Space-time in Cosmology

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Abstract

Space-time is a 4-dimensional continuum having 3 dimensions for space and the 4th for time.

This paper investigates how to describe space on the cosmological scale and whether space-time should be used in cosmology.

Contents

1 Introduction

Space-time is a 4-dimensional continuum having 3 dimensions for space and the 4th for time.

Space-time was initially defined by the Special Theory of Relativity whose context is an accelerating observer. Space-time is used by cosmology with the universe as the context. The two contexts are extremely different.

Any observer can use their defined coordinate system to describe their position and measure their motion. The observer can also use their defined coordinate system to describe the position of other objects and the motion of those objects. The rest of the universe does not move according to any coordinate system. This paper investigates how objects and light are described in the universe.

Cosmology uses space-time as a frame-work for understanding motion in the universe. This paper compares our understanding of motion with the space-time explanation for that observed motion.

2 Definition of Time

Time is a measurement. Time is not motion but time is used to measure motion. Chemical reactions are not instantaneous but we use time to measure them. Chemistry has nothing to do with motion. 60 seconds in a minute probably came from counting a person's pulse. " A normal resting heart rate for adults ranges from 60 to 100 beats per minute. "

If anyone needs an approximate time measurement they can just count their pulses to count a number of seconds (though not exact). Performing this count does not create time.

Temperature is another method of measurement. Perhaps it could be called another dimension for measuring an object's coordinates with its temperature at a particular time.

Time is not created but we define the increments for its measurement. We agreed on the definition of one second based on an atomic clock. This is called a universal time where each location on Earth has a time zone defined for deriving a local time.

The same scaling definition applies to temperature which can be in degrees C, F, or K.

When someone says time was created at the big bang that is like saying temperature was created at the big bang.

The current date and time are a reference with both incrementing at a defined rate. They describe my current now as part of the measurement of event sequences in the universe. There is only now and it is impossible to pick a different time for now, except for an accepted change like the daylight savings time adjustment. Essentially we agree to change the time of noon or the Sun at its highest compared to theSun rise. Earth's axial tilt results in changes in the time elapsed between sun rise and sun set. Our time of day does not begin with sun rise but the 24 hours in one rotation are centered on the highest sun, with 12 before and after.

Changing the date and time for now does not mean my now has changed to a different now in.

If someone says time travel is possible that is like saying one can change a watch and calendar and magically move to a new date and time as selected.

3 Describing a position

The observer selects or defines the coordinate system based on the requirements for a measurement.

In a laboratory for an experiment, the simple Euclidean geometry is often used. 3 linear dimensions are defined with the desired scaling. 3 letters are often used for the 3 linear dimensions, with x for left/right, y for up/down, z for in/out. The scaling is also defined, such as mm or inches, or perhaps much longer increments. The respective dimensions must be referenced to physical space. One example is X0, Y0, Z0 is often at the lower left corner of the working space; alternately X0 could be defined at the middle of the working space. This definition allows someone else to repeat an experiment exactly, by recording the positions using the same coordinate system definitions.

Time is sometimes considered a 4th dimension. To measure motion, the time difference between position measurements enables the calculation of velocity (distance per unit of time).

For measuring positions on earth, the respective observers can use the GPS coordinate system so measured positions can be shared and repeated. The GPS coordinate system is referenced to the center of the Earth.

For measuring positions in the universe, the respective observers can use the celestial coordinate system so measured positions can be shared and repeated.

excerpt from Wikipedia:

A celestial coordinate system is a system for specifying positions of satellites, planets, stars, galaxies, and other celestial objects. Coordinate systems can specify an object's position in three-dimensional space or plot merely its direction on a celestial sphere, if the object's distance is unknown or trivial.

(end excerpt)

my comment:

The celestial coordinate system uses two dimensions having angular values. The celestial coordinate system is referenced to the center of the Earth but is offset by the observer's current position on Earth's surface and their local time; this transformation enables its consistency during Earth's rotation.

A third linear dimension for the distance to the object allows the complete description of an object's position anywhere in the observable universe (using Earth as the reference).

reference link: Celestial coordinate system

4 Types of motion

4.1 Random motion

The observer can move oneself in a random direction such as left/right, up/down, or in/out.

An observer can move another object in the same random directions.

These motions are undefined having no measurement.

4.2 Directed motion

The observer can define a coordinate system to measure the current location of any object including oneself.

After the coordinate system is anchored to physical space the the observer can use it for accurately describing an intended motion in relation to other object's having a measured position.

4.3 Measured motion

In classical or Newtonian physics, objects are moving subject to external forces. None of these objects are in motion using a coordinate system. No motions are executed with coordinates like moving to X1.2, Y2.3. Every mass is in either motion or stopped based on forces acting on it. Every force on a mass has a vector for the resulting acceleration. This force can be any of the 3 fundamental forces: gravity, electic, magnetic. When knowing the mass, charge, and velocity, and distance for each relevant body these forces can be calculated.

4.4 Coordinated motion

A Gravitational Slingshot of a Space Probe is an example of coordinated motion.

When NASA calculates a trajectory of a space probe it uses the force of gravity defined by Newton.

Attached is a description of how NASA calculates these slingshots to execute a change in a probe's trajectory; a video is provided also. NASA has certainly demonstrated their technique with numerous successful missions.

The calculation of a slingshot involves these critical values (and more): a) the mass of the probe b) the mass of the planet c) the velocity of the probe d) the velocity of the planet.

During the probe's approach there is the mutual force of gravity between the two bodies where the paths of both bodies are affected simultaneously. Obviously the probe with a rather small mass is affected much more than the planet.

These calculations are based on simple Newtonian mechanics.

Could space-time be used for this caclvulation?

Relativity is based on spacetime curvature by a gravitational field. A gravitational field provides free fall acceleration toward that body which is spherical having uniform density. Conforming to those rules this body exerts this field which can be calculated from the mass density and radius. The mass of the observer, a smaller mass than the main body, is not involved in this free fall calculation. On Earth, applying a force to a body to lift it gives the body potential energy. Upon releasing the body it will have free fall acceleration toward the main body.

Curvature transforms this gravitational field into a distortion of the observer's reference frame or just changes in the observer's coordinate system. Curvature never involves the mass of the observer as it is not involved in a free fall acceleration. Curvature also never describes an affect on the body exerting this gravitational field which is affecting the observer's path. Relativity is limited to only the observer and their reference frame.

NASA never uses a gravitational field in its calculations for a slingshot trajectory. NASA does not use spacetime curvature.

Relativity assumed gravity had a velocity limit of c. NASA assumes gravity is instantaneous.

While not a disproof of relativity this post just shows relativity's spacetime would not work for NASA and was never used.

reference link: Gravitational slingshot

5 Travel of Light

Visible Iight is part of the electromagnetic radiation spectrum being generated by synchronized perpendicular electric and magnetic fields which propagate through a vacuum at the measured velocity called the constant c. These fields have a period of oscillation measured as wavelength or frequency. The wavelength is often measured in nanometers. This velocity can be reduced by the medium by a factor called the diffraction index. Light has no mass so a change in the medium is an immediate change in the velocity. This behavior is observed with light bending at the surface of water in a glass.

A prism demonstrates light is inherently a wave because perticles would not bend in a coordinated manner as observed; only a awave propagating in a medium matches the observation. Any behavior when light appears as a particle are due the cicumstances of the observation. Absorption and emission lines are not a particle behavior. A photon is just an abstraction of one wavelength of light. The distinction is important with diffraction.

6 Space-time Definition

7 Backgound Independence

Relativity is a theory defined to be background independent.

excerpts from Wikipedia:

' Background independence is a condition in theoretical physics, that requires the defining equations of a theory to be independent of the actual shape of the spacetime and the value of various fields within the spacetime.

In particular this means that it must be possible not to refer to a specific coordinate system—the theory must be coordinate-free. In addition, the different spacetime configurations (or backgrounds) should be obtained as different solutions of the underlying equations. '

reference link: Background Independence

my comment: This is the appropriate basis for the theory of relativity because relativity describes changes to only the observer's geometry, their 4-D spacetime. Relativity never includes or needs the background for the observer.

The underlying equations are also important because they demonstrate the context on the observer. The accelerating observer gets the spacetime curvature. Spacetime is a geometry with 4 defined dimensions: ct, x, y, z. This is the Euclidean geometry with a 4th dimension ct allowing time to be introduced as a linear dimension with units compatible with the standard first 3 linear dimensions. The motion of the accelerating observer is being manipulated by the observer's motion; the combination of change-x, change-y, change-z, change-t are used to calculate the space-time interval for the geometry transformation. This transformation involves only changes in the observer's position and never a reference to a physical location. The input into the metric tensor are: cdt, dx, dy, dz.

I know this topic is an oversimplification but sufficient.

Relativity does not require a connection to a coordinate system in physical space, when working solely within the context of the observer.

Isaac Newton is said to have worked in a background dependent context with absolute space and absolute time. In other words, objects could be described by their coordinates in physical space.

The terms of geometry enable the definition of the observer's coordinate system, with its dimensions or axes and their scaling. These dimensions are connected to physical space by relating each to a particular point in physical space. A simple example with the Euclidean geometry is defining X0,Y0,Z0 at the lower left corner of one's working space.

In this case the geometry has become background dependent by defining its coordinates in physical space.

This is the context often used by an observer.

To become background independent the observer could make all measurements of changes in positions without ever needing to define an absolute position of any objects.

In Newtonian physics (i.e., not relativity) the context of either background (in)dependence is never important. There is no behavior in Newtonian physics which must be connected to a specific point in the physical space of the universe. The forces of gravitational fields, electric fields, magnetic fields are all based in movable objects and are never anchored to a point in physical space. The distance is critical.

Instead of a Euclidean geometry, a similar technique is used for the celestial coordinate system where the two planes are related to the fixed point at the center of the Earth. Observers around the world can adjust this geometry for their location relative to the center of the earth. This is a background dependent context for a coordinate system usable by anyone on Earth.

Similarly the celestial coordinate system, referenced to the center of Earth is a backgound dependent context for the cosmological scale.

Relativity uses the concept of frame of reference. Excerpt start:

The motion of a body can only be described relative to something else—other bodies, observers, or a set of space-time coordinates. These are called a frame of reference. (rexcerpt end)

In physics, a frame of reference (or reference frame) consists of an abstract coordinate system and the set of physical reference points that uniquely fix (locate and orient) the coordinate system and standardize measurements.

reference link: Frame of Reference

my comment: This 'abstract coordinate system' can be the observer's context. Relativity implements its spacetime curvature as changes in the observer's frame of reference.

excerpt srart: ' General relativity generalizes special relativity and refines Newton's law of universal gravitation, providing a unified description of gravity as a geometric property of space and time, or spacetime. In particular, the curvature of spacetime is directly related to the energy and momentum of whatever matter and radiation are present. The relation is specified by the Einstein field equations, a system of partial differential equations. (excerpt end)

my comment: A statement above is misleading because it omitted critical words. It should be fixed like this with the added text in ¡ ¿ :

In particular, the curvature of ¡ the observer's¿ spacetime is directly related to the energy and momentum of whatever matter and radiation are present ¡ at the observer ¿.

This distinction is very important.

Curvature is NOT related to whatever matter and radiation are present ANYWHERE, but the curvature is directly related to the observer. This is just semantics but it should be correct and clear.

Relativistic behaviors affecting the observer's spacetime do not apply to the physical universe when limited to the observer.

However, cosmologists consider spacetime as a real thing, clearly a mistake.

excerpt begin:

The shape of the universe is the local and global geometry of the universe. The local features of the geometry of the universe are primarily described by its curvature, whereas the topology of the universe describes general global properties of its shape as of a continuous object. The shape of the universe is related to general relativity, which describes how spacetime is curved and bent by mass and energy. (excerpt end)

Spacetime universe is NOT a 'continuous object' with a shape. Spacetime is defined to be the observer's geometry affected by their proximity to 'mass and energy' but there is no geometry of the universe. The observer's spacetime geometry is background independent with no link to the physical space. It cannot be a real thing.

Spacetime cannot be anchored to the physical universe other than through the observer whose background independent geometry is affected by local relativistic effects. More about this is below.

The universe is infinite and everything in it is moving.

It is absolutely impossible to identify a single fixed point in the universe to anchor a proposed coordinate system of the universe.

Any attempt at such a geometry must begin with the observer. That means as the observer moves, this geometry of the universe is moving as well, so its respective axis planes could be rotating and their references shifting. Cosmological measurements are based on the observer.

In the big bang cosmology, spacetime (of the universe) was created at the big bang event.

Actually spacetime is limited by relativity to the observer so the big bang cannot create spacetime because only an observer has spacetime. Despite that inherent restriction this big bang theory proposes an instance of an obsever's spacetime was created and this 'thing' is a continuous object whose shape is described by spacetime.

If this is a real thing then it must have a physical location in the universe.

This location is impossible to assign. The universe has no fixed point to allow a coordinate system to be defined to describe the location of this continuous object.

Even stranger, cosmologists propose a thing called time in this universal spacetime was created with the big bang. Time is not a real thing; it is an incrementing count. Newton consider time separate from space and he was correct.

The confusion about universal spacetime worsens.

The spacetime curvature resulting from an observer at a mass is sometimes claimed to be obseved at great distances from Earth. Examples are black holes and light bending due to curved spacetime caused by a distant large mass like a galaxy. In each case the observer must be both where they are on Earth and simultaneously adjacent to that distant mass to get the correct curvature defined by relativity for an observer at that adjacent location in the universe. This combination is clearly impossible.

Cosmologists also propose the universe spacetime is expanding. It is impossible to identify the context for this spacetime within the real universe which must include a fixed point reference for its dimensions. This expansion is also not a real thing.

Expansion involves claiming the spacetime geometry is changing so the observer is measuring positions that can change due to the scaling in the observer's geometry.

Excerpt: ' The expansion of the universe is the increase of the distance between two distant parts of the universe with time. It is an intrinsic expansion whereby the scale of space itself changes. The universe does not expand "into" anything and does not require space to exist "outside" it. Technically, neither space nor objects in space move. Instead it is the metric governing the size and geometry of spacetime itself that changes in scale.

To an observer it appears that space is expanding and all but the nearest galaxies are receding into the distance. (excerpt end)

my comment: This expansion is the appearance to the observer, not real. In this expansion theory, space-time has its dimensional scaling increasing.

With space-time being background independent this proposed expansion is difficult to grasp when appied to space-time after its scope is expanded from only an observer to cover the entire universe.

However there are known problems with this expansion among physicists.

excerpt (several paragraphs): ' A much slower and gradual expansion of space continued until at around 9.8 billion years after the Big Bang it began to gradually expand more quickly, and is still doing so.

Metric expansion is a key feature of Big Bang cosmology, is modeled mathematically with the Friedmann-Lemaître-Robertson-Walker metric and is a generic property of the universe we inhabit. However, the model is valid only on large scales, because gravitational attraction binds matter together strongly enough that metric expansion cannot be observed at this time, on a smaller scale. As such, the only galaxies receding from one another as a result of metric expansion are those separated by cosmologically relevant scales larger than the length scales associated with the gravitational collapse that are possible in the age of the universe given the matter density and average expansion rate.

Physicists have postulated the existence of dark energy, appearing as a cosmological constant in the simplest gravitational models, as a way to explain the acceleration. According to the simplest extrapolation of the currently-favored cosmological model, the Lambda-CDM model, this acceleration becomes more dominant into the future. In June 2016, NASA and ESA scientists reported that the universe was found to be expanding faster than thought earlier.

While special relativity prohibits objects from moving faster than light with respect to a local reference frame where spacetime can be treated as flat and unchanging, it does not apply to situations where spacetime curvature or evolution in time become important. These situations are described by general relativity, which allows the separation between two distant objects to increase faster than the speed of light, although the definition of "separation" is different from that used in an inertial frame. This can be seen when observing distant galaxies more than the Hubble radius away from us (approximately 14.7 billion light-years); these galaxies have a recession speed that is faster than the speed of light. Light that is emitted today from galaxies beyond the cosmological event horizon, about 16 billion light-years, will never reach us, although we can still see the light that these galaxies emitted in the past. Because of the high rate of expansion, it is also possible for a distance between two objects to be greater than the value calculated by multiplying the speed of light by the age of the universe. These details are a frequent source of confusion among amateurs and even professional physicists.

Due to the non-intuitive nature of the subject and what has been described by some as "careless" choices of wording, certain descriptions of the metric expansion of space and the misconceptions to which such descriptions can lead are an ongoing subject of discussion within education and communication of scientific concepts. (excerpt end)

reference link: Expansion of the universe

my comment: I fully agree with characterization as 'careless wording' because we are told to believe that the scaling of galaxy positions within the universe changes over time and now the rate is faster.

We are also told to believe this scaling is changing faster due to dark energy which is defined as:

In physical cosmology, dark energy is an unknown form of energy which is hypothesized to permeate all of space, tending to accelerate the expansion of the universe.

my comment: There is no credibility for 'an unknown form of energy.'

This unknown spanning all of space is certainly more than just 'careless wording.' It is not believable.

Conclusion for spacetime:

It is incredible that an observer's frame of reference as described by relativity is proposed by cosmologists to encompass the entire universe.

This also suggests an observer must created with the big bang to be the basis for the universal spacetime. This is almost a metaphysical problem.

I will continue with another but somewhat related problem, spacetime dimensions.

Some cosmologists mention a mult-dimensional universe. There is no such 'thing' as that simply because a universe is just infinite space and has no built-in dimensions, but it has stuff in it. Dimensions arise with the observer's geometry. Our universe or an imagined universe has no dimensions.

This confusion exists for those who believe spacetime with its 4-D geometry based on the observer is a real thing. With that mistake, one could incorrectly believe our universe has 4 dimensions. It does not.

There is no real space-time for the universe in cosmology.

8 Motion in space-time

In relativity is the abstraction of the gravitational field affecting the motion of the observer. This is accepted as an approximation.

excerpt from Wikipedia:

The two-body problem in general relativity is the determination of the motion and gravitational field of two bodies as described by the field equations of general relativity. Solving the Kepler problem is essential to calculate the bending of light by gravity and the motion of a planet orbiting its sun. Solutions are also used to describe the motion of binary stars around each other, and estimate their gradual loss of energy through gravitational radiation. It is customary to assume that both bodies are point-like, so that tidal forces and the specifics of their material composition can be neglected.

General relativity describes the gravitational field by curved spacetime; the field equations governing this curvature are nonlinear and therefore difficult to solve in a closed form. No exact solutions of the Kepler problem have been found, but an approximate solution has: the Schwarzschild solution. This solution pertains when the mass M of one body is overwhelmingly greater than the mass m of the other. If so, the larger mass may be taken as stationary and the sole contributor to the gravitational field. This is a good approximation for a photon passing a star and for a planet orbiting its sun. The motion of the lighter body (called the "particle" below) can then be determined from the Schwarzschild solution; the motion is a geodesic ("shortest path between two points") in the curved space-time. Such geodesic solutions account for the anomalous precession of the planet Mercury, which is a key piece of evidence supporting the theory of general relativity. They also describe the bending of light in a gravitational field, another prediction famously used as evidence for general relativity.

reference link: Two-body problen in general relativity

my comment: Light is not affected by gravity. A photon is one wavelength of light and light is a wave not a particle which can have its path of propagation affected by a gravitational field. Gravity cannot bend light; only diffraction can bend light.

9 Space-time Confusion

There is a famous quote about space-time and motion.

“Spacetime tells matter how to move; matter tells spacetime how to curve.”

— John Archibald Wheeler, Geons, Black Holes and Quantum Foam: A Life in Physics

my comment:

This quote reveals confusion about the context of a coordinate system.

Space-time is a coordinate system not a force causing motion. Matter moves only in response to a force.

I use a coordinate system to describe positions in space. The objects inside a set of fixed dimensions are not affected by the specified dimensions.

If a shepherd defines a coordinate system to measure his fields, the sheep will not change their behavior in response to those dimensions.

Space-time is one way to describe the locations of matter in space butspace-time cannot tell anything to matter.

Similarly light travels in a straight line but affected by the diffraction index of its propagating medium.

Light will not respond to a coordinate system.

10 Gravitational Singularity

Space-time includes the concept of a gravitational singularity which is known to result in an infinite value which is physically impossible. A gravitational black hole is also known as a black hole.

excerpt start:

A gravitational singularity, spacetime singularity or simply singularity is a location in spacetime where the gravitational field of a celestial body is predicted to become infinite by general relativity in a way that does not depend on the coordinate system. The quantities used to measure gravitational field strength are the scalar invariant curvatures of spacetime, which includes a measure of the density of matter. Since such quantities become infinite at the singularity, the laws of normal spacetime break down.

Gravitational singularities are mainly considered in the context of general relativity, where density apparently becomes infinite at the center of a black hole, and within astrophysics and cosmology as the earliest state of the universe during the Big Bang. Physicists are undecided whether the prediction of singularities means that they actually exist (or existed at the start of the Big Bang), or that current knowledge is insufficient to describe what happens at such extreme densities.

my comment: The extreme density of a singularity is a combination of mistakes.

The infinite density arises when the gravitational field has curved to a geometric point in the space-time coordinate system. Therefore this is a point only to the observer whose path is being affected by this curvature.

The mass is still present in physical space but its gravitational field has been calculated as affecting only a point, or a position in space-time having no size. No term in geometry is real, like a point, line, or plane.

The extreme density is the result of the mistake and confusion treating this geometric point as something real. It is impossible to compress mass into a point of no size; this is openly admitted by the observation 'laws break down.'

In reality beyond this mathematical abstraction of space-time curvature, this mass is unaffected at its location in physical space. All other observers should be able to detect and measure this mass in space where the observer has a point in their coordinate system.

A coordinate system describes positions but its lines, planes and points are never real.

reference: link: Gravitational Singularity

The mathematics behind a black hole have been thoroughly reviewed by Stephen J Crothers. A black hole is not a real thing in the universe.

reference: youtube link: Stephen J Crothers on non-existence of black holes & the failure of General Relativity

reference: youtube link: Stephen Crothers: Black Holes & Relativity, Part One — EU 2013

reference: youtube link: Crothers Part Two — EU 2013

11 Tests To Confirm Space-time

There are claims tests have confirmed the validity of space-time. Those tests and results are misleading and not clear evidence.

Both tests have tailored results to give the illusion of confirmation.

11.1 gravitational lensing

The observation of the solar eclipse in 1919 is the primary claim of evidence.

The real explanation is light bending by diffraction through the solar atmosphere at the limb.

Here is an explanation of light bending by diffraction.

reference link: Can Stars Bend Light? General Relativity and Gravity with Dr. Edward Dowdye

my comment:

The results are consistent with diffraction in the solar atmosphere. Some have pointed out lensing should also occur with a star not right at the limb but the observation was intentionally at the limb. Books have been written suggesting Eddington had the opportunity to produce the desired results by himself, not observation, and the original photographic plates are gone. Others have suggested the viewing conditions would have made the required precision difficult. So much in modern cosmology depends on a 1919 expedition 100 years ago.

One is left with the dimemma: the observation is consistent with a) the known mechanism of diffraction or b) the theoretical prediction by Einstein. This is not conclusive confirmation.

There is even more confusion involved. There are statements Newton had calculated a predicted deflection but that is false; there is no record of that act by Newton, but others performed a calculation with their assumptions. One assumption must be light with a non-zero mass.

The assumption light could bend by gravity assumes light has a slight mass. A photon or one wavelength of light is still (today) assumed to have no mass.

There is a conundrum here. A wavelength of light, being one oscillation of the propagating synchronized electric and magnetic fields, has no mass. A photon is known to be massless but gravitational lensing requires light to have a non-zero mass to be affected by a gravitational field.

A wavelength of Light cannot be affected by gravity, or space-time.

This reference describes the possible doubt with Eddingtin's claims.

reference link: Einstein, Eddington and the 1919 eclipse

11.2 Mercury Precession

The precession of Mercury's orbit has been claimed a confirmation of relativity.

However the precession can be explained by tidal forces.

excerpt start:

" Einstein's general theory of relativity cannot explain Mercury's perihelion motion. He obtained "for the planet Mercury, a perihelion advance of 43" per century" by an incorrect integral calculus and many arbitrary approximations. His formula (1) is a poorly patched wrong result, tailored specially for Mercury. That is why his formula (1) fails to explain the perihelion motions for Earth and Mars. Einstein was unfair to blame "the small eccentricities of the orbits of these planets" for his failure. To sum up, Einstein's general theory of relativity is dubious." (excerpt end)

reference link: Precession of Mercury's orbit

12 Conclusion

Space-time should not be used by cosmology.

Space-time is a coordinate system defined for an observer.

Space-time cannot tell matter or light how to move on the cosmological scale. An external force tells matter how to move, not a coordinate system.

There is no black hole, no gravitational lensing.

Cosmology must use valid physics, not a mathematical abstraction developed for an observer affected by a gravitational field.