"Time…is what allows things to happen in sequence but keeps everything from happening at once".

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Abstract

The second law of thermodynamics is an expression of the universal principle of decay observable in nature. Time is a measure by which things happen, the yardstick of causality and is a fundamental property of the universe. We can deduce from $E = mc^2$ it is mass that gives an arrow to time and energy that gives it a rate of flow. The rate of flow of time is the square root of the energy of the universe divided by its mass (matter less antimatter). As mass is responsible for gravity, it can be re written as the rate of flow of time is the square root of the energy of the universe divided by its gravity. The rate of flow of time whilst being an average for the universe can vary locally. Time is the notches on the yardstick of entropy.

Word list

Time, the arrow of time, mass, matter, antimatter, energy, causality, second law of thermodynamics, entropy, speed of light, $E = mc^2$, gravitational time dilation, gravitational time contraction, photon, homogenous and isotropic, cosmological constant, inflation, universe, galaxy, solar system.

Ray Cummings, an early writer of science fiction, wrote in 1922,

"Time… is what keeps everything from happening at once".

It would be more accurate to say

"Time…is what allows things to happen in sequence but keeps everything from happening at once".

This is very true, without time there would be no causality

***"Time** is a part of the measuring system used to sequence events, to compare the durations of events and the intervals between them, and to quantify rates of change such as the motions of objects. The temporal position of events with respect to the transitory present is continually changing; future events become present and then pass further and further into the past. Time has been a major subject of religion, philosophy, and science, but defining it in a non-controversial manner applicable to all fields of study has consistently eluded the greatest scholars. Among prominent philosophers, there are two distinct viewpoints on time. One view is that time is part of the fundamental structure of the universe, a dimension in which events occur in sequence. Sir Isaac Newton subscribed to this realist view, and hence it is sometimes referred to as Newtonian time."* http://en.wikipedia.org/wiki/Time

This theory supports the above realist view of Newtonian time.

"The second law of thermodynamics is an expression of the universal principle of decay observable in nature. It is measured and expressed in terms of a property called entropy, stating that the entropy of an isolated system which is not in equilibrium will tend to increase over time, approaching a maximum value at equilibrium; and that the entropy change dS of a system undergoing any infinitesimal reversible process is given by δq / T, where δq is the heat supplied to the system and T is the absolute temperature of the system.

Entropy (arrow of time)

Entropy is the only quantity in the physical sciences that "picks" a particular direction for time, sometimes called an arrow of time. As one goes "forward" in time, the second law of thermodynamics says, the entropy of an isolated system will increase when no extra energy is consumed. Hence, from one perspective, entropy measurement can be thought of as a kind of clock—although not really an accurate measure of time."
Originally Posted by **Wikipedia**

Everything in the universe is made of energy but energy; on its own does not a universe make.

The universe is made of two things, energy and matter. Time is an expression of that relationship. The universe has to contain both energy and mass for the concept of either time or universe to have any real meaning.
There are two aspects to time, the direction of the arrow and the rate of flow. These are both the natural outcome of the interaction of the energy and mass (gravity) of the universe.

From Relativity we get $E = mc^2$ *or* $c = \sqrt{E/m}$

We can see from $c = \sqrt{E/m}$ that mass [gravity](matter forward arrow, antimatter backward arrow) without energy will provide an arrow to time but the clock will never tick.

Also, we can see from $c = \sqrt{E/m}$ energy without gravity will dissipate over an infinitely large space in an infinitely small time, actually no time, as the arrow of time will be double ended.

Therefore the arrow of time, which always points forward in its own universe, points forward relative to us and points backwards in an antimatter universe.

As $c = \sqrt{E/m}$ and speed is distance divided by time we can see that the rate of flow of time (Rt) is effectively the same as c and $= \sqrt{E/m}$.

The rate of flow of time is given by the energy of the universe divided by its mass $Rt = \sqrt{E/m + -ma}$
Or substituting gravity for mass
As $Rt^2 = c^2 = E/m + -ma$
Or $Rt = c = \sqrt{E/m + -ma}$
We could substitute gravity *(g)* for $m + -ma$
In which case $Rt = \sqrt{E/g}$

The universe contains net zero energy
If we consider energy positive and is driving the expansion of the universe then gravity can be considered to be a negative form of energy trying to make the universe contract. Together they add up to the universe having zero net energy.

Time is a fundamental property of the universe.
Time is a fundamental property of the universe. The rate of flow of time can be found by dividing the amount of energy of the universe by its gravity (matter less antimatter). The rate of flow of time whilst being an average for the universe can vary locally depending primarily on mass but also to a much smaller extent on emission of energy.

Properties of time
What properties does time possess? It has a direction, time flows from the past to the future, we call this the arrow and rate of flow of time. If we look at the different aspects of time singly what can we deduce from them? The arrow of time can point forward, backward or be double ended. What if the arrow points forward but the clock never ticks? What if the arrow is double ended and the rate of flow infinite? These are not something we expect to find in reality but never the less they are valid concepts.

What is Time, how does it arise, what gives time an arrow, why does it never flow backwards and what determines the rate of flow?
Time is a measure by which things happen, the yardstick of causality. We live in a universe that essentially only allows time to flow forward, were it to be otherwise we would not be here to contemplate it.

Arbitrary time
There are two aspects to time; one is the divisions that we are familiar with, seconds, minute's hours etc. These are arbitrary measurements based upon dividing one cycle (day). Arbitrary time is just a convenient way of dividing the passage (flow) of time.

The rate of flow of time
The first is the "rate of flow of time". Consider the analogy of a clock face; it is divided into a number of divisions, which represent arbitrary time. If we imagine the distance between the divisions represents the "rate of flow of time" we can see that if the clock face is larger then the distance between the divisions is also larger and the rate of flow of time is slower. Arbitrary time remains a constant whilst the rate of flow of time is variable. (This is not a bad analogy as the clock hands sweep out a larger representation of space-time.)

The arrow of time
The second aspect is direction. Time is a natural outcome of the universe and the direction ("the arrow of time") is governed by the Second Law of Thermodynamics. Time is the measure by which things change. It is derived from the fact that the useable energy (low entropy) in the universe is continually being used and transformed into high entropy (low quality energy. The second law of thermodynamics is an expression of the universal principle of decay observable in nature

As time is a fundamental property of the universe, we take a quick look at how the universe ticks
Think of the universe as a very large clockwork motor. At the start of a cycle the motor is wound up (low entropy) and at the end of a cycle the motor is run down (high entropy). This simple analogy is probably very accurate. At the start of a cycle antimatter white holes create energy and matter (hydrogen fuel to power the universe) thereby winding it up, stars burn fuel creating more energy, universe expands, fuel runs out, black holes mop up matter and energy, universe contracts, the arrow of time reverses, black holes become antimatter white holes. Black and white holes by reversing the arrow of time change order to chaos, to chaos to order and wind up the universe. The second Law of Thermodynamics is therefore, not violated.

Energy, mass, the speed of light and time
Everything in the universe is made from energy. Energy creates matter and everything in the universe is an aspect of that relationship.

Out of Einstein's Special and General, theories of Relativity came the most famous equation in human history $E = mc^2$. Einstein had the foresight to realize that energy, mass and the speed of light were all related. This little equation can tell us an awful lot about the universe.

As the equation contains the relationship between energy, mass and the speed of light, it is also telling us something about time. We can deduce from $E = mc^2$ that it is mass that gives the arrow of time a direction and that energy gives time a rate of flow.

The interaction of energy and mass define the speed of light. "Speed" introduces two new concepts, distance and time. Distance being the measure between two points in our three dimensional space. When Relativity refers to space time it does not mean that time is another spatial dimension. Think of the three spatial dimensions as being static in a real of film, with each consecutive frame representing an advancement of time.

From that we can see that the rate of flow of time in the universe $Rt = c = \sqrt{E/m + -ma}$. The speed of light squared equals the rate of flow of time. From this, we can see that the speed of light in the universe is allowed to be a constant because the rate of flow of time is a variable.

Energy (photons), unhindered travels at the speed of light. Mass, matter or antimatter, (gravity) puts the brakes on. If there is no mass, matter or antimatter, then the speed of light is infinite and the arrow of time double ended.

It is this interaction of gravity and energy that we call time. Gravity tries to slow down photons but photons travel at the speed of light, which is a constant. The speed of light is allowed to be a constant because the rate of flow of time is a variable.

Quantum mechanics allows for antimatter to be the same as ordinary matter but going backwards in time. Most scientists are against this idea but there is considerable evidence that it is probably true. If true then $Rt = \sqrt{E/m}$ needs to be re-written as $Rt = \sqrt{E/m - ma}$ where ma is antimatter. (or more precisely so the formula works in both a matter and antimatter universe $Rt = \sqrt{E/m + -ma}$)

A photon (traveling by necessity at the speed of light) experiences no passage of time. This is why a photon is its own 'antiparticle".

The fundamental clock

For the concept of time to have any useful meaning we need to find some fundamental constant of nature for the clock. The two most fundamental things are the speed of light and the frequency of vibration of an electron. In the Rutherford picture of an electron the frequency of light emitted is the same as the orbital frequency of that electron. The Bohr picture is a little different but at high energy levels, they are virtually the same.

Rutherford	Bohr
$f_{light} = f_{electron}$	$f_{light} = \Delta E / h$

As we can see that the frequency of light emitted is the same as the orbital frequency of that electron, the two being equivalent we could choose either the speed of light or the orbital frequency of an electron as the fundamental constant, the "clock". The speed of light would seem, in a way to be more fundamental as matter is created from energy. All of the other constants of nature are constant in regard to the speed of light. However, the speed of light is only a constant because the rate of flow of time is a variable.
A photon is the most fundamental object. It carries the arrow of time because it is both emitted and absorbed. It quantifies the rate of flow of time as it travels at the speed of light but the photon experiences no passage of time itself. As it has no mass it is unaffected by gravity but can tell us the relationship between itself and gravity.

During the twentieth century, the speed of light in a vacuum has reached the theoretical status of a "universal constant", a fixed value of c0 = 299,792,458 m s −1 being chosen in 1983 as a basis for the international unit system.

Gravitational time dilation

General Relativity allows for both relativistic time dilation and mass to affect the rate of flow of time. Mass slows the rate of flow of time as does traveling near the speed of light.

"Gravitational time dilation *This has been demonstrated by noting that atomic clocks at differing altitudes (and thus different gravitational potential) will eventually show different times. The effects detected in such experiments are extremely small, with differences being measured in nanoseconds."*

From Wikipedia, the free encyclopedia

The relative rate of flow of time
As the rate of flow of time in the universe is proportional to the amount of energy divided by its mass (matter), a stationary observer in the universe will always experience the same passage of time. However, a distant observer outside the universe might perceive a very different rate of flow of time. One hour to the observer within the universe could represent one minute or a million years to the observer outside.

The predictions of $Rt = \sqrt{e/m} + -ma$ or $(Rt = \sqrt{e/g})$
To help us think about time let us consider four hypothetical universes:-

A) one containing energy but no matter
B) one containing matter but no energy
C) one containing both matter and energy
D) Lets also consider one containing energy and equal parts of matter and antimatter

A) Consider a hypothetical universe made of energy but no mass (matter)

$E = mc^2$ *or* $c = \sqrt{E/m}$

In a hypothetical energy, only universe the speed of light is still the speed of light but the arrow of time is double ended and the rate of flow of time infinite. In this, universe things can happen but without cause and effect. (Energy can spontaneously appear or disappear) Energy likes to dissipate therefore such a universe would expand towards the infinite and cool until the temperature dropped to absolute zero (high entropy).

Time as we know it does not exist and without mass nor does the universe.

Another way of looking at this is if there is no gravity (matter) then there is no arrow of time.

It would seem energy can exist outside of time as predicted by quantum mechanics, energy of the vacuum.

Energy gives time a rate of flow, which is infinite in both directions unless moderated by gravity [mass] (matter or antimatter). Matter or antimatter give the arrow of time a direction and the blend of matter/antimatter and energy govern the rate of flow of time.

Energy without matter or antimatter means there is no distinct arrow to time, time does not exist. Mass, matter and antimatter, give time an arrow.

In this "universe", there is no causality as everything happens all at once.

It may be more accurate to think of this as not a universe at all but more the normal state of the vacuum.

B) Consider a hypothetical universe made of (mass) matter but no energy

$E = mc^2$ *or* $c = \sqrt{E/m}$

The arrow of time will point forward but the clock will never tick. Such a universe will in effect be a black hole. Matter (gravity) gives the arrow of time a direction, energy a rate of flow. In this frozen universe, there is no causality because nothing ever happens. There is no change in entropy. (All of the same arguments would apply to an antimatter universe but relative to us, the arrow of time will point backwards). To a distant hypothetical observer this universe would last forever.

Note
Neither of the above hypothetical universes could ever exist. In the matter only one, the black hole universe would decay and create energy. In the energy only one, energy could create pair particles.

Energy of the universe equals zero

If the net energy of any universe is required to be zero and there is evidence for that and taking energy as being positive, gravity as being negative then neither universe can have zero energy. In the matter only universe gravity can be thought of as exerting negative energy.

Mass provides an arrow to time. Matter makes the arrow point forward. Antimatter makes the arrow point backward. Energy provides a rate of flow.

For the concept of time to have any real meaning, the universe must contain both energy and matter.

C) Our universe, one that contains energy and matter

$E = mc^2$ *or* $c = \sqrt{E/m}$

The above arguments taken to their logical conclusions, explains much of the mechanics of our universe, one that contains both mass and energy. Gravity is trying to make the universe collapse; energy is trying to make it expand. Together they equal zero energy.

Energy although indirectly affected by gravity is actually "**THE** repulsive force" causing the expansion of the universe and can be thought of as positive or a "positive force". Gravity can be thought of as the negative "force" trying to make the universe smaller.

Cosmological Constant
As energy is the positive "force", causing the expansion of the universe there is no need to conjure up an exotic force of repulsion. No cosmological constant is required.

The size of the universe
The size of the universe is dependent upon two factors, the amount of energy from the original creation event and the ratio of energy/matter at the time. This is constantly changing as stars convert mass into energy and ultimately consume all useable fuel.

Added together the repulsive force of energy and the gravitational force of mass equal zero. (As the ratio of energy to matter is variable it would seem that the 'net" energy can not remain zero but there are other factors at work here. If energy is increasing [low entropy] and matter, decreasing then energy will drive the universe to expand [high entropy]. The other factors to be taken into account are the rate of flow of time changing and the strength of gravity changing. It is proposed that all of these factors taken together combine to return the net energy to zero.)

The rate of flow of time in the universe equals the speed of light squared.

The speed of light will remain fairly constant over a large range of mass: energy ratios. It seems probable that the mechanics of the universe only allow for a limited range of ratios.

The speed of light sets the upper limit to how fast anything can happen in the universe. As $Rt = c$ nothing can exceed the speed of light. A photon of light experiences no passage of time. The hands of a clock traveling at the speed of light would never move. If the clock could travel faster than the speed of light, the hands would rotate backwards.

The rate of flow of time and the speed of light
Common sense requires the speed of light to remain constant regardless of the rate of flow of time. It also requires the perceived passage of time to be a constant, which it is as

the rate of flow of time is a variable. The world would seem a very strange place if it were otherwise.

If mass (matter or antimatter) give the arrow of time a direction and energy a rate of flow then the rate of flow of time *(Rt)* is directly proportional to the square root of energy *(E)* divided by mass *(m)*
$Rt = \sqrt{E/m}$
From relativity we get $E = mc^2$ or $c^2 = E/m$
So we can see that $Rt = c = \sqrt{E/m}$
The speed of light is a constant because the rate of flow of time is a variable. The perceived passage of time is also a constant because the rate of flow of time is a variable

Why is the universe so uniform on a large scale?
"the universe that started off very hot and cooled as it expanded is in agreement with all the observational evidence we have today. Nevertheless, it leaves a number of important questions unanswered ... Why is the universe so uniform on a large scale? Why does it look the same at all points of space and in all directions?'
Stephen Hawking

Read on for the answers to both questions.

D) What happens when matter and antimatter are in equal quantities? *This is the condition between universes, the end of one and the start of the next.*

$E = mc^2$ *or* $c = \sqrt{E/m}$ *or* $c = \sqrt{E/m + -ma}$

From $Rt = E/m + -ma$
We can see that if matter equals antimatter they cancel each other and the arrow of time is equally double ended. The rate of flow of time is infinite in both directions. Were it not for the *mass* of matter and antimatter the expansion would be infinite. With matter and antimatter in balance, **the universe undergoes a finite period of inflation in which there is no causality.** The greater the rate of inflation, the faster the acceleration and the greater the mass/anti-mass which may be a limiting factor to inflation, unless cancelled by the lack of causality. **The result being the universe appears homogenous and isotropic.** The expansion is finite as the arrow of time becomes imbalanced in favor of matter (relatively speaking). It is the arrow of time and the rate of flow of time that allow causality. Therefore, without a distinct arrow of time there can be no causality.
However, as it is properties of time that we are talking about the arrow can go from being equally double ended to being one-way, in a sense outside of time. The rate of flow of time in the universe is an average of its total energy divided by its gravity (the mass of matter less the mass of antimatter). However, on a local scale the rates of flow of time can vary considerably.

If $Rt = \sqrt{E/m}$ then it is telling us something about the size of the universe and whether it is expanding or contracting.

Size of the universe

The factors that define the maximum "size" of the universe are the total amount of energy from the original creation event and the energy/mass ratio at the time. At the end of the fuel burning stage, the universe has converted all of its "available fuel" into energy. The universe contains the maximum amount of energy and the minimum amount of mass. Expansion of the universe continues until the repulsive force of the energy is equaled by that of the attractive force of gravity. Although the universe contains the maximum amount of energy, expansion has increased its entropy.

Expansion or contraction

When Rt is above a certain figure the universe is expanding, below it is contracting.

Locally the rate of flow of time can be different from the universe as a whole

The universe has an average rate of flow of time being the square root of its total energy divided by its total mass. However, this can vary on a local scale. Massive objects dilate the rate of flow of time as does acceleration. If any large mass of antimatter existed, it would contract the rate of flow of time, as would any *very large* emission of energy.

Substituting gravity for mass

As $Rt = c = \sqrt{E/m + -ma}$
We could substitute gravity *(g)* for $m + -ma$
In which case $Rt = \sqrt{E/g}$

Conclusion

"Time…is what allows things to happen in sequence but keeps everything from happening at once".

We can now explain the above statement:-

"Time" – the dynamic relationship between energy and mass (or energy and gravity).

"is what allows things to happen in sequence" energy does work and in so doing dissipates (entropy increases)

"but keeps everything from happening at once" energy is slowed down by gravity (mass).

Time is a measure by which things happen, the yardstick of causality and is a fundamental property of the universe. The direction of the arrow and rate of flow of time equals the square root of the energy of the universe divided by its gravity.

It is this interaction of gravity and energy that we call time. Gravity tries to slow down photons but photons travel at the speed of light, which is a constant. The speed of light is allowed to be a constant as the rate of flow of time is a variable.

In a hypothetical energy, only universe the speed of light is still the speed of light but the arrow of time is double ended and the rate of flow of time infinite. In this, universe things can happen but without cause and effect. (Energy can spontaneously appear or disappear) Time as we know it does not exist and without mass nor does the universe.

In a hypothetical mass only universe, the speed of light is still the speed of light, the arrow of time has a direction but the clock never ticks. In this frozen universe, there is no cause and effect because nothing ever happens. It is frozen in time.

A photon is the most fundamental object. It carries the arrow of time because it is both emitted and absorbed (cause and effect). This is essentially the same as the thermodynamic arrow of time (entropy).

Not only does the photon carry the arrow of time but also it quantifies the rate of flow of time, as it travels at the speed of light.
The speed of light $c = Rt = \sqrt{E/m + -ma}$. The flow of time is always forward in its own universe. A photon, as it has no mass is its own "antiparticle" and by its very nature can only travel forward in time, even if that time appears backwards from our perspective.

The paradoxical thing about a photon is it can tell us the direction and rate of flow of time but it experiences no passage of time itself. It can tell us the relationship between itself and gravity whilst not being affected by gravity.

The second law of thermodynamics is an expression of the universal principle of decay observable in nature. It contains the arrow of time and ultimately the fate of each cycle of the universe.

"Although the second law of thermodynamics ultimately leads to the universal principle of decay observable in nature. In the process, it produces all of the beauty and growth that the universe floods us with in abundance. The final expression of the second law of thermodynamics is a black hole but a black hole recycles itself into a white hole a frightening thing of great beauty and the ultimate source of renewal and growth".

Michael J. Savins

"Any intelligent fool can make things bigger and more complex... It takes a touch of genius - and a lot of courage to move in the opposite direction".
Albert Einstein

See http://vixra.org/abs/1103.0113
Time passes slower on the Earths surface than it does in space. This has to be taken into account for Global Positioning Satellites.

Time passes slower in the Solar System than it does outside in the galaxy.
See http://vixra.org/abs/1103.0103
Time passes slower in the galaxy than it does in the local cluster, empty space, void etc.