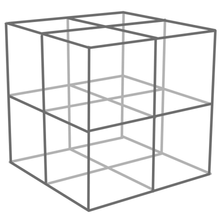
Physical Model of Spacetime

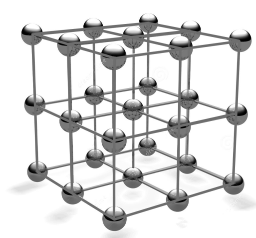
Kepler Gelotte

Abstract: This paper proposes an physical model of the Universe where space is continually inflating at a constant rate c and where time is emergent and is experienced as the movement of space through particles of mass. Massless particles don't interact with inflating space and and are forced to ride the wave outward.

Structure of Space

To start I make a few assumptions. Space is made up of Planck size cells creating a 3 dimensional foam. This 3 dimensional space is surrounded with a 4 dimensional void exerting a constant negative pressure around each cell. The negative pressure of the void causes more cells to be created in a process similar to cavitation. This formation of new space cells continues at a constant rate.



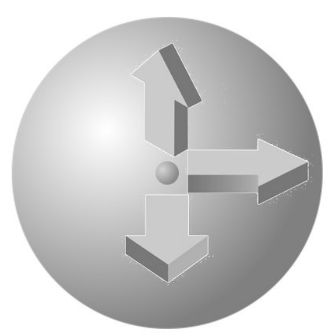


The nucleation points for the new space cells would be the vertices between existing space cells as they would experience the greatest combined negative pressure. I also make the assumption here is that cells stop expanding when they reach Planck size either because they become unstable or the pressure from adjacent expanding cells becomes too great.

Space therefore is not static but is continually being replaced with new frames of space.

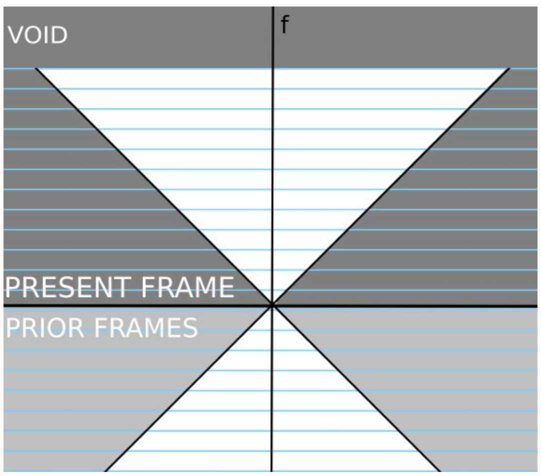
In the diagram I depict space as an ordered lattice of square cells for demonstration purposes only. Space cells must be randomly shaped otherwise the regularities would propagate outwards. In the case of the lattice, space would expand as an ever growing cube which is of course not what we experience. [TODO: either find an existing proof that random structure produces a sphere or write a computer model showing this]

By looking at a single space cell in a frame, it's descendant space cells would create an ever expanding sphere.



If you examine all the descendants of all space cells starting in an initial frame you would see a stable 3 dimensional space constantly being replaced with new frames in the center with expansion happening only at the outer edge of the Universe at rate c.

Picking a single space cell as a starting point and setting the vertical axis as an inertial reference frame, we end up with the familiar light cone diagram.



The vertical axis is not time but rather the accumulating frames of space.

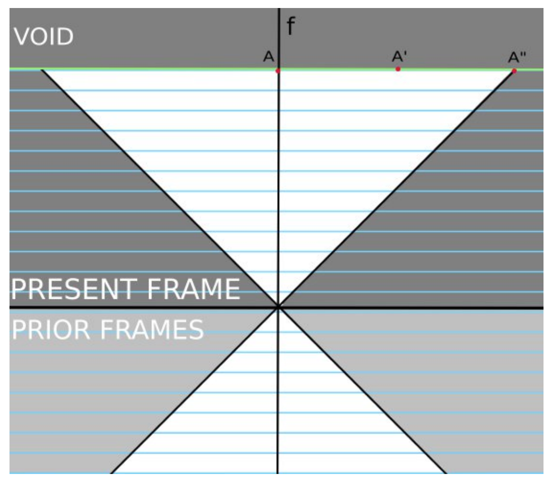
Time and Time Dilation

In this model time is an emergent property. To experience 1 second of time an object of mass must have $c_f = \frac{c_m}{L_p} \approx 1.85*10^{43}$ frames of new space pass through them. I use the symbol c_m to refer to the meters light travels in 1 second and c_f the number of frames. c remains the same m/s but is just used to convert the amount of space passed through an object to it's perceived amount of time.

Movement along an arbitrary axis x of length Δx reduces the amount of frames passing through an object by that amount. This means that the space passing through that object in motion after $N*c_f$ frames is $(Nc_m - |\Delta x|)$.

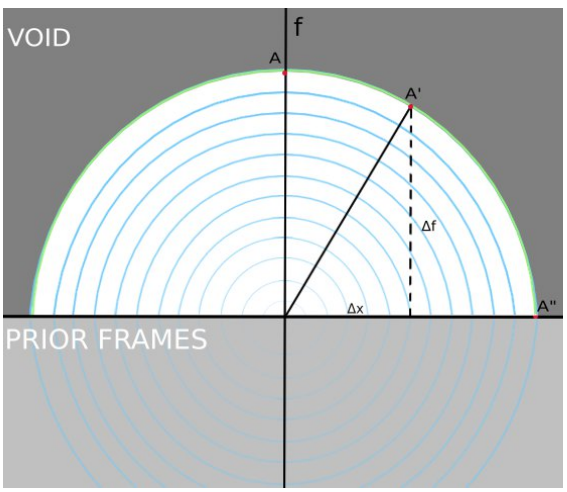
If an object had no motion, $(Nc_m - 0)$ the maximum amount of space would have passed through it. An object moving at the maximum rate of frame production would have no space pass through it $(Nc_m - Nc_m)$.

This diagram below shows the three cases.



Objects A, A' and A" start in the same point with synchronized clocks. At the final frame Nc_f A has not moved relative to its inertial frame and (Nc_m) space has moved through it. A' has moved right by Δx and has had $(Nc_m - |\Delta x|)$ space move through it. A" has moved right at the speed of light and has had no space move through it $(Nc_m - Nc_m)$.

In the diagram the vertical axis is the newly created frames. New frames of space relative to a starting point appear as shells expanding outward as mentioned previously. In order to have the vertical axis represent time in this inertial reference frame we need to project the final frame down to the shell where the starting point is the origin and the radius is $N*c_m$. This will keep the distance from the starting point to the final destination frame the same as long as the path followed by each object is a straight line - any change in direction would change Δx . This applies to the x,y,z coordinates only. Direction does not need to be straight traversing the frames.



To calculate the amount of space that passed through A' at frame $N*c_f$:

$$(Nc_m)^2 = \Delta f^2 + \Delta x^2$$

$$\Delta f^2 = (Nc_m)^2 - \Delta x^2$$

$$\Delta f = \sqrt{(Nc_m)^2 - \Delta x^2}$$

$$\Delta f = N\sqrt{c_m^2 - \left(\Delta x^2/N^2\right)}$$

Apply the conversion factor to change the distance to time:

$$\Delta t_{A'} = \Delta f\frac{1_s}{c_m} = N\sqrt{c_m^2 - \left(\Delta x^2/N^2\right)}\,\frac{1_s}{c_m}$$

$$\Delta t_{A'} = N\sqrt{1 - \frac{\Delta x^2/N^2}{c_m^2}}\,seconds$$

while the time from the inertial reference frame:

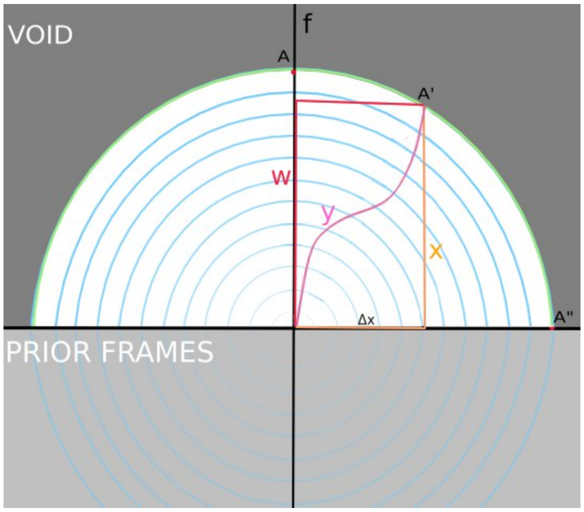
$$\Delta t_A = Nc_m\frac{1_s}{c_m} = Nseconds$$

Converting proper time to coordinate time of the inertial reference frame gives the standard time dilation formula in terms of distance:

$$\Delta t_{A'} = \frac{\Delta t_A}{\sqrt{1 - \frac{\Delta x^2/N^2}{c_m^2}}}$$

This formula shows that time is only dependent on Δx. As long as the direction stays constant and the start and end space cell are not changed, acceleration will not affect the final clock time.

In the diagram below, object **w** remains stationary and then travels Δx at the speed of light to A'. Object **x** travels Δx at the speed of light and then stops until it reaches A'. Object **y** accelerates and then decelerates Δx to A'. If all clocks were synchronized at the start, and the total distance traveled by all three objects is the same, the times on all clocks will still be synchronized at A'. Their clocks will will have different times during their journey however.

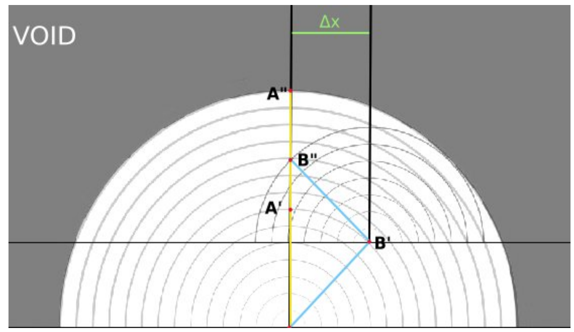


Twin Paradox

Time is experienced locally by each object and their clocks can only be compared when they are coincident. If two objects next to each other synchronized their clocks and each took a different path and later checked the time on their clocks after returning to each other, the object whose path was longer would have the slower clock. This is assuming flat spacetime – i.e. no warping due to mass, dark energy etc.

In the diagram that follows, one twin travels Δx and arrives at B' . The twin then turns around and returns the same way arriving at B". Since there was a change in direction a new starting point is needed for the second segment of the journey.

The other twin stays stationary in the inertial reference frame and arrives first at A' and finally at A". A' and B' are in the same frame as are A" and B". It appears as if the traveling twin is in an earlier frame when (s)he returns because of the longer path taken than the stationary twin.



It is apparent that any change in direction starts a new segment Δx_i and the proper time for any object is the sum:

$$\Delta t = \sum_i N_i \sqrt{1 - \frac{\Delta x_i^2 / N_i^2}{c_m^2}}\ seconds$$

Interestingly if it were possible to fix your position relative to the Universe your clock would run the fastest compared to all other clocks not in your frame. Also if cavitation stopped and no new frames were created, time would stop and movement would be frozen.