DOWNLOAD PDF POSTULATES OF SPECIAL THEORY OF RELATIVITY

Chapter 1 : Postulates of Relativity

The special theory of relativity deals with the problems involving non-accelerated frames of reference.. Postulates of the theory of relativity A scientific theory usually begins with general statements called postulates, which attempt to provide a basis for the theory.

Cosmology before relativity The mechanical universe Relativity changed the scientific conception of the universe, which began in efforts to grasp the dynamic behaviour of matter. His work and that of others led to basic concepts, such as velocity , which is the distance a body covers in a given direction per unit time; acceleration, the rate of change of velocity; mass, the amount of material in a body; and force, a push or pull on a body. The next major stride occurred in the late 17th century, when the British scientific genius Isaac Newton formulated his three famous laws of motion , the first and second of which are of special concern in relativity. In constructing his system, Newton also defined space and time, taking both to be absolutes that are unaffected by anything external. Beginning with the perhaps mythical observation of a falling apple and then considering the Moon as it orbits Earth , Newton concluded that an invisible force acts between the Sun and its planets. He formulated a comparatively simple mathematical expression for the gravitational force; it states that every object in the universe attracts every other object with a force that operates through empty space and that varies with the masses of the objects and the distance between them. Light and the ether However, this success at explaining natural phenomena came to be tested from an unexpected directionâ€"the behaviour of light , whose intangible nature had puzzled philosophers and scientists for centuries. In the Scottish physicist James Clerk Maxwell showed that light is an electromagnetic wave with oscillating electrical and magnetic components. Experiments soon confirmed the electromagnetic nature of light and established its speed as a fundamental parameter of the universe. Ocean waves and sound waves consist of the progressive oscillatory motion of molecules of water and of atmospheric gases, respectively. But what is it that vibrates to make a moving light wave? Or to put it another way, how does the energy embodied in light travel from point to point? For Maxwell and other scientists of the time, the answer was that light traveled in a hypothetical medium called the ether aether. Supposedly, this medium permeated all space without impeding the motion of planets and stars; yet it had to be more rigid than steel so that light waves could move through it at high speed, in the same way that a taut guitar string supports fast mechanical vibrations. Despite this contradiction, the idea of the ether seemed essentialâ€"until a definitive experiment disproved it. In the German-born American physicist A. This could only mean that the ether had no meaning and that the behaviour of light could not be explained by classical physics. According to classical physics, Einstein should have seen the second light wave moving at a relative speed of zero. Nothing in the theory allows a light wave to have a speed of zero. Another problem arose as well: But in classical mechanics the same laws apply for all observers, and Einstein saw no reason why the electromagnetic laws should not be equally universal. The constancy of the speed of light and the universality of the laws of physics for all observers are cornerstones of special relativity. Starting points and postulates In developing special relativity, Einstein began by accepting what experiment and his own thinking showed to be the true behaviour of light, even when this contradicted classical physics or the usual perceptions about the world. While such a law of addition of velocities is valid in classical mechanics, the Michelson-Morley experiment showed that light does not obey this law. This contradicts common sense; it implies, for instance, that both a train moving at the speed of light and a light beam emitted from the train arrive at a point farther along the track at the same instant. Nevertheless, Einstein made the constancy of the speed of light for all observers a postulate of his new theory. As a second postulate, he required that the laws of physics have the same form for all observers. Then Einstein extended his postulates to their logical conclusions to form special relativity. Consequences of the postulates Relativistic space and time In order to make the speed of light constant, Einstein replaced absolute space and time with new definitions that depend on the state of motion of an observer. Einstein explained his approach by considering two observers and a train. One observer stands alongside a straight track; the other rides a train moving at constant speed along the track. Each views the world relative to his own surroundings. The fixed observer measures distance from a mark inscribed on the track and measures time with his watch; the train passenger measures distance from a mark inscribed on his railroad car and measures time with his own watch. If time flows the same for both observers, as Newton believed, then the two frames of reference are reconciled by the relation: For example, suppose the train moves at 40 km per hour. The fixed observer measures x as 60 km and t as one hour. This analysis seems obvious, but Einstein saw a subtlety hidden in its underlying assumptionsâ€"in particular, the issue of simultaneity. The two people do not actually observe the lightning strike at the same time. Even at the speed of light, the image of the strike takes time to reach each observer, and, since each is at a different distance from the event, the travel times differ. Taking this insight further, suppose lightning strikes two trees, one 60 km ahead of the fixed observer and the other 60 km behind, exactly as the moving observer passes the fixed observer. Each image travels the same distance to the fixed observer, and so he certainly sees the events simultaneously. The motion of the moving observer brings him closer to one event than the other, however, and he thus sees the events at different times. Simultaneous eventsSimultaneous events may appear to coincide in time for one observer but not for another because of differences in their spatial positions. Einstein concluded that simultaneity is relative; events that are simultaneous for one observer may not be for another. This led him to the counterintuitive idea that time flows differently according to the state of motion and to the conclusion that distance is also relative. In the example, the train passenger and the fixed observer can each stretch a tape measure from back to front of a railroad car to find its length. The two ends of the tape must be placed in position at the same instantâ€"that is, simultaneouslyâ€"to obtain a true value. However, because the meaning of simultaneous is different for the two observers, they measure different lengths. This reasoning led Einstein to new equations for time and space, called the Lorentz transformations , after the Dutch physicist Hendrik Lorentz , who first proposed them. In the case of the flashlight beam projected from a train moving at the speed of light, an observer on the train measures the speed of the beam as c. According to the equation above, so does the trackside observer, instead of the value 2c that classical physics predicts. To make the speed of light constant, the theory requires that space and time change in a moving body, according to its speed, as seen by an outside observer. The body becomes shorter along its direction of motion; that is, its length contracts. Time intervals become longer, meaning that time runs more slowly in a moving body; that is, time dilates. In the train example, the person next to the track measures a shorter length for the train and a longer time interval for clocks on the train than does the train passenger. The relations describing these changes are where L0 and T0, called proper length and proper time, respectively, are the values measured by an observer on the moving body, and L and T are the corresponding quantities as measured by a fixed observer. Length contraction and time dilationAs an object approaches the speed of light, an observer sees the object become shorter and its time interval become longer, relative to the length and time interval when the object is at rest. The relativistic effects become large at speeds near that of light, although it is worth noting again that they appear only when an observer looks at a moving body. He never sees changes in space or time within his own reference frame whether on a train or spacecraft , even at the speed of light. Relativistic mass Cosmic speed limit To derive further results, Einstein combined his redefinitions of time and space with two powerful physical principles: One result is that the mass of a body increases with its speed. An observer on a moving body, such as a spacecraft, measures its so-called rest mass m0, while a fixed observer measures its mass m as which is greater than m0. For this reason, no material object can reach the speed of light, which is the speed limit for the universe. Light itself can attain this speed because the rest mass of a photon , the quantum particle of light, is zero. One well-known case is the twin paradox , a seeming anomaly in how special relativity describes time. Suppose that one of two identical twin sisters flies off into space at nearly the speed of light. According to relativity, time runs more slowly on her spacecraft than on Earth ; therefore, when she returns to Earth, she will be younger than her Earth-bound sister. But in relativity, what one observer sees as happening to a second one, the second one sees as happening to the first one. To the space-going sister, time moves more slowly on Earth than in her spacecraft; when she returns, her Earth-bound sister is the one who is younger. How can the space-going twin be both younger and older than her Earth-bound sister? The answer is that the paradox is only apparent, for the situation is not appropriately treated by special relativity. To return to Earth, the spacecraft must change direction, which violates the condition of steady straight-line motion central to special relativity. A full treatment requires general relativity, which shows that there would be an asymmetrical change in time between the two sisters. Four-dimensional space-time Special relativity is less definite than classical physics in that both the distance D and time interval T between two events depend on the observer. The term cT in this invariant quantity elevates time to a kind of mathematical parity with space. Noting this, the German mathematical physicist Hermann Minkowski showed that the universe resembles a four-dimensional structure with coordinates x, y, z, and ct representing length, width, height, and time, respectively. Hence, the universe can be described as a four-dimensional space-time continuum , a central concept in general relativity. Experimental evidence for special relativity Because relativistic changes are small at typical speeds for macroscopic objects, the confirmation of special relativity has relied on either the examination of subatomic bodies at high speeds or the measurement of small changes by sensitive instrumentation. For example, ultra-accurate clocks were placed on a variety of commercial airliners flying at one-millionth the speed of light. After two days of continuous flight, the time shown by the airborne clocks differed by fractions of a microsecond from that shown by a synchronized clock left on Earth, as predicted. Larger effects are seen with elementary particles moving at speeds close to that of light. The reason is that, relative to the moving muons, the distance of 9 km contracted to 0. Similarly, a relativistic mass increase has been confirmed in measurements on fast-moving elementary particles, where the change is large see below Particle accelerators. Such results leave no doubt that special relativity correctly describes the universe, although the theory is difficult to accept at a visceral level. At infinite speed, light would traverse any distance in zero time. Similarly, according to the relativistic equations, an observer riding a light wave would see lengths contract to zero and clocks stop ticking as the universe approached him at the speed of light. Page 1 of 3.

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Chapter 2 : Relativity | physics | theinnatdunvilla.com

In a surprising number of cases, the laws of physics in special relativity (such as the famous equation =) can be deduced by combining the postulates of special relativity with the hypothesis that the laws of special relativity approach the laws of classical mechanics in the non-relativistic limit.

Einstein based his theory of relativity on two very simple postulates: The laws of physics are the same in each reference frame, independent of the motion of this reference frame. The speed of light, c, is the same in every reference frame. What is a reference frame? Any nonaccelerating frame in which an observation can be made. The first one of these postulates should not raise any objections. Since we are moving very nearly in a circle, each 6 month our velocity vector reverses direction. But we still expect that a physics measurement is independent of the season it was made in! The second postulate explains what Michelson and Morley measured. However, this is not quite so easy to digest. Now you shine a laser in forward direction. The light of the laser has a speed c, according to Einstein. This leads to all kinds of interesting and borderline unbelievable consequences. All of them have, however, been experimentally verified by now. And so we now know that this theory is correct. We can never think of space and time the same way again! The speed of light, c, obviously plays a very special role in the theory of relativity. While we are at it, we define two very useful dimensionless quantities: Sometimes people argue that everything is relative, that there is no absolute truth any more. Nothing could be more wrong! Instead Einstein introduced a new absolute truth that was previously unknown with his postulates.

Chapter 3 : Special relativity - Wikipedia

The first postulate is the relativity principle: local physics is governed by the theory of special relativity. The second postulate is the equivalence principle: there is no way for an observer to distinguish locally between gravity and acceleration.

Lorentz derived equations 14 and 15 first, based on an ether theory, years before Einstein first published his special relativity theory. A proof of this sort lies more on a philosophical and empirical plane I think. I consider, for instance, the postulate of the constant speed of light to be in contradiction with Galilean transformation and therefore false: Furthermore and perhaps foremost, I think the Kennedy-Thorndike experiment5 an altered version of the famous Michelson-Morley experiment shows that the relativistic transformation equations can never explain nor describe the results thereof. The Kennedy-Thorndike experiment implies that for each conceivable difference in length between the arms of an interferometer, a different length contraction factor should apply. See analysis 2 below for a proof based on a contradiction between the two postulates of special relativity theory. Analysis 2 To proof relativity theory wrong it is not enough to show the errors in the several existing mathematical derivations of the transformation equations, since it might always be possible to derive a new one in the future. So probably we have to focus more on non-mathematical, experimental and philosophical arguments as mentioned above to falsify relativity. This is especially hard because almost any observation or experiment concerning the propagation of light has apparently been explained within relativity theory and because argumentative reasoning quickly results in vagueness and endless discussions. Now, proving explanations for experiments wrong can only be the last step in the process of falsifying a theory, I think, since to be convincing at this, agreement is required about the principles of the theory, the behavior of what is measured, the justness of the method of measuring, and the interpretation of the measurements. Other attempted proofs of the falsity of special relativity theory often founder on confusion about the relativistic effects of time-dilation and length-contraction. The question of whether these effects are real or only observational, and thus relative subjective , and how the nature of these effects relates to the moving reference frames and their physical reality are at the heart of the problem of dealing with relativity. Therefore, the following text will try to clear up this issue for once and for all. As we know, Einstein based his special theory of relativity on the following two postulates: The laws of physics are the same in all inertial systems reference frames that move uniformly and without rotation. There are no preferred inertial systems. When a certain reference-frame moves with constant speed with respect to another, processes of nature will obey the same laws of physics in either reference-frame. The speed of light in vacuum has the same constant value c in all inertial systems. In relativity, time is a matter of clocks. This last statement is true in classical physics as well as in relativity theory. Whatever clock we use, its working is based on some natural process, which is assumed to repeat itself evenly and therefore mark even "lengths of time". So clocks behave in the same way in all inertial frames, irrespective of the relative uniform motion those frames have with respect to each other. The first undisputable conclusion based on the first postulate and on logic reasoning is therefore: Relativistic time-dilation is never a real physical phenomenon, that is to say: Measuring the time it takes any physical process to complete within the inertial system of the clock, will in all inertial frames yield the same results using said clock in the same system as in which the process takes place. Length-contraction in relativity is something that applies to moving physical objects of practicably measurable lengths. The idea came out of an ether theory in which the earth and all objects on it was thought to get contracted in length in the direction of its motion around the sun, whilst moving through a medium for light-waves which was supposed to be at rest with respect to the sun. In this theory there clearly existed a physical cause for a possible contraction. However, when with the advent of relativity theory the notion of the ether was discarded, the physical possibility of a contraction was also taken away. Since the first postulate states that there is no preferred inertial system, an object must have the same spatial properties in all inertial systems, regardless of its speed with respect to other inertial frames. Relativistic length-contraction is never a real physical phenomenon. Spatial properties of any object are constant within its own inertial frame of reference, and are not physically altered due to any velocity this frame might have with respect to another. From 3 and 4 we can induce: All basic relativistic effects time-dilation and length-contraction can, if observed, only be of relative or subjective nature, due to observational circumstances, as in the observation of a natural process from within another inertial frame than the one in which said process takes place, or because of the limited speed of information transfer in the observation. So, when discussing thought-experiments, real experiments or observed phenomena within relativity theory, conclusions 3, 4 and 5 should always apply as should the postulates of course. With this in mind at least when agreement on these conclusions has been reached it suddenly becomes much easier to discuss empirical and thought-experiments. Now, assuming that in principle it is possible to directly! This is because length-contraction only applies to physical objects such as rulers, not to the space in which light travels. So as the ruler contracts, the measurement of the location of the front of the signal will increase. Just the fact that these co-ordinates differ from what would be expected from Galilean transformations which in relativity do still apply to the calculation of the primed co-ordinates observed from within C demonstrates that the second postulate which is the sole foundation of the relativistic transformation equations requires the relativistic effects to be real physical phenomena. So the second postulate requires length-contraction and time-dilation to be real physical phenomena, while from the first postulate it follows, as proven above in conclusions 3, 4 and 5, that any observed relativistic effects cannot be real. Ergo, the second postulate is in contradiction with the first. And since without the second postulate there is no relativity theory, an obvious attempt to fix this problem would be to dismiss the first postulate. But there were good reasons to include this postulate in the special theory of relativity: So the second postulate needs the first, and cannot exist alone. Thus the absolute and constant speed of light is a false postulate, and it renders the whole theory of relativity meaningless. For a century now, special relativity managed to achieve the impossible: A thorough review of our physical paradigm appears to be necessary.

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Chapter 4 : Postulates of special relativity - Wikipedia

Special theory of relativity or special relativity is a physical theory which states the relationship between space and time. This is often termed as STR theory. This is theory is based on two postulates - Laws of Physics are invariant; Irrespective of the light source, the speed of light in a vacuum is the same in any other space.

The laws of physics hold true for all frames of reference. This is the simplest of all relativistic concepts to grasp. The physical laws help us understand how and why our environment reacts the way it does. They also allow us to predict events and their outcomes. Consider a yardstick and a cement block. If you measure the length on the block, you will get the same result regardless of whether you are standing on the ground or riding a bus. Next, measure the time it takes a pendulum to make 10 full swings from a starting height of 12 inches above its resting point. Again, you will get the same results whether you are standing on the ground or riding a bus. Note that we are assuming that the bus is not accelerating, but traveling along at a constant velocity on a smooth road. Now if we take the same examples as above, but this time measure the block and time the pendulum swings as they ride past us on the bus, we will get different results than our previous results. The difference in the results of our experiments occurs because the laws of physics remain the same for all frames of reference. The discussion of the Second Postulate will explain this in more detail. It is important to note that just because the laws of physics are constant, it does not mean that we will get the same experimental results in differing frames. That depends on the nature of the experiment. For example, if we crash two cars into each other, we will find that the energy was conserved for the collision regardless of whether we were in one of the cars or standing on the sidewalk. Conservation of energy is a physical law and therefore, must be the same in all reference frames. The Second Postulate of the Special Theory of Relativity The second postulate of the special theory of relativity is quite interesting and unexpected because of what it says about frames of reference. The speed of light is measured as constant in all frames of reference. This can really be described as the first postulate in different clothes. If the laws of physics apply equally to all frames of reference, then light electromagnetic radiation must travel at the same speed regardless of the frame. This is required for the laws of electrodynamics to apply equally for all frames.

Chapter 5 : Postulates of special theory of relativity

Special relativity is mathematically self-consistent, and it is an organic part of all modern physical theories, most notably quantum field theory, string theory, and general relativity (in the limiting case of negligible gravitational fields).

Basics of special relativity[change change source] Suppose that you are moving toward something that is moving toward you. If you measure its speed, it will seem to be moving faster than if you were not moving. Now suppose you are moving away from something that is moving toward you. If you measure its speed again, it will seem to be moving more slowly. This is the idea of "relative speed"â€”the speed of the object relative to you. Before Albert Einstein, scientists were trying to measure the "relative speed" of light. They were doing this by measuring the speed of star light reaching the Earth. They expected that if the Earth was moving toward a star, the light from that star should seem faster than if the Earth was moving away from that star. However, they noticed that no matter who performed the experiments, where the experiments were performed, or what star light was used, the measured speed of light in a vacuum was always the same. He thought that as Earth moves through space, all measurable durations change very slightly. Any clock used to measure a duration will be wrong by exactly the right amount so that the speed of light remains the same. Imagining a " light clock " allows us to better understand this remarkable fact for the case of a single light wave. Also, Einstein said that as Earth moves through space, all measurable lengths change ever so slightly. Any device measuring length will give a length off by exactly the right amount so that the speed of light remains the same. The most difficult thing to understand is that events that appear to be simultaneous in one frame may not be simultaneous in another. This has many effects that are not easy to perceive or understand. Since the length of an object is the distance from head to tail at one simultaneous moment, it follows that if two observers disagree about what events are simultaneous then this will affect sometimes dramatically their measurements of the length of objects. Furthermore, if a line of clocks appear synchronized to a stationary observer and appear to be out of sync to that same observer after accelerating to a certain velocity then it follows that during the acceleration the clocks ran at different speeds. Some may even run backwards. This line of reasoning leads to general relativity. Other scientists before Einstein had written about light seeming to go the same speed no matter how it was observed. This has the remarkable implications that speed-related measurements, length and duration, change in order to accommodate this. The Lorentz transformations[change change source] The mathematical bases of special relativity are the Lorentz transformations, which mathematically describe the views of space and time for two observers who are moving relative to each other but are not experiencing acceleration. To define the transformations we use a Cartesian coordinate system to mathematically describe the time and space of "events". Each observer can describe an event as the position of something in space at a certain time, using coordinates x,y,z,t. The location of the event is defined in the first three coordinates x,y,z in relation to an arbitrary center 0,0,0 so that 3,3,3 is a diagonal going 3 units of distance like meters or miles out in each direction. The time of the event is described with the fourth coordinate t in relation to an arbitrary 0 point in time in some unit of time like seconds or hours or years. Let there be an observer K who describes when events occur with a time coordinate t, and who describes where events occur with spatial coordinates x, y, and z. This is mathematically defining the first observer whose "point of view" will be our first reference. Let us specify that the time of an event is given: This can be calculated as the distance from the observer to the event d observed say the event is on a star which is 1 light year away, so it takes the light 1 year to reach the observer divided by c, the speed of light several million miles per hour , which we define as being the same for all observers. This is correct because distance, divided by speed gives the time it takes to go that distance at that speed e.

Chapter 6 : Special relativity - Simple English Wikipedia, the free encyclopedia

Physicists state that a postulate of special relativity is the constancy of the speed of light, when the truth is that the only postulate is the inertial postulate.

At the time it completely revolutionised our understanding of space and time. Read on for a simple explanation of special relativity and its startling consequences. What is a frame of reference? To understand special relativity, the concept of a frame of reference needs to be understood. A frame of reference is a set of coordinates used to determine the positions and velocities of objects within that frame. Inertial frames of reference are a special case of frames that are moving at a constant speed. Special relativity exclusively deals with inertial frames of reference, hence the name special. The principle of relativity - The laws of physics are the same in all inertial frames of reference. For example, an experiment performed within a train moving at constant speed will produce the same results when performed on the train station platform. The train and the stationary platform are examples of different inertial frames of reference. The principle of invariant light speed - The speed of light in a vacuum , c, is the same in all inertial frames of reference. A light clock The light clock is a particularly simple example that can be used to demonstrate the consequences of special relativity upon time. The light clock is a theoretical clock that uses light to measure the time. Specifically, a pulse of light is reflected between two parallel mirrors that are spaced such that one second is the time for light to travel between the mirrors. The image below shows this setup as viewed by two different frames of reference. As viewed if the light clock is stationary relative to the observer, labelled as a stationary frame. The frame labelled as moving shows what an observer would see if the light clock is moving relative to the observer. Note that this is somewhat analogous to the aforementioned train example. The setup of our theoretical light clock in two different frames of reference. Notice how relative motion in the frame on the right modifies the observed path of light. As shown by the simple maths in the above image only pythagoras theorem is required , the moving frame produces a longer path for the light to travel. However, due to the principle of invariant light speed, the light is travelling the same speed in both frames. Hence, the time taken for the light pulse to reflect is longer in the moving frame, the associated second is longer and time runs slower. The exact formula for how much longer can easily be calculated and is given below. If it was a special type of clock then you could compare a light clock to your normal wristwatch and determine if your were within a moving frame. This breaks the principle of relativity. Therefore, the effect must be equally true for all clocks. The slowing down of time from relative movement is actually a fundamental property of our universe. Or put simply, "moving clocks run slow". The formula for time dilation is given below and introduces the Lorentz factor. The lorentz factor, represented by the greek symbol gamma, is a common factor in the equations of special relativity. Due to the Lorentz factor, the effects of special relativity are only significant at speeds comparable to the speed of light. A good example of time dilation is muons incident on the atmosphere. A muon is a particle that can roughly be thought of as a "heavy electron". However, we do detect a significant amount of muons. From our frame of reference, the internal clock of the muon runs slower and hence the muon travels further due to special relativistic effects. Length contraction Special relativity also causes lengths to be changed by relative motion. Or put simply, "moving objects shrink along the direction of travel". Lorentz transformation To shift the coordinates of events between different inertial frames of reference the Lorentz transformation is used. The transform relations are given below alongside the geometry of the frames of reference. As the passage of time is relative to the frame of reference, simultaneous events will not be simultaneous in other frames of reference. Everything has a rest energy which is equal to the mass times the speed of light squared, energy and mass are in a sense equivalent. The rest energy is the minimum amount of energy a body can possess when the body is stationary , motion and other effects can increase the total energy. I will give two quick examples of this mass-energy equivalence. Nuclear weapons are the clearest example of converting mass into energy. Inside a nuclear bomb only a small mass of radioactive fuel is converted into a huge amount of energy. Conversely, energy can also be converted into mass. This is utilised by particle accelerators, such as the LHC, where particles are accelerated up to high energies and then collided. The collision can produce new particles with higher masses than the particles that were initially collided.

Chapter 7 : What is Einstein's Theory of Relativity? - Universe Today

Einstein's theory of relativity is a famous theory, but it's little understood. The theory of relativity refers to two different elements of the same theory: general relativity and special relativity. The theory of special relativity was introduced first and was later considered to be a special.

Which are given in the list below: The laws of physics are the same in all inertial frames of reference. The speed of light in free space has the same value in all inertial frames of reference in all directions. Theory of Relativity The theory of relativity is concerned with the way in which the observers who are in a state of relative motion describe the physical phenomenon. Theory of relativity is given by Albert Einstein in which states that there is no absolute state exist in the universe, all states are relative. The theory of relativity is concerned with the way in which the observers who are in a state of relative motion describe the physical phenomenon. The special theory of relativity has an undeserved reputation as a difficult subject. It is not mathematically complicated; most of its details can be understood using techniques well known to readers of this text. Perhaps the most challenging aspect of special relativity is its insistence that we replace some of our ideas about space and time, which we have acquired years of common sense experiences with new ideas. The kinematics developed by Galileo and mechanics developed by Newton, which forms the basis of what we call classical physics, had many triumphs. Particularly noteworthy are the understanding of the motion of the planets and the use of kinetic theory to explain certain observed properties of gasses. However, a number of an experimental phenomenon cannot be understood, with the otherwise successful classical theories. Let us discuss few of these difficulties. Troubles with our ideas about time Troubles with our Ideas about the length Troubles with our Ideas about velocity Troubles with our Ideas about light There are two parts of the theory of relativity: The general theory of relativity Special theory of relativity look! Special theory of relativity The special theory of relativity deals with the problems involving non-accelerated frames of reference.. Postulates of the theory of relativity A scientific theory usually begins with general statements called postulates, which attempt to provide a basis for the theory. From these postulates, we can obtain a set of mathematical laws in the form of equations that relate physical variables. For about two centuries, the mechanics of Galileo and Newton withstood all experimental tests. In this case, the postulates concern the absolute nature of space and time. Based on his thought experiment about catching a light beam, Einstein realized the need to replace the Galilean laws of relative motion. In his paper, entitled on the Electrodynamics of moving bodies, Einstein offered two postulates that form the basis of his Special theory of relativity. The 1st postulate in the generalization of the fact that all physical laws are same in the frame of reference moving with the uniform velocity with respect to one another. If the laws of physics are different for different observers in the relative motion, the observer could determine from this difference that which of them were stationary in space and which of them were moving. But such distinction does not exist, so this postulate implies that there is no way to detect absolute uniform motion. Results of the special theory of relativity Following results are concluded from the special theory of relativity and we discuss them here with outgoing their mathematical derivation. Time Dilation According to the special theory of relativity, time is not the absolute quantity. It depends upon the motion of the frame of reference. Proper Time Suppose an observer is stationary in an inertial frame. He measures the time interval between two events in this frame. This is known as proper time. Relativistic Time If the observer is moving with respect to the frame of events with velocity v or the frame of events is moving with respect to the observer would not time interval, but it would be such that As the quantity is less than one, so t is greater than. Even with the aging process of the human body is slowed by motion at very high speed. Length Contraction If you are in motion relative to two points that are a fixed distance apart, the distance between two points appears to be shorter than when you were at rest relative to them. This effect is known as length contraction. Length contraction happens only along the direction of motion. No such contraction would be observed perpendicular to the direction of motion. Proper length The length of an object or the distance between two points measured by an observer who is relatively at rest is called proper length. Relativistic Length If an observer and an object are in relative motion with the speed v, then the contracted length is given by As the quantity is less than one, so the proper length is always greater than relativistic length. Let us see the video about length contraction. Importance of Special theory of relativity Relativity affects every aspect of physics; we have concentrated on mechanics, and later in this text, we consider the effect of relativity on electromagnetism. Indeed, we must carefully reexamine every subfield of physics from the perspective of the special theory, verifying that each is consistent with the two postulates. We must also note that relativity has passed every experimental test without the slightest discrepancy. It is a theory that is of great aesthetic value, providing us with a view more satisfying than that of classical physics about the validity of different perspective and symmetries. It is also a theory of the great practical value, providing engineers with the proper guidance to construct large particle accelerators and providing those concerned about the maintaining standard with the proper producers for correcting the reading of the atomic clocks when they are transported from the location to another. It is not too great a leap to extend that view to assert that inertial observers should also draw identical conclusions from observing an experiment in which there is a net force. Finally, why should we single out the laws of mechanics for this equivalence? By expending it to equivalence for inertial observers for all the laws of physics, we arrive at the first postulate. The second postulate is also a reasonable one. It seems unrealistic to be able to transmit a signal at an infinite speed, thereby providing instantaneous communication throughout the universe. Moreover, experiments on the relativity of the time show that such instant communication between distant points is not consistent with observation. If there is limiting speed, then surely by the first postulate it must be the same for all observers, regardless of their state of motion. For some, the first exposure to the relativity of simultaneity, the apparent shrinking of moving rods, and the slowing down of time may be disturbing. However, a bit of thought will persuade you that the classical alternatives are even more disturbing. For example, a classical rigid rod of definite length is not a concept that is consistent with relativity; a signal at one end cannot be transmitted instantly to the other end. We must give up the idea of all observers being able to use the same measuring rod. We replace this idea with one that gives each observer a measuring rod and permits that observer to use that rod to make measurements within a particular frame of reference. No observers measuring instruments or results are preferred over any others. There is no necessity to grant preferred status to either of them or to any other inertial observer. According to the classical physics, space and time are absolute. This leads to the result the laws of physics must be different or different observers. Relativity, on the other hand, tells us that the laws of physics must be the same for all observers, and as a consequence space and time become relative concepts. The arbitrary and complex physical world of classical physics, in which each observer must use a different set of physical laws, becomes the more uniform and simple physical world of relativity. Relativity broadens our view of the universe by placing them among the many inertial observers of that universe. It brings together concepts that, according to the classical physics, were treated separately; for instance, space and time into space-time, or mass and energy into rest energy. It points the way toward a single, unifying theory that includes all possible interactions between particles; electricity and magnetism into electromagnetism; electromagnetism and the so-called weak forces into the electroweak interactions, the electroweak and the strong nuclear interactions into one of the proposed Grand Unified Theories GUTs ; and finally GUTs and gravity into the hypothetical theory of Everything. Einstein, who knew about only the first of this unification, would surely be very pleased with these developments.

DOWNLOAD PDF POSTULATES OF SPECIAL THEORY OF RELATIVITY

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Einstein's theory of special relativity created a fundamental link between space and time. The universe can be viewed as having three space dimensions â€" up/down, left/right, forward/backward â€" and one time dimension. This 4-dimensional space is referred to as the space-time continuum.

Gradually I despaired of the possibility of discovering the true laws by means of constructive efforts based on known facts. The longer and the more desperately I tried, the more I came to the conviction that only the discovery of a universal formal principle could lead us to assured results How, then, could such a universal principle be found? Autobiographical Notes [p 5] Einstein discerned two fundamental propositions that seemed to be the most assured, regardless of the exact validity of the then known laws of either mechanics or electrodynamics. These propositions were the constancy of the speed of light and the independence of physical laws especially the constancy of the speed of light from the choice of inertial system. In his initial presentation of special relativity in he expressed these postulates as: There is conflicting evidence on the extent to which Einstein was influenced by the null result of the Michelsonâ€"Morley experiment. The derivation of special relativity depends not only on these two explicit postulates, but also on several tacit assumptions made in almost all theories of physics , including the isotropy and homogeneity of space and the independence of measuring rods and clocks from their past history. A more mathematical statement of the Principle of Relativity made later by Einstein, which introduces the concept of simplicity not mentioned above is: Special principle of relativity: Einstein later derived these transformations from his axioms. Principle of relativity Reference frames and relative motion[edit] Figure The primed system is in motion relative to the unprimed system with constant velocity v only along the x-axis, from the perspective of an observer stationary in the unprimed system. The changing of the speed of propagation of interaction from infinite in non-relativistic mechanics to a finite value will require a modification of the transformation equations mapping events in one frame to another. Reference frames play a crucial role in relativity theory. The term reference frame as used here is an observational perspective in space which is not undergoing any change in motion acceleration , from which a position can be measured along 3 spatial axes. An event is an occurrence that can be assigned a single unique time and location in space relative to a reference frame: Since the speed of light is constant in relativity in each and every reference frame, pulses of light can be used to unambiguously measure distances and refer back the times that events occurred to the clock, even though light takes time to reach the clock after the event has transpired. For example, the explosion of a firecracker may be considered to be an "event". We can completely specify an event by its four spacetime coordinates: The time of occurrence and its 3-dimensional spatial location define a reference point. In relativity theory, we often want to calculate the coordinates of an event from differing reference frames. The equations that relate measurements made in different frames are called transformation equations. To gain insight in how spacetime coordinates measured by observers in different reference frames compare with each other, it is useful to work with a simplified setup with frames in a standard configuration. Instead, any two frames that move at the same speed in the same direction are said to be comoving. Lack of an absolute reference frame[edit] The principle of relativity , which states that physical laws have the same form in each inertial reference frame , dates back to Galileo , and was incorporated into Newtonian physics. However, in the late 19th century, the existence of electromagnetic waves led physicists to suggest that the universe was filled with a substance that they called " aether ", which would act as the medium through which these waves, or vibrations travelled. The aether was thought to constitute an absolute reference frame against which speeds could be measured, and could be considered fixed and motionless. Aether supposedly possessed some wonderful properties: The results of various experiments, including the Michelsonâ€"Morley experiment , led to the theory of special relativity, by showing that there was no aether. In relativity, any reference frame moving with uniform motion will observe the same laws of physics. In particular, the speed of light in vacuum is always measured to be c, even when measured by multiple systems that are moving at different but constant velocities. Relativity without the second postulate[edit] From the principle of relativity alone without assuming the constancy of the speed of light i. In the Lorentzian case, one can then obtain relativistic interval conservation and a certain finite limiting speed. Experiments suggest that this speed is the speed of light in vacuum.

Chapter 9 : Proof of the Falsity of the Special Theory of Relativity

The second postulate of the special theory of relativity is quite interesting and unexpected because of what it says about frames of reference. The postulate is: The speed of light is measured as constant in all frames of reference.