The Grid ©
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Even early man observed and made records of what he saw in the sky. His understanding of spacetime was limited to small areas of the Earth which he thought were flat. It made sense that they would assume that a unit of distance would be the same length no matter where the unit was used. Early man impose an equal unit grid on the Earth and the skies. Observations of Earth locations as well as celestial observations were recorded on this grid. All of the great civilizations used an equal size grid as the basis for their math and geometry which allowed them to construct their buildings and navigate across the surface of the planet. Figure G-1 shows how the Egyptians thought about space.

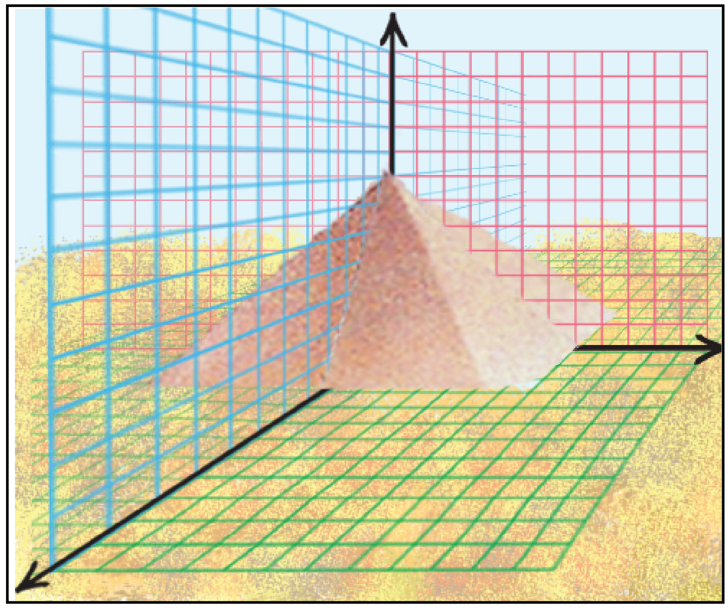

Figure G-1, The Egyptians and other great civilizations of the past laid out three dimensional grids to enable them to build their intricate constructions.

Additions were made to the equal size unit grid so that it became the Cartesian Coordinate System that we use today. On this system we can record the locations of masses, and, using Kepler's and Newton's equations, we can predict the motions of masses. *All integration and differentiation processes require*

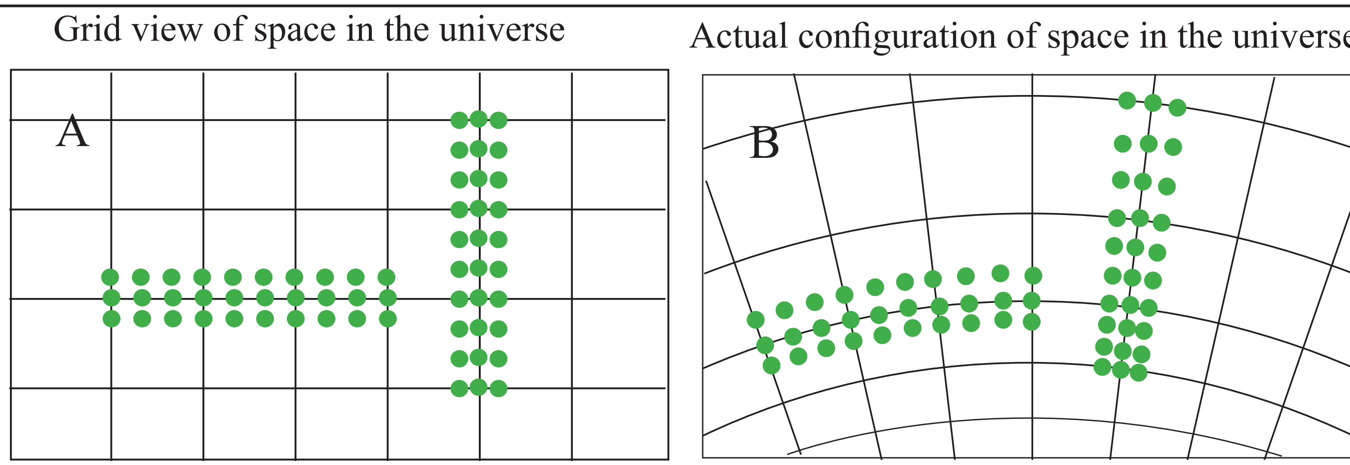

Figure G-2. A represents the historical way people have thought of space. The equal size of the space units is necessary when using the equations of Kepler and Newton. Actually, we have discovered that B represents the way that mass affects space.

In Figures A and B the green dots represent elementary particles which are the constituents of masses. These elementary particles hang together into the shapes we know because they are in electromagnetic equilibrium. It is assumed that their masses are small and can be ignored. In B, it is assumed that there is a dominating mass (not shown) below the bottom of the graph. In these figures, the masses could be rulers which are three units long. People see them as in Figure A because humans are subject to the same warpage as the rulers and cannot detect the difference directly. The reality in Figure B represents the particles actual configurations. This new understanding of space must be inferred from analysis of data we receive from cosmological experiments.

equal size units for them to yield accurate answers.

In general, they believed that the Earth was flat and that the grid was an exact representation of space. The curvature on the surface of the Earth was sufficiently small so that Newton and Kepler could compensate for the difference between the grid and actual spacetime. Using constants and accelerations their equations could accurately predict the behavior of masses as long as the grid was a good approximation for their scenario.

We now believe that mass contracts the space unit and dilates the time unit, in the mass' vicinity, so that the sizes of the space units and time units always change as one moves toward and away from any mass. In fact, the only time that an equal size unit grid actually represents the spacetime of the universe is when there is **no** mass in it at all.

Figure G-2 shows how our new understanding of space has fundamentally changed. The green dots represent elementary particles of mass. The particles hold their shapes because they are in electro-weak equilibrium. So, the four groups of green dots could represent rulers each three units long. In graph A, the particles are oriented according to pre-modern thought in which space is flat. In graph B, the same particles are shown in their proper configuration in space which is dominated by a large mass (not shown) at the bottom of the graph. The particle separations are all uniform in Graph A. However, the particles at the top of the vertical ruler in graph B are farther apart than those at the bottom. This is because they are farther away from the dominating mass and therefore in less contracted space. This relationship holds true for all the particles in Graph B. Particles in an array will be farther apart in less constricted space. (In Figure G-2, the masses of the individual particles are assumed to be so small that they can be ignored.)

If there is any mass at all in the universe, the grid becomes just an **approximation** for spacetime. This difference between actual spacetime and the grid becomes a serious problem when the amount of contraction and/or dilation becomes great. In Figure G-3, a grid is overlaid on a series of rings. The distance

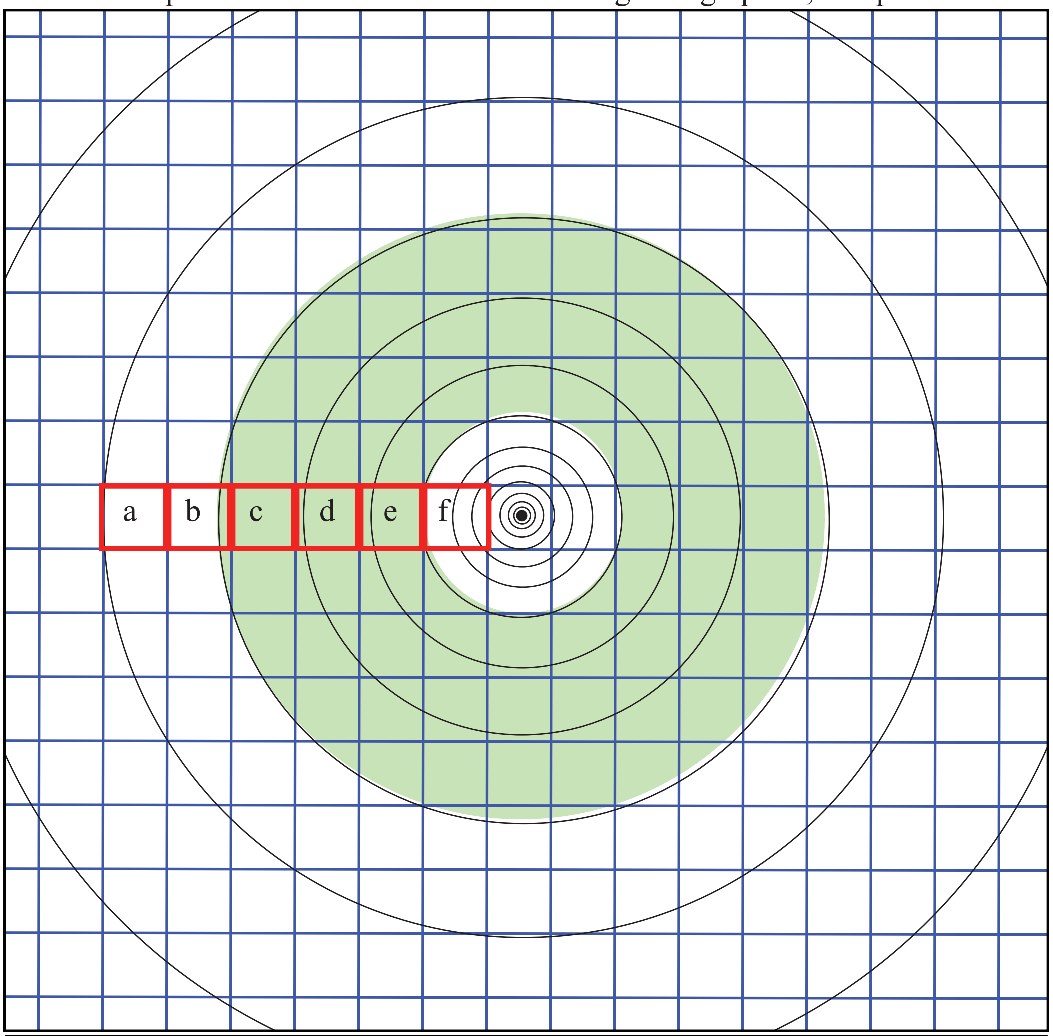

Figure G-3. The black dot at the center represents any mass. The blue lines show a grid with the mass at the center. The distance between each line represents one unit. The black rings represent the way the mass would change the space units in its vicinity. Each distances between the rings represents one unit. The green zone represents the area in which the grid approximates the actual units well enough to be useful. Grid unit c is just a bit smaller than an actual unit in its vicinity; grid unit d is about the same size and the actual unit; and grid unit e is just a little smaller than the actual unit in its vicinity. Grid unit f is too large and encompasses three actual units. Farther out from the green zone, the units are too small to approximate the actual space unit as it takes two of them, a and b, to equal one actual unit.

between points of intersection of the lines in the grid represent one space unit. The rings represent how the mass at the center contracts the space around it. In this graph the distance between the rings is the equivalent of a one distance unit. Grid units c, d, and e agree with the sizes of the ring units enough to allow the grid to be useful. Grid unit f is too big to be compatible with the spacetime in its vicinity as it is equal to three contracted ring units. Grid units a and b are smaller than the ring units in their location and must be added together to approximate one of the ring's units. So, grid units a, b, and f are outside the zone of usefulness. The green ring marks out the region in which the grid, and the equations of Kepler and Newton, is useful in predicting the behavior of masses.

If the size of the grid units is enlarged to accommodate the larger outer rings, then the green ring would lose its usefulness at its inner edge. The whole ring would move farther out from the center. If the grid units are made smaller, then the outer units would lose their usefulness and the green ring would move closer in to the center. Regardless of the size of the grid units, there is a limit to the usefulness of a grid to represent spacetime.

For example, the grid, and Kepler's equations, and the force equations of Newton do well in predicting the behavior of the behavior of celestial objects orbiting the Sun until we evaluate the orbit of Mercury.

Mercury is the closest object to the sun and experiences the greatest spacetime warpage of all the planets. Our grid fails when it has to deal with this amount of warpage. This failure is the reason that the equations of Kepler and Newton could not accurately predict the behavior of Mercury. In 1845, Leverrier's calculations generated a 43" discrepancy per century in Mercury's orbit. In 1915, Einstein used General Relativity to explain this behavior. General Relativity states that the observed gravitational attraction between masses is the result of the warping of space and time by the masses.

So, while the grid is very useful for the surface of the Earth and most solar system calculations, it fails to be useful when the spacetime warpage becomes great. At some point in the outer solar system, the grid will fail and Einstein's principles will have to be used to predict the behavior of objects.

Certainly, the green ring of grid usefulness is very small when there is a black hole in the scenario or when we are evaluating the spacetime for a galaxy. The grid may be imposed on these celestial objects and answers calculated from Newton's equations, but the answers will be wrong because the grid is no longer a good enough approximation for the spacetime being explored.

For the past 100 years we have known that space and time are inexorably merged into spacetime. One cannot change without causing a change in the other, as in Lorentz transformations. Space and time conserve each other. When the size of the space unit increases, the size of the time unit decreases. When the space unit is contracted the time unit is dilated. We experience the latter conditions on Earth. As one approached Earth the space unit is contracted and the time unit is dilated. How do we properly handle time?

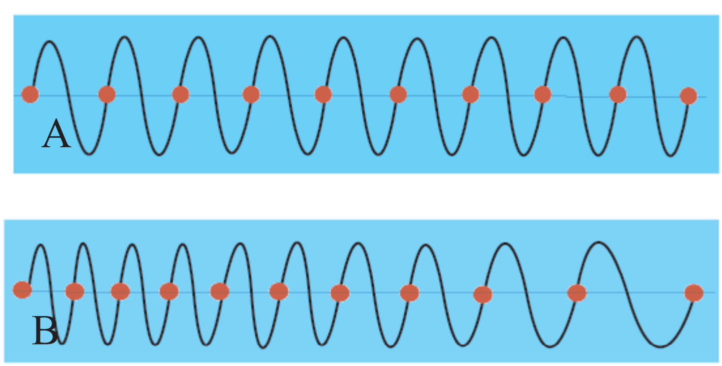

Figure G-4. These sine waves represent signals generated by a Cesium clock. We use them to measure the size of the time unit. In graph A there is no change in the size of the time unit as indicated by the equal distance between the red dots. In graph B the size of the time unit is increasing as one moves to the right.

When we measure space, we measure the separation between two different points in space at the same time. Since we measure distances constantly so as not to bump into things, this doesn't seem too complicated. When we measure time, we measure the separation of two different points in time at the same place. This process seems a bit obscure at first. It will make more sense if we think of our current use of the cesium atom as a time keeper.

The different particles of the cesium atom all respond to the spacetime and energy environment in which they find themselves. In a cesium clock, the cesium atoms are exposed to specific microwaves. The microwave photons are absorbed by the outer electrons of the cesium atom and then the photons are released at very precise time intervals. It is the precision of these precise time intervals that we use to measure time. The official definition of a second is: the duration of 9,192,631,770 cycles of microwave light absorbed or emitted by the hyperfine transition of cesium 133 atoms in their ground state undisturbed by external fields. More simply put, the microwaves cause the electrons in the cesium atom to absorb energy and then these atoms emit a signal which we use to regulate our clocks.

We can graphically represent this emission as a sinusoidal wave on a graph. We shall designate each ascending node of the sine wave (see Figure G-4) by red dots. Then the distance between the nodes, or dots, represent one cycle. The distance between each node would represent the time separation of two different points in time at the same place. This is how we measure time. It is this cycle which changes as time passes. This cycle is multiplied by 9,192,631,770 regardless of the size of the cycle to create a second. Therefore the length of the second increases or decreases depending on the increase or decrease of the cycle. It is simply said that the time unit is increasing or decreasing.

In Figure G-4, the upper graph represents the way time would be graphed in a static time model since the nodes (red dots) are all the same distance apart. This is how we experience time. In the lower graph, the nodes are getting closer together as one moves to the left, indicating that the time unit is getting smaller or contracting. The size of the time unit is indicated by the distance between the red dots. The farther apart the dots are, the more dilated the time unit is. The changing size of the time unit is how the universe actually works.

When we walk around the surface of the Earth, we experience time as in Figure G-4 (A). The GPS satellites experience a time unit that is constant, but, the size of their time unit is smaller (the red dots are closer together). If we shot a Cesium clock up to the GPS satellites, the size of the time units in the clock's signal would change from the larger unit experienced at Earth's surface to the smaller units experienced by the satellites. The

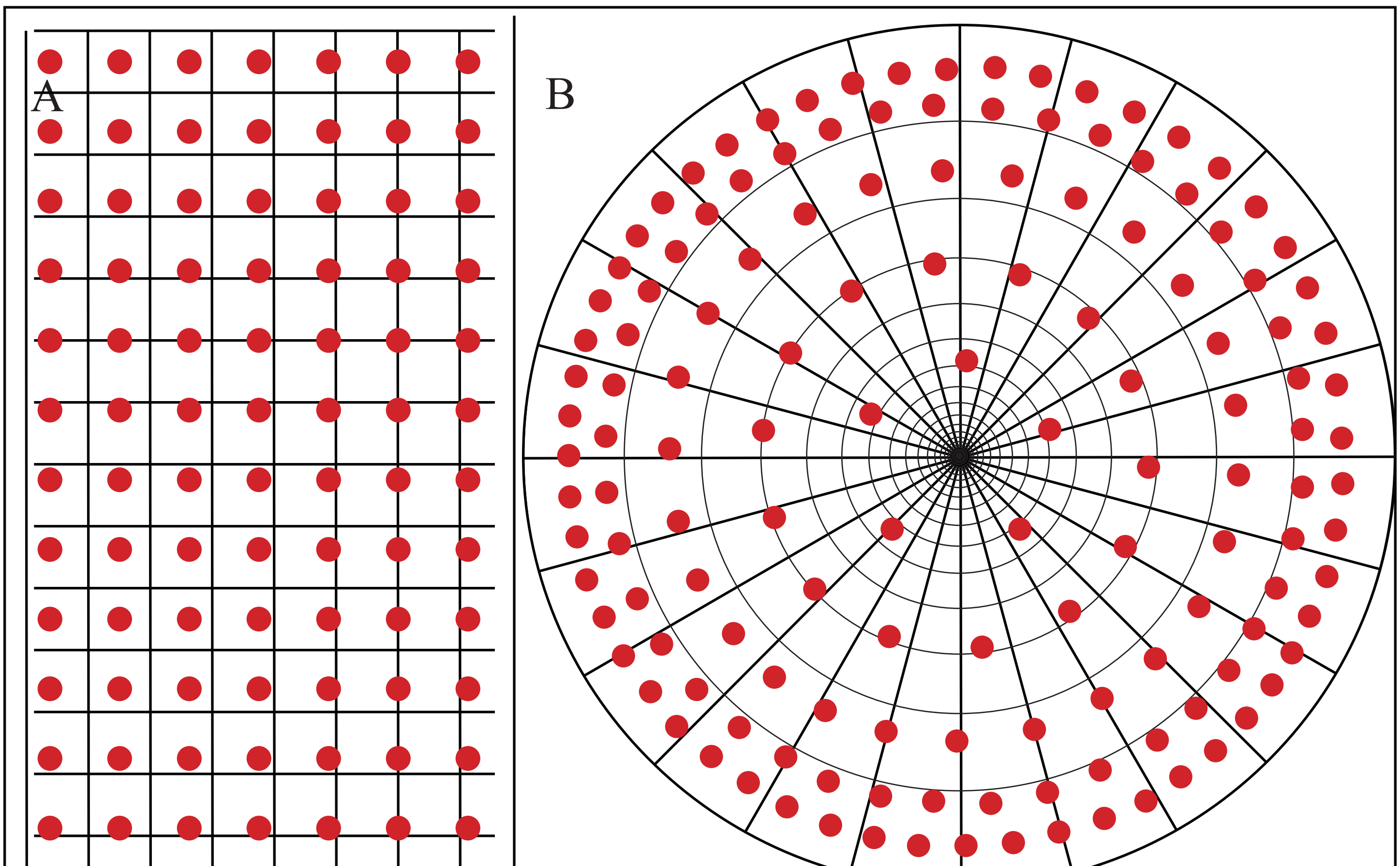

Figure G-5. In these two dimensional arrays, the distances between the red dots indicates the size of the time units. The distances between the intersections of the lines indicates the size of the space units . In Part A all the distance units are the same length and all of the time units are the same. This is the traditional way to view space and time. In Part B, the time units increase in size as the center is approached indicating that time is being dilated by the mass at the center. In B,T the distance units get smaller as the center is approached indicating that the mass is contracting the space around it. This is how the modern astronomer sees spacetime.

graph of the clock's output would look like Figure G-4 (B) moving from right to left.

When we talk about space and time, we are really talking about spacetime and must address the conserving mechanism which combines them. When either one's unit size increases the other one's decreases. Figure G-5 graphically shows, with two-dimensional arrays, the difference between the traditional view of space and time (A) and the modern, post Einstein, view of spacetime (B). In Part A all the space units are the same distance and all the time units are of equal length. This was the view from the earliest times until Einstein presented his views on Relativity. Part B shows how spacetime behaves around a mass located at the center. The diagram shown a contracted space close to the mass. This is indicated by the smaller distances between the rings. Time is shown dilating as the mass is approached by the increased distance between the red dots.

It was originally thought that the speed an object was going caused the changes in spacetime and the faster the object went the more contracted space would be in front of the object and the more dilated would be the time. We thought that speed warped spacetime. We now know that mass warps the spacetime around it. Mass contracts the space unit around it and the bigger the mass the more contraction there is. The time unit is dilated around a mass and the bigger the mass the more time dilation there is. These changing unit sizes are the cause of the failure of the grid and the equations which rely on an equal unit size grid. The green zone in Figure G-3 is the only region around a mass in which a grid can be successfully used.

There are clearly two scenarios in which the green zone is very small. The first scenario is one involving a black hole. There is a very large spacetime warpage around a black hole. So, the application of a grid and grid equations between and orbiting body and the center of a black hole results in false conclusions. An example of this situation is Spaghettification. A second scenario would be any application of the grid or its equations across a galaxy. These two situations are explored in the section called Spaghettification.