Time

What does it mean?

U3a Science group Halesworth

Sources: ‘Longitude’ by David Sobel and WJH Andrews

‘A Brief history of Time’ by Stephen W Hawking

‘The Order of Time’ by Carlo Rovelli

IFL Science : What is the space continuum?

Richard Webb in New Scientist: The mysteries of the fourth dimension.

And many other articles on the web.

History of Time

The word for the experience of change

The word **TIME** conjures up many human experiences.

The sun in the sky has given rise to the human experience of set periods, days(from di, divide), months, and years. The way we experience the arrival of light and dark, the growth of plants and animals, inspired the need to quantify. In the organisation of larger groups, it became helpful to dissect the day into periods which could be used to coordinate activities.

Sundials could establish mid-day and after that shorter periods in between. Humans adapted to life by time. By the 14th century mechanical timepieces were constructed in Europe that could tell the hour. Clocks appeared on church towers, bells tolled the hours.

The rise of travel

Once humans started to travel they realised that time was not the same when moving long distances on earth. Especially when travelling at sea, instruments observing the sun could establish the latitude of the vessel by following the passage of the sun, but not the longitude, as the passage of the sun would be the same at any one point of the meridian.

The only way to calculate position would be the time the ship travelled in any one direction at which speed. The speed could be calculated with a mechanical log, the direction with a compass, but there were no clocks, other than sand-timers which were unsuitable on moving ships and so were early pendulum clocks.

The Longitude quest

John Harrison took 19 years and 4 attempts to solve the problem in England in the 1770s by perfecting a mechanical clock which could be wound up and keep time correctly for many months at sea. It enabled the much safer passages around the globe and contributed to Britain’s rise to global power. The captains finally knew where they were at sea.

He won a royal competition set in 1753 for 20.000 pounds.

H4 by John Harrison

This would be mounted in a hardwood box and wrapped in oilcloth. It was then positioned in the middle of the ship for lowest movement.

Time took over life

Travel on land too was transformed by the railways in the next century. They had to have a **time-table**. To coordinate travel, the time everywhere had to be the same. Greenwich mean time, designed for ships, became the basis of time everywhere in England.

People started to **ask each other the time.** Clocks, watches, became ubiquitous.

Life became a **Dance to the music of time.**

With international travel starting to become popular, the world had to be divided into **time zones** to make coordination of transportation possible. This happened in 1883.

Science of Time

From Aristotle to Quantum Theory

Science and the proposal of entropy

Aristotle proposed that no value of time was available until there was change. Only change made us perceive **time**. Only interaction between objects was measurable.

Newton argued that **absolute mathematical time** is not perceptible, but he postulated that it exists.

Ludwig Boltzmann, son of Austrian clockmaker turning physicist, discovered in the 1920s that heat is an agitation of the molecules of matter. When it cools the agitation decreases. If we apply heat, the agitation returns (microwave).Some energy is always lost in this process, which he and others called entropy. Earth has very slow entropy as the energy received from the sun more or less equals the energy radiated from the earth. Gravity works against entropy to hold the earth together. But the **changes that happen in life on earth are what we perceive as time.**

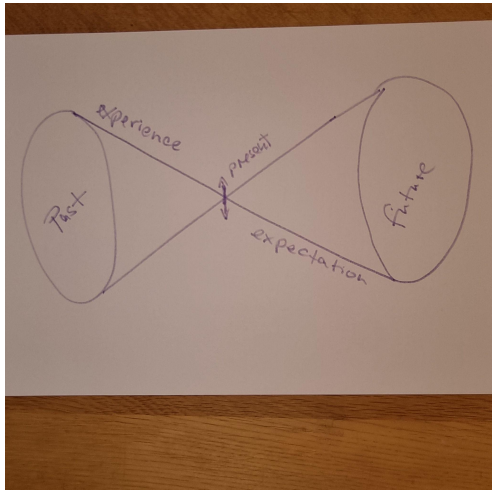
The second law of thermodynamics

Heat passes from a warm body to a cold one, never the other way. Time cannot be reversed.. Change only occurs when there is heat. All our heat on earth comes from the sun. Stars explode and heat their environment. As they cool they experience entropy.

Living organisms consume substances to generate heat or other energy. Some of that energy is lost. The entropy of this process is perceived as **time**. It cannot be reversed.

How do we perceive time?

We perceive **time** as before and after the present. Both Hawkins and Rovelli use the image of the double cone to illustrate this.



Past and future

Our brain is pre-programmed to memorise the past and extrapolate the future.

Apparently according to an article in earth.com, it has now been established that the core of **time perception** is in **the basal ganglia** and the **cerebellum**. Our brain allows us to, for instance, listen to music and correctly anticipate the next notes. A lifetime's experience is our ability to predict the future accurately enough to organise our environments and our lives. We draw on one part of the cone to project the other. The present is not available, **time is always in motion.**

Most of us have found that we wake up just before the alarm we had set…our brain remembered the **length of time**?

Time perception and ageing

The older we get the more we perceive **time as flying by**. It is thought that the complexity of our brain is such that it takes more time to store new information from experiences than it did when our memory banks were less congested. Therefore we learn less in the same period of time and **think time has speeded up**. If **time is the flow of experience**, or change we perceive, then, indeed it has.

The function of gravity

Up to now we have looked at time on earth, on its surface to be precise. But Einstein correctly presumed, before it could be exactly measured with atomic clocks, that **time would pass more slowly at higher altitudes**. He was belatedly proved correct. Time also passes slower in aeroplanes, they are farther away from the centre of gravity. (do we not all notice that?). But what happens if we leave earth altogether?

Space time

Free from the movement of the earth around the sun, what we are left with is the light that reaches us from heavenly bodies.

Scientists have calculated the speed of light (be it as waves or photons) and measure the distance between objects visible in space in “light years”. But years are earthly concepts, and more and more **time, as we understand** it, has been **written out** of the understanding of the universe.

Quantum theory with its built in uncertainties makes things more confusing. If we travelled at the speed of light, would we be in all places at the same time? Gravity is found to be able to bend light, especially near black holes…can time be bent? Physics has come back to being natural philosophy. Not all is provable (yet).

Time in the universe?

The Scientist **Leibnitz dropped the t (symbol for time in physics)** in his name to **Leibniz** to show his belief in the non-existence of absolute Newtonian time. In astronomical physics, and especially in quantum physics, time is no longer considered.

By 1915 Einstein had realised **that light could be bent by gravity** and quantum physics no longer followed the arrow of time. He realised that we see the world only from the inside, as part of it, and therefore never entirely objectively. Quantum theory is based on probability, not on established fact.

An interesting theory of circularity

One of the theories I came across is that the universe is circular. The force of gravity acts on elements like Helium clouds to compress them ever more tightly until they form fusion as Hydrogen which then contracted by gravity so much that it forms an exploding star and sends its energy back into the space around it in waves or photons (light). These are then again attracted by the gravitational field of black holes which swallow them up and again compress the whole into a massive Hydrogen bomb…the next star etc.

If this was true, time would indeed be superfluous in that it would become circular. No one has yet explained the origin of the Big Bang with any certainty. Only that it happened faster than light ???

Conclusion

The **flow of time** is not a characteristic of the universe, it is our particular perspective from the surface of the earth. Thermodynamics are necessary for entropy, they are necessary for change, which we **perceive as time**.

The heat from the sun is the energy that drives entropy on earth. The food we eat, grown in the light of the sun, is our source of energy in that cycle and it eventually produces our ageing. The arrow of entropy on earth is **our time**. **Thermodynamics are the basis of our time**.

For a more scientific presentation of Thermodynamics please see Ken's slides from 2016.

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