp = c0 = 299,792,458 meters per second, a fundamental physical constant.

$$v_{ph}=\frac{1}{\sqrt{\mu_0\epsilon_0}}$$

https://en.wikipedia.org/wiki/Electromagnetic_wave_equation - is the speed of light (i.e. phase velocity) in a medium with permeability mu0, and permittivity epsilon0. In a vacuum, vph = c0 = 299,792,458 meters per second, a fundamental physical constant.

Permeability of free space, in a vacuum
mu0 = 1.25663706212(19)x10-6 H/m

Permittivity of free space
epsilon0 = 8.854,187,8176x10-12
so
1 / Sqrt(1.25663706212(19)x10-6 x
8.854,187,8176x10-12)
= 299,792,457.9 ie the speed of light

https://en.wikipedia.org/wiki/Vacuum_permeability
https://en.wikipedia.org/wiki/Permittivity

It seems mu0 and epsilon0, in a vacuum, needn't thus far be correct in free interstellar and intergalactic space. Being measured SI units, it hasn't been possible to measure them outside of our solar system or Milky Way galaxy. We can improve on those measurements by partially going beyond the immediate extent of the solar system. Something of that is also mentioned in this video which comments on time dilation for GPS measurements - https://youtu.be/Z4oy6mnkyW4 . Some clarification is here https://en.wikipedia.org/wiki/Gravitational_time_dilation and https://www.britannica.com/science/time-dilation and Time Dilation - Einstein's Theory Of Relativity Explained! https://youtu.be/yuD34tEpRFw

Someone stated that Einstein's equations 1916 were built on the shoulders of Maxwell's equations 1873. But in Maxwell's and Einstein's times we weren't able to measure or theorize about permeability0 or permittivity0 outside our Milky Way galaxy or

perhaps our solar system.
(https://en.wikipedia.org/wiki/Speed_of_light#Measurement)
Why is the speed of light what it is? Maxwell equations vizualised.

It's clear that the speed of light has only been measured within our Milky Way galaxy, so we can't be scientifically certain what it's speed is in the weak gravitational field of intergalactic space (and there may be some variation within interstellar space too). The furthest measurement is stated to be that of James Bradley in 1728, "Gamma Draconis is at a distance of 154.3 light-years (47.3 parsecs) from the Sun,[1] as determined by parallax measurements from the Hipparcos astrometry satellite" ie well within the stated 100,000 light year diameter of the Milky Way.

https://en.wikipedia.org/wiki/Gamma_Draconis

https://en.wikipedia.org/wiki/James_Bradley

Measurements of upto 1000 parsecs will be valid as they're determined by trigonometry. But such measurements are limited to within the Milky Way galaxy, so aren't applicable to intergalactic light-years/speed. Again similarly, "We can be confident from physical parallax measurements using simple trigonometry, by the Hubble Space Telescope, that at least a "size"/distance up to a maximum of about 1000 parsecs or 3,260 light years (for parallax measurements) can be used for Stellar Aberration measurements for stars in our galaxy, ie still within the Milky Way."

Also General Relativity predicts that time dilation occurs ("varying in space or time") the closer to any mass. GPS satellite adjustment for time dilation is quite interesting, and highly suggestive of significant time dilation, viewed outside the solar system. see https://youtu.be/Z4oy6mnkyW4 General Relativity: Top 05 Mishaps [inc INTERSTELLAR].
We know that GPS satellites are adjusted for time dilation, so any

testing for that can improve on those adjustments the further we go from Earth orbit. Eventually a more ideal time dilation test will be done in interstellar space, but in the meantime we can improve on currently known results as we go incrementally further from Earth, out into the solar system away from the Sun and planets beyond the heliosphere.

c = 1 / Sqrt(1.25663706212(19)x10-6 x 8.854,187,8176x10-12)
= 299,792,457.9 ie the speed of light
Again, when theory conflicts with observation then observation prevails.
https://physics.info/general-relativity/
Time dilation is

$$t' = \frac{t}{\sqrt{(1 - \frac{2Gm}{rc^2})}}$$

Given above that time dilation t' includes c^2, which can be calculated from mu0 and epsilon0, we know that time dilation also depends on permeability and permittivity of free space. Time (dilated) will vary with respect to c, the further it is viewed from any mass.
where...
t = duration of an event in the gravitational field of some object (a planet, a sun, a black hole)
t' = duration of the same event when viewed from infinitely far away (a hypothetical location where the gravitational field is zero)
m = mass of the gravitating object
r = distance from the gravitating object to where the event is occurring (their separation)
c = speed of light in a vacuum (a universal, and apparently unchanging constant)
G = universal gravitational constant (another universal, and apparently unchanging constant)

In Einstein's theory of relativity, space and time became a thing - a thing that could do stuff like expand, contract, shear, and warp (or bend or curve).

(An aside - For the curious intellectual, here is a proposed revised concept of the ether, in relation to GPS satellites [5.8 Summary of ether-dragging hypothesis](#))

https://en.wikipedia.org/wiki/Speed_of_light#Measurement
Why can't you go faster than light? Fermilab 2017
https://youtu.be/A2JCoIGyGxc
We know for certain that time slows down in proximity to any mass, and in (Albert Einstein's Theory of Relativity it says that [15mins 7secs] in black holes spacetime curvature becomes infinite and time stops altogether), and conversely time is faster away from all mass. It's not clear to me if the permeability and permittivity of free space might possibly be different outside of any gravitational field, and similarly we can't be sure if gravitational constant G and the Finestructure constant vary. Someone said that Relativity theory includes the possibility of wormholes, where travelling through space is much quicker. (Will Wormholes Allow Fast Interstellar Travel? PBS Space Time July 2020 youtube) If that's a real scientific possibility according to Relativity theory then time itself could also speed up the further away from any mass.

Atomic Clocks Are Reinventing Time
Bloomberg Quicktake 20/2/21
https://youtu.be/hzLTgtFaPLY

How Atomic Clocks Work
Dom Burgess 2017
https://youtu.be/l8CI3bs9rvY