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Chapter 1 : Main differences between Lightspeed Retail & Lightspeed Onsite

It's no longer necessary for us to apply the earlier SR idea that lightspeed has to be globally constant across the region, it turns out that Nature is happy to violate that rule, as long as lightspeed is still locally constant. So if an observer is drifting in a strong-gravity region where gravitational time dilation is causing their clocks to.

Of course, you would require more than the energy in the whole known universe in order to attain c being massive. The only thing for certain is that the speed of light appears to be constant. In fact no one yet has been able to actually prove it. Einstein would have been better of saying he thinks the speed of light is the fastest thing in the universe. Phaedrus February 19, at 8: First of all, you have to understand, there is no such thing as an absolute speed. All motion is relative to something. Speed is a measure of how fast something is moving relative to something else. It has a speed in relation to other things. Every object in the universe could be said to have almost an infinite number of speeds, because there are an almost infinite number of other things to move in relation to. So to say that an object cannot move beyond the speed of light, that necessarily means you are saying that there is no thing in the entire universe which is moving at a speed faster than c in relation of this object you are talking about. When you talk about going faster and faster towards the speed of light, people think you are in this spaceship and the speedometer needle is rotating to the right more and more, but is slowing down as it approaches this RED line which indicates light speed. And the space ship is ready to explode or something. Your mass is increasing to infinity! Your time is slowing and slowing. If something on the other side of the galaxy is moving away from us here on earth, at a speed approaching c, then we are also, moving away from that object at a speed approaching c. So right now as you sit here reading this, you may very well be moving at a speed in relation to another object in the universe, which is all speed is that is close to the speed of light. Do you feel you are highly massive because of this? Do you feel your time is highly retarded? Do you feel you are thinner in one dimension than normal? No, you feel just fine. Its only the people on that other object on the other side of the galaxy as they look at you on your planet earth, they will see these effects, such as your time being slowed down in comparison. Lets say you are going on a journey to another star, that is 4 light-years away from here. Both our ship and this other ship are now moving at. So lets imagine a huge inertial frame in space that includes these 2 stars. That will be like an objective inertial frame over which these space ships will travel. When the 2 rockets, one from earth and one from planet B meet in the middle, they are both going. Looking down on this inertial frame from above, the 2 spaceships are approaching one another at a speed of 1. Now, in my view, that shows that things CAN travel at a speed greater than the speed of light. Because ship A the one from earth is moving with respect to ship B at a speed greater than light. We are talking about the speed that ship B will be perceived to be moving in relation to the inertial frame defined by space ship A. Because of the relativity equations, you will see the ship is NOT moving in relation to inertial frame based on ship A at a speed greater than the speed of light. From ship A, if they look at ship B, it will be shortened in the direction of travel. The mass of ship B will be way up. The ticks of a clock on ship B will be way slowed down from those on the observers on ship A. But are all these effects really happening to ship B? Or are they just distortions based on the great speeds that are being attained between the 2 ships. I think if these effects actually happen as anticipated by the special theory of relativity, then I would say if anything they are distortions of perceptions from one ship to the other. If you really want to see whats happening between these 2 ships, you move up off the inertial plane which contains the 2 stars and the 2 star ships, and from that vantage point, you can see that the ships are approaching one another at a speed of 1. So, I think what you want to do is, remember, that when you hear scientists and journalists talking about this idea that nothing can exceed the speed of light, what they really mean is that, no observer will ever directly measure some object or wave or whatever, moving at a speed greater than the speed of light. The people on ship A will see time slowed down on ship B, but they will know that this is a perceptual distortion based on their moving past ship B at a very high rate of speed. They know these are all distortions caused by fact they are moving with respect to each other at high rate of speed. But they know in reality both ships are the same. And if you look at things from objective point of view, they are approaching each other faster than the speed of light. And remember, there is no such thing as absolute speed, right? There is only speed in relation to something else. And if you are flying in a space ship to another star system, it is perfectly reasonable for you to have a speed in relation to another space ship also flying to your star system. And thus your speed in this case is a speed that exceeds the speed of light. Notice that throughout this whole thought experiment, I am living within the constraints laid out by the special relativity theory. And still I came away with one object moving faster than the speed of light in relation to another object. People talk about not being able to exceed the speed of light, like outer space is the big 3-D grid and everything is just sitting there in this grid and moving in relation to this grid. Well, that is old Newtonian thinking. Now, its true that I am sort of trying to critique the new Einsteinian view of things, but I do believe that there is not some absolute grid underlying space or something like that. Jesse May 9, at All speed is relative to something. Time and distance are inter-related thoughts. Perhaps time IS distance. The Aussies will go mad.

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Chapter 2 : Speed of Light in Gravity

The speed of light in vacuum, commonly denoted c, is a universal physical constant important in many areas of blog.quintoapp.com exact value is ,, metres per second (approximately , km/s (, mi/s)).

We stand shoulder to shoulder with our Dealer Partners to understand their unique business, passion, and clientele. Together, with our Dealer Partners, we will deliver the best customer experience in the industry. We know by putting people and partners first, everything else falls into place. We want the strength of our commitment to be delivered through the strength of our partners. Become an exclusive Dealer Partner: Allow our teams to work with you. Experience the benefits as a Client using our LED displays: Utilize the power of advertising with LED displays to spur action. Start a career at Vantage LED: I started this company in with a handful of dedicated individuals, and now, we have grown to a team of experienced, passionate people creating solutions and driving innovation. In everything you do, make an impact. We are all involved in your success. We have the most passionate and accessible CEO in the industry who always takes on the challenge to innovate our products, our systems, and our offerings daily to help push our partners, drive our company, and push this industry forward. New software features and hardware do not enter the field without rigorous testing and development. After thorough research, a seamless field introduction is initiated with proper follow through. A seamless transition into the field means little to zero downtime. The most attentive Sales Team ready and willing to help our dealer partners be knowledgeable and competitive by providing effective solutions for their clients. By providing powerful insight and collateral, our clients gain the knowledge they need about this unique advertising medium. By striving to educate our clients with proper resources, true partnerships are the result. A dedicated team who constantly go above and beyond the call, donating their time to great organizations such as Mile Club , Red Nose Day, and Susan G. Komen for the Cure. To ensure this, the Team keeps an active inventory of product available from multiple sources to eliminate any delays , constant communication on the floor and a healthy work schedule to maintain motivation, quality and timeliness of product completion. An outstanding and proactive Support Team who deliver concierge level service for our dealer partners and their clients. With this proactive approach, we will not only retain the trust of our informed partners, but our product will continue to be an effective advertising tool for our partners end users, which is the ultimate goal. This is the value of being a trusted resource, manufacturer, and partner in this ever-changing industry. A very active and engaging Marketing Team who deliver exciting, new, and fun ways to help dealer partners and their teams. They take the initiative to reach out and provide effective resources and tools to build their brand, credibility, and their business, while always listening to new ideas and tools they need to succeed. All the teams of Vantage LED take the time to stop and focus on each other and our community. Our goal is to succeed with a great product which affords us to make the world a better place.

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Chapter 3 : The Speed of Light

FTL travel of non-information. In the context of this article, FTL is the transmission of information or matter faster than c, a constant equal to the speed of light in a vacuum, which is ,, m/s (by definition of the meter) or about , miles per second.

There is no limit on the value of a proper speed as a proper speed does not represent a speed measured in a single inertial frame. A light signal that left the Earth at the same time as the traveller would always get to the destination before the traveller. Possible distance away from Earth[edit] Main article: Space travel using constant acceleration Since one might not travel faster than light, one might conclude that a human can never travel further from the Earth than 40 light-years if the traveler is active between the age of 20 and A traveler would then never be able to reach more than the very few star systems which exist within the limit of 20â€”40 light-years from the Earth. This is a mistaken conclusion: Their speed will not be seen as higher than the speed of light by observers on Earth, and the traveler will not measure their speed as being higher than the speed of light, but will see a length contraction of the universe in their direction of travel. And as the traveler turns around to return, the Earth will seem to experience much more time than the traveler does. So, while their ordinary coordinate speed cannot exceed c, their proper speed distance as seen by Earth divided by their proper time can be much greater than c. This is seen in statistical studies of muons traveling much further than c times their half-life at rest , if traveling close to c. For example, this occurs in most glasses at X-ray frequencies. Such a wave component must be infinite in extent and of constant amplitude otherwise it is not truly monochromatic , and so cannot convey any information. However, even this situation does not imply the propagation of signals with a velocity above c, [16] even though one may be tempted to associate pulse maxima with signals. The latter association has been shown to be misleading, because the information on the arrival of a pulse can be obtained before the pulse maximum arrives. For example, if some mechanism allows the full transmission of the leading part of a pulse while strongly attenuating the pulse maximum and everything behind distortion , the pulse maximum is effectively shifted forward in time, while the information on the pulse does not come faster than c without this effect. The diffraction causes that the peak of pulse propagates faster, while overall power does not. However, in general relativity , velocity is a local notion, so velocity calculated using comoving coordinates does not have any simple relation to velocity calculated locally. Rules that apply to relative velocities in special relativity, such as the rule that relative velocities cannot increase past the speed of light, do not apply to relative velocities in comoving coordinates, which are often described in terms of the "expansion of space" between galaxies. All of these are currently traveling away from us at speeds greater than the speed of light. Because the Hubble parameter is decreasing with time, there can actually be cases where a galaxy that is receding from us faster than light does manage to emit a signal which reaches us eventually. Although the last scattering surface is not at any fixed comoving coordinate, the current recession velocity of the points from which the CMB was emitted is 3. At the time of emission their speed was Thus we routinely observe objects that are receding faster than the speed of light and the Hubble sphere is not a horizon. The current distance to this cosmological event horizon is about 16 billion light-years, meaning that a signal from an event happening at present would eventually be able to reach us in the future if the event was less than 16 billion light-years away, but the signal would never reach us if the event was more than 16 billion light-years away. The effect was predicted before it was observed by Martin Rees [clarification needed] and can be explained as an optical illusion caused by the object partly moving in the direction of the observer, [28] when the speed calculations assume it does not. The phenomenon does not contradict the theory of special relativity. Corrected calculations show these objects have velocities close to the speed of light relative to our reference frame. They are the first examples of large amounts of mass moving at close to the speed of light. Quantum mechanics[edit] Certain phenomena in quantum mechanics , such as quantum entanglement , might give the superficial impression of allowing communication of information faster than light. According to the no-communication theorem these phenomena do not allow true communication; they only let two observers in different locations see the same system simultaneously, without any way of controlling what either sees. Wavefunction collapse can be viewed as an epiphenomenon of quantum decoherence, which in turn is nothing more than an effect of the underlying local time evolution of the wavefunction of a system and all of its environment. Since the underlying behavior does not violate local causality or allow FTL communication, it follows that neither does the additional effect of wavefunction collapse, whether real or apparent. The uncertainty principle implies that individual photons may travel for short distances at speeds somewhat faster or slower than c, even in a vacuum; this possibility must be taken into account when enumerating Feynman diagrams for a particle interaction. However, macroscopically these fluctuations average out, so that photons do travel in straight lines over long i. Therefore, this does not imply the possibility of superluminal information transmission. There have been various reports in the popular press of experiments on faster-than-light transmission in optics â€" most often in the context of a kind of quantum tunnelling phenomenon. Usually, such reports deal with a phase velocity or group velocity faster than the vacuum velocity of light. Hartman effect The Hartman effect is the tunneling effect through a barrier where the tunneling time tends to a constant for large barriers. When the prisms are in contact, the light passes straight through, but when there is a gap, the light is refracted. There is a non-zero probability that the photon will tunnel across the gap rather than follow the refracted path. For large gaps between the prisms the tunnelling time approaches a constant and thus the photons appear to have crossed with a superluminal speed. Winful from the University of Michigan suggests that the Hartman effect cannot actually be used to violate relativity by transmitting signals faster than c, because the tunnelling time "should not be linked to a velocity since evanescent waves do not propagate". Casimir effect In physics, the Casimir effect or Casimir-Polder force is a physical force exerted between separate objects due to resonance of vacuum energy in the intervening space between the objects. This is sometimes described in terms of virtual particles interacting with the objects, owing to the mathematical form of one possible way of calculating the strength of the effect. Because the strength of the force falls off rapidly with distance, it is only measurable when the distance between the objects is extremely small. Because the effect is due to virtual particles mediating a static field effect, it is subject to the comments about static fields discussed above. In this experiment, the measurement of the state of one of the quantum systems of an entangled pair apparently instantaneously forces the other system which may be distant to be measured in the complementary state. However, no information can be transmitted this way; the answer to whether or not the measurement actually affects the other quantum system comes down to which interpretation of quantum mechanics one subscribes to. An experiment performed in by Nicolas Gisin at the University of Geneva has demonstrated non-local quantum correlations between particles separated by over 10 kilometers. A quantum physics experiment also performed by Nicolas Gisin and his colleagues in Geneva, Switzerland has determined that in any hypothetical non-local hidden-variables theory the speed of the quantum non-local connection what Einstein called "spooky action at a distance" is at least 10, times the speed of light. Delayed choice quantum eraser Delayed choice quantum eraser an experiment of Marlan Scully is a version of the EPR paradox in which the observation or not of interference after the passage of a photon through a double slit experiment depends on the conditions of observation of a second photon entangled with the first. This means that all inertial observers, regardless of their relative velocity , will always measure zero-mass particles such as photons traveling at c in a vacuum. These transformations have important implications: The relativistic momentum of a massive particle would increase with speed in such a way that at the speed of light an object would have infinite momentum. To accelerate an object of non-zero rest mass to c would require infinite time with any finite acceleration, or infinite acceleration for a finite amount of time. Either way, such acceleration requires infinite energy. Some observers with sub-light relative motion will disagree about which occurs first of any two events that are separated by a space-like interval. In special relativity the coordinate speed of light is only guaranteed to be c in an inertial frame ; in a non-inertial frame the coordinate speed may be different from c.

Chapter 4 : Physical constants - MATLAB physconst

In this theory, light is described by the fundamental excitations or quanta of the electromagnetic field, called photons. In QED, photons are massless particles and thus, according to special relativity, they travel at the speed of light in vacuum. Extensions of QED in which the photon has a mass have been considered. The limit obtained depends on the model used: Another reason for the speed of light to vary with its frequency would be the failure of special relativity to apply to arbitrarily small scales, as predicted by some proposed theories of quantum gravity. Refractive index In a medium, light usually does not propagate at a speed equal to c; further, different types of light wave will travel at different speeds. An actual physical signal with a finite extent a pulse of light travels at a different speed. The blue dot moves at the speed of the ripples, the phase velocity; the green dot moves with the speed of the envelope, the group velocity; and the red dot moves with the speed of the foremost part of the pulse, the front velocity The phase velocity is important in determining how a light wave travels through a material or from one material to another. It is often represented in terms of a refractive index. The refractive index of air is approximately 1. In exotic materials like Boseâ€"Einstein condensates near absolute zero, the effective speed of light may be only a few metres per second. However, this represents absorption and re-radiation delay between atoms, as do all slower-than-c speeds in material substances. As an extreme example of light "slowing" in matter, two independent teams of physicists claimed to bring light to a "complete standstill" by passing it through a Boseâ€"Einstein condensate of the element rubidium , one team at Harvard University and the Rowland Institute for Science in Cambridge, Mass. However, the popular description of light being "stopped" in these experiments refers only to light being stored in the excited states of atoms, then re-emitted at an arbitrarily later time, as stimulated by a second laser pulse. During the time it had "stopped," it had ceased to be light. This type of behaviour is generally microscopically true of all transparent media which "slow" the speed of light. In other materials, it is possible for the refractive index to become smaller than 1 for some frequencies; in some exotic materials it is even possible for the index of refraction to become negative. A pulse with different group and phase velocities which occurs if the phase velocity is not the same for all the frequencies of the pulse smears out over time, a process known as dispersion. Certain materials have an exceptionally low or even zero group velocity for light waves, a phenomenon called slow light , which has been confirmed in various experiments. It is impossible to transmit information with a light pulse any faster than the speed of the earliest part of the pulse the front velocity. It can be shown that this is under certain assumptions always equal to c. When a charged particle does that in a dielectric material, the electromagnetic equivalent of a shock wave , known as Cherenkov radiation , is emitted. This applies from small to astronomical scales. On the other hand, some techniques depend on the finite speed of light, for example in distance measurements. Small scales In supercomputers , the speed of light imposes a limit on how quickly data can be sent between processors. Processors must therefore be placed close to each other to minimize communication latencies; this can cause difficulty with cooling. If clock frequencies continue to increase, the speed of light will eventually become a limiting factor for the internal design of single chips. The relative sizes and separation of the Earthâ€"Moon system are shown to scale. Similarly, communications between the Earth and spacecraft are not instantaneous. There is a brief delay from the source to the receiver, which becomes more noticeable as distances increase. This delay was significant for communications between ground control and Apollo 8 when it became the first manned spacecraft to orbit the Moon: As a consequence of this, if a robot on the surface of Mars were to encounter a problem, its human controllers would not be aware of it until at least five minutes later, and possibly up to twenty minutes later; it would then take a further five to twenty minutes for instructions to travel from Earth to Mars. NASA must wait several hours for information from a probe orbiting Jupiter, and if it needs to correct a navigation error, the fix will not arrive at the spacecraft for an equal amount of time, creating a risk of the correction not arriving in time. Receiving light and other signals from distant astronomical sources can even take much longer. Astronomical distances are sometimes expressed in light-years , especially in popular science publications and media. Proxima Centauri , the closest star to Earth after the Sun, is around 4. Distance measurement Radar systems measure the distance to a target by the time it takes a radio-wave pulse to return to the radar antenna after being reflected by the target: The Lunar Laser Ranging Experiment , radar astronomy and the Deep Space Network determine distances to the Moon, [83] planets [84] and spacecraft, [85] respectively, by measuring round-trip transit times. High-frequency trading The speed of light has become important in high-frequency trading , where traders seek to gain minute advantages by delivering their trades to exchanges fractions of a second ahead of other traders. One way is to measure the actual speed at which light waves propagate, which can be done in various astronomical and earth-based setups. Historically, the most accurate results have been obtained by separately determining the frequency and wavelength of a light beam, with their product equalling c. Consequently, accurate measurements of the speed of light yield an accurate realization of the metre rather than an accurate value of c. Astronomical measurements Measurement of the speed of light using the eclipse of Io by Jupiter Outer space is a convenient setting for measuring the speed of light because of its large scale and nearly perfect vacuum. Historically, such measurements could be made fairly accurately, compared to how accurately the length of the reference distance is known in Earth-based units. It is customary to express the results in astronomical units AU per day. Another method is to use the aberration of light , discovered and explained by James Bradley in the 18th century. A moving observer thus sees the light coming from a slightly different direction and consequently sees the source at a position shifted from its original position. From the angular difference in the position of stars maximally By combining many such measurements, a best fit value for the light time per unit distance could be obtained. The relative uncertainty in these measurements is 0. On the way from the source to the mirror, the beam passes through a rotating cogwheel. At a certain rate of rotation, the beam passes through one gap on the way out and another on the way back, but at slightly higher or lower rates, the beam strikes a tooth and does not pass through the wheel. Knowing the distance between the wheel and the mirror, the number of teeth on the wheel, and the rate of rotation, the speed of light can be calculated. Because the mirror keeps rotating while the light travels to the distant mirror and back, the light is reflected from the rotating mirror at a different angle on its way out than it is on its way back. From this difference in angle, the known speed of rotation and the distance to the distant mirror the speed of light may be calculated.

Chapter 5 : "Relativity in Curved Spacetime" - Table of Contents

From the ceiling of passenger car, light ray is emitted down somewhat to the right. One passenger car is moving to the right, another passenger car is moving to the left at the same speed.

Updated by Don Koks. Original by Steve Carlip and Philip Gibbs The short answer is that it depends on who is doing the measuring: Does the speed of light change in air or water? Light is slowed down in transparent media such as air, water and glass. The ratio by which it is slowed is called the refractive index of the medium and is usually greater than one. When people talk about "the speed of light" in a general context, they usually mean the speed of light in a vacuum. They also usually mean the speed as measured in an inertial frame. This vacuum-inertial speed is denoted c. Is c, the speed of light in a vacuum inertial frame, constant? But this is not the end of the matter. The SI is based on very practical considerations. Definitions are adopted according to the most accurately known measurement techniques of the day, and are constantly revised. At the moment you can measure macroscopic distances most accurately by sending out laser light pulses and timing how long they take to travel using a very accurate atomic clock. The best atomic clocks are accurate to about one part in It therefore makes sense to define the metre unit in such a way as to minimise errors in such a measurement. The SI definition makes certain assumptions about the laws of physics. For example, it assumes that the particle of light, the photon, is massless. If the photon had a small rest mass, the SI definition of the metre would become meaningless because the speed of light would change as a function of its wavelength. The SI Committee could not just define it to be constant; instead, they would have to fix the definition of the metre by stating which colour of light was being used. Experiments have shown that the mass of the photon must be very small if it is not zero see the FAQ entry What is the mass of the photon? Any such possible photon rest mass is certainly too small to have any practical significance for the definition of the metre in the foreseeable future, but it cannot be shown to be exactly zeroâ€”even though currently accepted theories indicate that it is. This is actually a postulate of special relativity, discussed below. Previously the metre and second have been defined in various different ways according to the measurement techniques of the time. They could change again in the future. We now know that there are variations in the length of a mean solar day as measured by atomic clocks. Standard time is adjusted by adding or subtracting a leap second from time to time. There may have been even larger variations in the length or the metre standard caused by metal shrinkage. But the SI definition highlights the point that we need first to be very clear about what we mean by constancy of the speed of light, before we answer our question. We have to state what we are going to use as our standard ruler and our standard clock when we measure c. In principle, we could get a very different answer using measurements based on laboratory experiments, from the one we get using astronomical observations. We could, for example, take the definitions of the units as they stood between and Then, the metre was defined as 1,, Unlike the previous definitions, these depend on absolute physical quantities which apply everywhere and at any time. Can we tell if the speed of light is constant in those units? By eliminating the dimensions of units from the parameters we can derive a few dimensionless quantities, such as the fine-structure constant and the electron-to-proton mass ratio. These values are independent of the definition of the units, so it makes much more sense to ask whether these values change. If they did change, it would not just be the speed of light which was affected. All of chemistry depends on their values, and significant changes would alter the chemical and mechanical properties of all substances. Furthermore, the speed of light itself would change by different amounts according to which definition of units was used. In that case, it would make more sense to attribute the changes to variations in the charge on the electron or the particle masses than to changes in the speed of light. In any case, there is good observational evidence to indicate that those parameters have not changed over most of the lifetime of the universe. See the FAQ article Have physical constants changed with time? Note that the fine-structure constant does change with energy scale, but I am referring to the constancy of its low-energy limit. Special Relativity Another assumption on the laws of physics made by the SI definition of the metre is that the theory of relativity is correct. It is a basic postulate of the theory of relativity that the speed of light is the same in all inertial frames. This can be broken down into two parts: The speed of light is independent of the motion of the observer. The speed of light does not vary with time or place. To state that the speed of light is independent of the velocity of the observer is very counterintuitive. Some people even refuse to accept this as a logically consistent possibility, but in Einstein was able to show that it is perfectly consistent if you are prepared to give up assumptions about the absolute nature of space and time. In it was thought that light must propagate through a medium in space, the ether, just as sound propagates through the air and other substances. The two scientists Michelson and Morley set up an experiment to attempt to detect the ether, by observing relative changes in the speed of light as Earth changed its direction of travel relative to the sun during the year. To their surprise, they failed to detect any change in the speed of light. Fitzgerald then suggested that this might be because the experimental apparatus contracted as it passed through the ether, in such a way as to countermand the attempt to detect the change in velocity. Lorentz extended this idea to changes in the rates of clocks to ensure complete undetectability of the ether. Einstein then argued that those transformations should be understood as changes of space and time rather than of physical objects, and that the absoluteness of space and time introduced by Newton should be discarded. The theory is not only mathematically consistent, it agrees with many direct experiments. The Michelson-Morley experiment was repeated with greater accuracy in the years that followed. In Dayton Miller announced that he had detected a change in the speed of light and was even awarded prizes for the discovery, but a s appraisal of his work indicated that the most likely origin of his results lay with diurnal and seasonal variations in the temperature of his equipment. Modern instruments could easily detect any ether drift if it existed. Today, high energy physicists at CERN in Geneva and Fermilab in Chicago routinely accelerate particles to within a whisker of the speed of light. Any dependence of the speed of light on inertial reference frames would have shown up long ago, unless it is very slight indeed. Their measurements are actually made in a non-inertial frame because gravity is present. But what if we pursued the original theory of Fitzgerald and Lorentz, who proposed that the ether is there, but is undetectable because of physical changes in the lengths of material objects and the rates of clocks, rather than changes in space and time? For such a theory to be consistent with observation, the ether would need to be completely undetectable using clocks and rulers. Everything, including the observer, would have to contract and slow down by just the right amount. Such a theory could make exactly the same prediction in all experiments as the theory of relativity; but it would reduce the ether to essentially no more than a metaphysical construct unless there was some other way of detecting itâ€”which no one has found. In the view of Einstein, such a construct would be an unnecessary complication, to be best eliminated from the theory. The Speed of Light as Measured by Non-Inertial Observers That the speed of light depends on position when measured by a non-inertial observer is a fact routinely used by laser gyroscopes that form the core of some inertial navigation systems. These gyroscopes send light around a closed loop, and if the loop rotates, an observer riding on the loop will measure light to travel more slowly when it traverses the loop in one direction than when it traverses the loop in the opposite direction. This is known as the Sagnac Effect. The gyroscope does employ such an observer: You will sometimes find discussions that insist the only correct way to describe the Sagnac Effect is by reference to an inertial frame: Those who insist that non-inertial descriptions are invalid are like the man whose house is about to be picked up by a cyclone: But you might want to hang on to your house while doing so. I presume, too, that those who argue that distant measurements are all about coordinates and make no physical sense will have a problem with the fact that GPS works. But time certainly does run more quickly onboard a GPS satellite: These distant effects are perfectly real and physical. But the simple fact is that if you send two horses in opposite directions around the same race track, then the horse that crosses the finish line first must have run faster. The different arrival times of the two light beams have nothing to do with anything strange going on with "the geometry of spacetime": The observer sitting on the rotating loop concludes that the beams simply move at different speeds. But the observer on the loop is neither inertial nor sitting right next to each beam at all times of its flight. Discussing non-inertial observers can be simpler if we consider not the rotating frame of a laser gyroscope, but the "uniformly accelerated" frame of someone who sits inside a rocket, far from any gravity source, accelerating at a rate that makes them measure their weight as constant. So consider the question: The answer is then that 1 an observer stationed on the ceiling measures the light on the ceiling to be travelling with speed c, 2 an observer stationed on the floor measures the light on the floor to be travelling at c, but 3 within the bounds of how well the speed can be defined discussed below, in the General Relativity section , a "global" observer can say that ceiling light does travel faster than floor light. Begin with the relativity idea that an inertial observer does measure the speed of light to be c. Our standard of simultaneity says that right now on a particular planet in the Andromeda galaxy at the tail of the train, some clock reads zero just as ours reads zero, and that clock clicks at the same rate as ours. Suddenly the space between here and Andromeda has become like the train mentioned above: Imagine that two planets in that galaxy are 2 light-days apart, and one sends a pulse of light to the other. During the period that we accelerated and clocks in Andromeda jumped 2 days ahead of us, that light pulse travelled from one planet to the other. So while you accelerate towards Andromeda, both light and clocks i. So now transfer that discussion to a rocket you are sitting in, far from any gravity and uniformly accelerated, meaning you feel a constant weight pulling you to the floor. Light travels faster near the ceiling than near the floor. But if you are on the floor, you maintain that light travels faster than c near the ceiling. You can also infer that as a distant wavefront travels transversely to your "up" direction, the more distant parts of it will be travelling faster than the nearer parts. Think of another train behind you if you prefer, but now the velocity v has changed sign: So your changing standard of simultaneity makes clock readings behind you jump backwards, even though the "train clocks" themselves are still "timing forwards" as far as they are concerned. The clocks immediately behind you will appear almost normal, but at some critical distance further back, the amount by which your new standard of simultaneity makes them seem to jump back just balances the amount by which they have timed forwards, and the result is that, as far as your standard of simultaneity is concerned, they have stopped.

Chapter 6 : Is lightspeed constant only to the observer? | Yahoo Answers

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Why exactly is the speed of light constant in vacuum? A proof requires more than a phenomenon. This is an interesting philosophical question. Which theories whole structures, not just little fragmentary claims are right is in the end determined by mere phenomena. Nobody gave us any book of true assertions, we have to cobble them together out of observation and mathematical logic. Now it was logically possible that those laws were only true in one special reference frame, but by no experiment including the famous attempt by Michelson and Morley provided any evidence that they failed to work in any inertial frame. From this new framework, all sorts of other effects could be derived, and they were all confirmed. Among those many effects are the energy-dependent lifetimes of particles, the exact dynamics of fast-moving particles, the patterns of radiation from accelerating particles, the magnetism-like velocity-dependent term accompanying each fundamental force, etc. Ultimately, the framework ran into trouble with gravity, and had to be replaced by General Relativity, which in turn probably will ultimately have to be replaced maybe by something like String Theory some day. How can photons be massless? Thank you for your answer. Is there a rational reasoning to this phenomenon? Also, I have another question regarding light. If light can be sucked into a black body, then it must have mass, no matter how little. Thank you again for your time. Can you deduce the existence of a table from logical first principles? The sense that relativity is irrational rests on some common-sense assumptions about the nature of space and time. It turns out those common-sense assumptions are just wrong, usable only as good approximations for a limited range of phenomena. Relativity is a set of precise rules for describing how space-time looks from different viewpoints, just as objective and definite and logically consistent as common-sense, but not the same set of rules as common-sense. One is right and the other is wrong, and observation is what tells us which is which. There is no frame in which the light is standing still, since as we started with its speed is constant. Its rest mass is zero. There are zero-rest-mass things that always travel at c, and nonzero-rest-mass things that never travel at c. Some other experimental and theoretical ingredients which you may find also elsewhere on this site are given below. From this symmetry, all of electricity and magnetism can be derived, and it has been tested to exquisite precision, particularly in the quantum corrections to g-2 for the electron. People have worked very hard to test it, and to see if the model breaks down anywhere, but it works very very well. But we have evidence from high-energy particle collisions that this theory is just embedded in another beautiful model, the electroweak interaction, which describes the weak force, and the model is also spectacularly successful there too. We keep testing things at the edge of our knowledge, and modifying our models as we go along. But it does identify the photon as the thing that travels at the speed of light a similar symmetry applies to gluons, the massless carriers of the strong force. But now we are stuck with the problem of explaining why their masses are so small compared with everything else. Sorry to "annoy" you again. You stated that when light travels at light speed, it has zero mass. Light does serve as the source of a gravitational field. Semi-classically, then, you can think of it as having a gravitational mass and thus falling in a gravitational field. The rest of the curvature of the beam comes from the non-Euclidean curved nature of space in General Relativity. How do you measure the speed of light? The answer to this question might help in understanding why the speed of light is constant further. There are a number of ways to measure the speed of light. Earlier measurements were woefully wrong: Galileo and others tried to compare the speed of light to that of sound, unsuccessfully. The constancy of the speed of light is a different matter. All experiments, both in the laboratory and in astronomical measurements, have verified that this is true. Does the speed of light change? Hi, Thanks for the Reply!!. I Understand that the observations show the constancy of speed of light. Now I have another question. If we take the speed of light just after the big bang and the speed of light now, Is there a difference in the value of c? So far as we can tell, c has been fixed at least since a very short time after the Big Bang. Why assume light speed is constant? I used to believe that the speed of light was constant from all perspectives, therefore I assumed it was simple to prove. OK Im going back a few steps, but i was not satisfied with your answer of how it has been proven that lights speed is constant. First i would like to point out that the assumption that the speed of light is a constant is what allowed the present formulas and theories to be created; therefore obviously none of these formula can be used to prove the preceding presumption. That would be circular reasoning. Is there any experiment capable of demonstrating the consistency of the speed of light? Poincare said just that. If we try to define speed by using any physical objects at all to measure distance and time, the same physical objects give the same light speed for light going by us in any direction. Our neighbor who is moving past us tries the same measurements with identically constructed meter sticks and clocks, and gets the same speed. These sorts of measurements have been done repeatedly, starting with the famous Michelson-Morley experiment. We could stubbornly insist that only one of those frames is the "correct" one, but that assertion would tell us nothing new and correct about anything we observe. Or we could postulate with Einstein that all laws of physics, including ones to be discovered, will look the same in each frame. That was a spectacularly successful prediction for the many laws that have been discovered since Why would anybody choose such major complications, when the much simpler choice of having laws that are independent of spatial orientation works perfectly well? To repeat a philosophical point- yes all of science involves some circular logic. You try to find simple self-consistent rules and see which fit the phenomena. Is speed of light zero? Hi,I want to ask, Is it possible that the speed of light is zero and what we assume "speed of light is constant" is just expanding speed of our universe?. As we know that matter is deeply connected to space as a result we feel gravity,likewise light is also connected to space and when it is created it accelerates with the speed of expanding space because atoms are way too heavy when compared to light and light probably has the mass somewhat equivalent to that of space. Just a hypothetical thought. How could each ray have speed of zero? Does light have mass? Still unsatisfied with the initial answers to the question: If light would has mass, agrees with light being sensitive to the space curvature or a black whole. However, this idea conflicts with the initial assumptions: Why then speed of light is constant? Light which is traveling in a particular direction has no invariant mass, i. The E and p of the light enter into the General Relativistic gravity equations just like any other E and p. The geodesic paths followed by light are just the limiting paths for any particles whose velocity approaches c. By "semi-classically" we just meant "pretending that space is Euclidean". Could you follow up with an explanation of what inconsistency you believe you see? Thanks so much for your answer on this fascinating topic. I was unsatisfied with the idea of formulating two separate concepts of mass that are not intuitive. Are these supposed to be equivalent? Is such a movement part of an object momentum? Accordingly, I can understand that light moves faster because its momentum is much lower. However light is sensitive to gravity, for example light follows the geodesics in space. It is possible that neutrinos have even less mass, so they interact less with space curvature gravity and, therefore, they do not follow the earth warping space. Will this explain the fact that neutrinos may travels faster than light? Yes, the mass that appears in the gravity source term and the one that appears in the velocity-momentum ratio are the same thing. As you say, this equivalence is at the heart of General Relativity. You also ask if GR effects on neutrino travel might give the apparent faster-than-light travel reported by the group from CERN. The answer is no. The total GR effects on the coordinates near Earth are only around one part per billion, much smaller than the discrepancy reported for neutrino speeds. Now it may be that there was some subtle problem with clock synchronization involving GR effects as a clock was slowly transported from the neutron source to the detector. However, no such effect on the fast-traveling neutrinos themselves could be nearly large enough to account for the reported anomaly. The first questioner Bill asked a question which might be interpreted as: Given these considerations, my question is: There are really two questions there. The current answer is no. In fact, it would hardly even mean anything to derive c, since it has units e.

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Chapter 7 : Faster-than-light - Wikipedia

Lightspeed Technologies develops expert computer networking solutions to create positive, lasting outcomes for our customers. We do this by hiring the brightest; having an innate interest in constant research and development; and committing to our customers' success.

Ok I got a question. We also know that light cant escape a black hole gravity field. So lets assume I got a light source just near a black hole lets assume the gravity field is radial ,my light source is transmiting light outwards fron the black hole,in the exact oposite direction of the gravity vector. Now since we know the light cant escape than we know it will change direction and move to the black hole. Since the light changed its direction it had to slow down,stop and start accelerating in the diffrent direction. Thus not compling with what we all learnt,that light moves at a constant speed. Yes I know I look at this mostly on Newtonic physics,I would love to hear your quantom physics awnser to this. Note that the speed of light is always equal to c in special relativity. It is also always equal to c in General relativity, as long as one uses local clocks and rulers to measure that speed. This is important, because to use the slightly over-simple popular explanation clocks are known to tick at different rates depending on their location when one considers the effects of General relativity. It should be reasonably obvious that if clocks tick at different rates, one has to specify which clock to use to measure the time to compute the speed. There is, however, a choice of clock and a corresponding choice of ruler that makes the speed of light always constant and equal to c even in GR - this is a clock and ruler of some physical jargon: Suppose you are in a spaceship falling into a black hole. We will assum in this simple example that the spaceship is free-falling into the black hole and that its engines are off. The front of the spaceship emits a particle of light a photon, if you will, though you should think of it clasically and not quauntum mechanically just as it enters the event horizon. The light particle is emitted away from the black hole. The light particle will follow a very simple path. It will maintain constant Schwarzschild coordinates. To speak slightly losely, it will neither approach nor recede from the black hole, it will just "hang in space" - using Schwarzschild coordinates as a reference. The spaceship, however, can and must fall into the black hole. The person on the spaceship knows the length of the spaceship, and has clocks on the front and rear of the spaceship which he has synchronized. He computes the travel time from when the light particle was emitted at the front, and when the light particle is received at the back. Taking the length of the spaceship divided by the time to traverse it gives the speed of the light particle relative to the spaceship. In the book "Relativity: A curvature of rays of light can only take place when the velocity of propagation of light varies with position. Since Einstein talks of velocity a vector quantity: This interpretation is perfectly valid and makes good physical sense, but a more modern interpretation is that the speed of light is constant in general relativity. The problem here comes from the fact that speed is a coordinate-dependent quantity, and is therefore somewhat ambiguous. This is already true in special relativity: In special relativity, the speed of light is constant when measured in any inertial frame. In general relativity, the appropriate generalisation is that the speed of light is constant in any freely falling reference frame in a region small enough that tidal effects can be neglected. In this passage, Einstein is not talking about a freely falling frame, but rather about a frame at rest relative to a source of gravity. In such a frame, the speed of light can differ from c, basically because of the effect of gravity spacetime curvature on clocks and rulers. Thus, talking about "speed" is ambiguous, there are multiple definitions of what it might mean. With the modern definition of speed, the speed of light is always constant in SR and in GR. With some other defintions of speed, definitions which are commonly used though not "modern" , the speed of light is still always constant in SR, but with these alternate defintions, the speed is not necessarily constant in GR.

Chapter 8 : Two new ways to measure the gravitational constant

Table of Contents Welcome About the Author Lightspeed is locally constant Lightspeed is now defined as constant The gravity well.

Two new ways to measure the gravitational constant August 30, by Bob Yirka, Phys. G values obtained in this work compared with recent measurements. In their paper published in the journal Nature, the group describes the two methods and how accurate they were. Gravity is one of the four fundamental forces of nature the others are the weak and strong interaction and electromagnetism. Despite hundreds of years of concerted effort by scientists around the world, there is still no explanation for how it works. Adding to the frustration is the fact that no one has been able to find a way to measure its actual force â€"scientists have been trying to do that for hundreds of years, as well. In modern times, researchers have come very close, howeverâ€"the current accepted value is 6. In this new effort, researchers working in China have modified a standard way of measuring the gravitational constantâ€"torsion pendulums. The method was first devised by Henry Cavendish back in , and since then, has been modified many times to make it more accurate. In the first approach, the researchers built a device consisting of a silica plate coated with metal hung in the air by a wire. Two steel balls provided a gravitational attraction. The force of gravity was measured by noting how much the wire twisted. The second approach was similar to the first, except that the plate was hung from a spinning turntable that kept the wire in place. In such an apparatus, the gravitational force was measured by noting the rotation of the turntable. In both approaches, the researchers added features to prevent interference from nearby objects and disturbances, including seismic. They report measurements of 6. Qing Li et al. Measurements of the gravitational constant using two independent methods, Nature Despite two centuries of experimental effort, the value of G remains the least precisely known of the fundamental constants. A discrepancy of up to 0. Here we report two independent determinations of G using torsion pendulum experiments with the time-of-swing method and the angular-acceleration-feedback method. We obtain G values of 6. These values have the smallest uncertainties reported until now, and both agree with the latest recommended value within two standard deviations.

Chapter 9 : Is The Speed of Light Everywhere the Same?

It isn't apparent what are the main differences between both products carried by Lightspeed blog.quintoapp.com the sales consultants aren't able to respond to my question.

Locally where you are you will always measure the speed of light at However in the presence of gravity if I am at a different location than yours then I could measure the speed of light at your location to be any value smaller than or greater than It depends on where I am and where you are it depends on locations. So in the presence of gravity the speed of light becomes relative variable depending on the reference frame of the observer. This does not mean that photons accelerate or decelerate; this is just gravity causing clocks to run slower and rulers to shrink. Recalling the very famous second postulate of Special Relativity by Einstein The other factor besides acceleration is gravity. Einstein emphasized in his paper in For example, an observer outside gravitational fields measures the speed of light locally in his location at At the same time an observer freefalling into that black hole zero-g measures the speed of light locally in his location at If he tries to resist his freefall into that black hole by firing his rockets for example he will not measure the speed of light locally anymore at Again when he looks towards the black hole he sees the speed of light there much slower; when he looks away from the black hole he sees the speed of light there much faster. In any case, freefalling or not, he will never see the speed of light outside gravitational fields at Finally, there is no difference between the effects of g-forces experienced from these rockets and the effects of g-forces experienced when standing on planets, stars In the presence of gravity the speed of light becomes relative. To see the steps how Einstein theorized that the measured speed of light in a gravitational field is actually not a constant but rather a variable depending upon the reference frame of the observer: Einstein wrote this paper in in German download from: It predated the full formal development of general relativity by about four years. Where is the gravitational potential relative to the point where the speed of light co is measured. Light appears to travel slower in stronger gravitational fields near bigger mass. You can find a more sophisticated derivation later by Einstein from the full theory of general relativity in the weak field approximation: Einstein, Princeton University Press See pages , eqn ; the variable velocity of light expressed in coordinates is: Light appears to travel slower near bigger mass in stronger gravitational fields. A non-mathematical discussion of this can be found in: Bergmann takes the deflection of light by the gravitational field of a star as evidence of the decreased speed of light in a gravitational field. You can also find modern direct derivations that lead to the same results by Einstein: Cheng, Oxford University Press For the results see pages , eqn 3. For the results but not in coordinates see page 93, eqn 6. There is a difference between the radial speed of light and the tangential speed of light. The effects of gravitation can only be accurately represented by a tensor field. Contrary to Special Relativity, the measured speed of light in a gravitational field is not a constant, but rather a variable depending upon the reference frame of the observer; what one observer sees as true another observer sees as false. The only observers that can actually agree that the speed of light outside gravitational fields is Since only in "local inertial frames" does the measured speed of light equals the nominal speed of light If you are in a spaceship and fire your rockets then you are not inertial. If you are orbiting the sun then a gravitational force is accelerating you towards the sun; hence you are not inertial either even if your tangential speed around the sun remains constant. You can find the answer in: In the first case the magnitude of the velocity vector changes but its direction remains constant, while in the second case the magnitude is constant but the direction changes. In each of these cases the motion is non-inertial, but there is a conceptual distinction to be made. Earth can only be a local inertial frame if it exits the solar system, or it enters a gravitational freefall towards the sun straight in from afar. Similarly in classical orbital mechanics, as long as Earth is orbiting the sun then Earth is non-inertial accelerated by the sun. It also turned out to be a constant forever.