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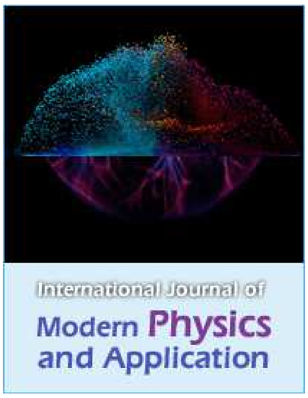

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Reflections on the Nature of Time

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Abstract
Other than quantities like mass and space time is not easy to understand and is a mystery since ever. However for any measurement in physics time is required so that from a more philosophical point of view nothing may exist without time. Time is measured using periodical re-occurring events like the movement of our planet around the sun. At the absolute zero point no movement exists and therefore nothing may be measured, which means that time is absent, a possible explanation for the singularity of a black hole. Mathematics is a tool and the basis for our description of the world. This description is continues and mathematics uses descretisation only to ease computations. If the descretisation is small enough this approach converges to the analytical solution. Other than in mathematics it has been proven by observations on a small scale that nature does not behave continues but discrete, how it is described in quantum mechanics. The superposition of movements and velocity is an experience of our daily life. It has been observed that this superposition does not occur at the velocity of light. In order to keep physics consistent a transformation of time is necessary, which results in the theory of relativity. If we make our world discrete with a smallest distance that e.g. reflects the smallest difference in radii for electrons in an atom and take the velocity of light as a maximum possible velocity this requires a smallest discrete time step. Using such approach a transformation of time becomes obsolete.

1. Introduction

"Indeed an exceedingly gifted man; almost all that he says is beyond comprehension." This is what Peer Gynt says about Begriffenfeldt the director of a mad house in Cairo [1]. Begreifen is a synonym in the German language for "to comprehend" from which the director's name is derived. It means that we grasp or touch things to comprehend the world around us. Also the word "comprehend", which is derived from the French word "comprendre" means to take something into our hands. As humans we are limited by our sins and passions and we have to understand that a lot of things are beyond our comprehension. Science is a method to overcome this handicap, however also scientists are captured in their perception. They also fight for their truth and cognition.

The comprehension in physics is the measurement. Physics is the science dealing with the description of the world from the smallest to the largest dimensions and it tries to measure it all in similar units. The basis of these units is usually of a magnitude that we can "*begreifen*". A pound or stone stands for the mass, a yard or foot for distance, a barrel or pint for volumes. Units for electricity that came to human vision by lightning and thunder have been named after their explorers like coulomb and ampere. Electricity itself is named after "*Elektra*" from the Greek mythology and her name stands for "*Amber*", which played a role in the discovery of electricity. There are English, German, and international "*Candles*" for the strength of light, calories and British thermal units for heat. For temperature we have degrees, something more abstract, in Fahrenheit or Celsius.

However the most measured quantity is probably the time. Time is measured in Years, one cycle of the earth around the sun, in Months, a cycle of the moon around the earth, in Days, a cycle of the earth around itself, in Hours, which are 60 Minutes that are divided into 60 Seconds, where a Second is a heartbeat. Time or us is self evident and one will hardly find anybody who cannot explain what time is. Time is defined and measured relative to a sequence of events. This may be as said the periodic rotation of the earth or the well defined time as provided by an atomic clock.

2. Time

For all measurements in physics time is involved. We cannot measure a distance without spending time. It needs time to get from one point in space to another, to place one end of a scale to a point and the other end of a yardstick to the next point. This also applies to the measurement of mass and other physical properties. It means that nothing would exist without time. In every description of the real world time is necessary. As a standpoint in physics things are defined by an observation. An observation can only be made using time.

As a consequence of such statement it is obvious that to create a universe beside what we know as matter time is needed. In the big bang time and mass reacted in space. In areas or volumes where there is no time, it is not possible to make observations based on the real world's physics. If there is no time between our universe and the next one in space it is impossible to see that next universe, a behavior that explains why the universe is not observed to be infinite.

Where there is no time there is no matter to be observed. If matter is being brought into a volume of whatever extent without time the matter will disappear. Also with a mathematical description of the world such black hole results in a singularity without time.

3. Time and Temperature

Time is defined by the observation of change. This is what temperature has common with time; apart from that for both quantities the same abbreviation is being used. The temperature of a gas can be defined by the velocity of the movement, translation and rotation, of atoms and molecules [2,3]. This means that if there is no time there is no temperature or temperature is zero. The third law of thermodynamics says that by no technical process the absolute zero point can be achieved. This does not mean that the absolute zero point cannot exist.

A black hole in space is defined as a point that exhibits such a strong gravitational force that even light cannot escape [4]. In a mathematical sense it is a singularity. Regarding the statements above the temperature should be undefined or be zero in a black hole. If we did an experiment in a laboratory and we were close to the absolute zero point, statistically there might be volumes with zero temperature where matter should disappear in small black pin holes.

4. A Continues or Discrete World

For the description of the world mathematics is a helpful science. We are assuming the world to be continues and describe its state in equations. These equations often obtain terms with changes of a quantity depending on another quantity. Velocity is e.g. the change of a location with time. A problem can be defined by such changes and the interdependence on other processes and it is then packed into a differential equation, which is solved and the solution gives the state of the system in space and time.

A simple example is mortgage. If a particular sum is borrowed it has to be paid back and also the interest rate has to be paid. This means that every time money is paid the debt is reduced and the amount of the interest that has to be paid is reduced. The exact amount of debt and interest can be calculated for any point in time by a mathematical equation.

However this is not how life is. In real life the interest is paid once a month and not continuously as well as money is a discrete matter. The state of debt and interest can be calculated month by month. At the end of story the same or similar results are obtained using the exact equation or the discrete monthly approach with a negligible small difference depending on the time intervals used for paying back.

Let us come back to differential equations to describe the state of a system and look at the example of flow of fluids through a porous medium [5]. The mathematical approach is the partial differential equation that describes the problem. In the case of fluid flow in porous media it cannot be solved analytically. To solve it, the problem is discretized in space by defining a 3-dimensional grid. The differential equation is transferred to finite differences represented by the grid which results in a system of linear equations that can be solved. To do this also the time has to be discretized [6,7].

Another, physical approach to the problem is to start from a discrete world. The space can be divided into grid cells that can have a Cartesian geometry or even can be unstructured. The flow from every grid cell to its neighbors during a defined time can be analytically calculated. This also results in a system of linear equation that has to be solved. This system of equations is the same as that one derived for the solution of the continuous partial differential equations [8, 9].

If the mathematical and the physical description of the world need the same set of linear equations to be solved, why shouldn't the real world be discrete? From quantum mechanics we know that the energy of the radiation emitted from processes in an atom can only have discrete values. If a smallest increment in length of 10^{-30} m is assumed, a distance that is small enough to describe processes in an atom, and the velocity of light is the highest possible, then the time increment is in the order 10^{-38} s.

Such a description of the world represents the situation on a microscopic scale and becomes continuous on the large scale.

5. Transformation of Coordinates

It may happen that we look at a picture on a wall and it seems to us that it is tilted, though a water-level was used when putting the nail into the wall. The reason the picture looks tilted may be the tilt of the wall or even the house. In the co-ordinate system the water-level is working in the picture hangs perpendicular but not on the wall. In such system a simple movement may correct the mistake, a simple co-ordinate transformation.

In a moving system things may become a little bit more difficult. When we observe a person walking in a train it will have the walking velocity which, added to the velocity of the train, results in the total velocity we can observe from outside. Such transformations are common practice, e.g. in a sailing boat, where the skipper has to consider the boat's velocity when he calculates the true wind in the sail as well as the directions the wind is blowing and the boat is sailing.

What happens, if the velocities become very high, close to the velocity of the light, which we use for our observations? This was the question Michelson asked in a famous experiment. On the earth we sit in a fast moving system, so the light should have different velocities in different directions depending if it travels with or against the movement of the earth or perpendicular. In the experiment a light beam is split up into 2 beams, which travel to other mirrors on ways so that they travel perpendicular paths. When these 2 light beams come together again they should have different travel times and this should result in an interference which would give characteristic patterns on the screen. But nothing was observed, which means that the velocity of the light is independent of the system it is travelling in.

Such findings mean that in a co-ordinate transformation to a fast moving system we have also to transform time in addition to space co-ordinates. This is done in the Lorentz transformation and resulted in Einstein's theory of relativity [10,11].

Such transformations are necessary in a mathematical continuous world. However what happens in a discrete world. In a discrete world we have a grid in space. Any particle can only be on such grid point and not in between. If we postulate the same for the time then the maximum speed a particle can have is the ratio of the distance in the space grid and of the smallest time step. If e.g. the space grid is defined to have a grid size of 10^{-30} m and the time grid has a spacing of $3.3 \cdot 10^{-39}$ s the maximum possible velocity would be $3 \cdot 10^{8}$ m/s.

If such systems are defined a time transformation is not necessary any more to describe the observations made by the Michelson experiment assuming that the light travels at the maximum velocity that is possible. In any such system if it is moving or not the maximum velocity is the same. If a particle is observed in a different system it will exhibit the same velocity, 'jumping' from one grid point to the next in one time step. In the Michelson experiment the observer is part of the system and cannot distinguish the velocity the system may have into different directions. Velocities can only add up to the maximum possible velocity.

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