

## **Starlight in a 6,000 Year Old Universe**

(appropriate for High Schoolers and older)

Michael R. Daily 4/17/08 (2 lessons, 60 minutes each)

(reference: D. Russell Humphreys, Starlight & Time: Solving the Puzzle of Distant Starlight in a Young Universe, Master Books, 2006)

### **Isaiah 45:18**

**For thus says the LORD, who created the heavens (He is the God who formed the earth and made it, He established it and did not create it a waste place, but formed it to be inhabited),**

The question we are going to look at over the next two weeks is: If the universe is only 6,000 years old and was created in 6 days as indicated by the Bible, how come we can see galaxies and stars that are 15 billion light-years away? In other words the stars and galaxies are so far from us that it takes the light from them 15 billion years to reach Earth so that we can see them. The implication being that those objects were in existence 15 billion years ago so the universe must be a least 15 billion years old if not older.

### **Exodus 20:11**

**For in six days the LORD made the heavens and the earth, the sea and all that is in them, and rested on the seventh day; therefore the LORD blessed the sabbath day and made it holy.**

### **Exodus 31:16-18**

**'So the sons of Israel shall observe the sabbath, to celebrate the sabbath throughout their generations as a perpetual covenant.' 17"It is a sign between Me and the sons of Israel forever; for in six days the LORD made heaven and earth, but on the seventh day He ceased from labor, and was refreshed." 18When He had finished speaking with him upon Mount Sinai, He gave Moses the two tablets of the testimony, tablets of stone, written by the finger of God.**

The Bible makes it clear that the universe (heavens) was created in only 6 days.

The reason studying this is important is because if you can be convinced that Genesis 1 (and Exodus 20 & 31) is not true the next challenge people will hit you with is, "If you don't believe Genesis 1 is true, then you are a fool for believing any of the Bible is true". There is no middle ground. The Bible claims to be the perfect Word of God – either it is or it isn't.

Its also important that you understand a few things about science otherwise it will be easy for people to deceive you.

What is science? When we say, "science says the universe is 15 billion years old, science says man evolved in the following way", what does that mean, "science"? That type of science is really made up of two things:

- 1) **Real science** – observations, experimental data, repeatable experiments. We Christians love this stuff and we have no problem with it – we like it. But there is another part of science:
- 2) **Philosophy** – This includes dogma or ideology (strongly held beliefs) and in science it usually is presented in the form of assertions. What is an assertion? The word "assertion" is a scientific word which means "to strongly insist" that something is true. When a scientist makes an assertion he is saying, "I have no data, I have no observational evidence, there are no experimental results that support what I am about to say, nevertheless I strongly insist that the following must be true". This is philosophy. We Christians reject philosophy in all its forms.

### **Colossians 2:8,9**

**See to it that no one takes you captive through philosophy and empty deception, according to the tradition of men, according to the elementary principles of the world, rather than according to Christ. For in Him all the fullness of Deity dwells in bodily form,**

Its critical that you be able to tell the difference between real science – observation and experimental results – and philosophy in the form of assertions. Accept the real science but reject assertions.

The physics that will help us understand how a young universe can appear to be old was discovered by a young German patent clerk who had an unusual hobby. His hobby was theoretical physics.

Albert Einstein's discoveries of special and general relativity provide the physics to explain how a universe only 6,000 years old can have galaxies 15 billion light years away from us.

So, if Einstein's laws of relativity are correct (they have been experimentally proven time and again) how come the scientific community still thinks the universe is 15 billion years old or older? We'll study how that happened.

### **Overview of Cosmology**

Cosmology - a branch of astronomy that deals with the origin, structure, and space-time relationships of the universe ; *also* : a theory dealing with these matters

**Job 22:12 - "Is not God in the height of heaven? Look also at the distant stars, how high they are!"**

### **Psalm 19:1**

**The heavens are telling of the glory of God; And their expanse is declaring the work of His hands.**

### **Psalm 33:6**

**By the word of the LORD the heavens were made, And by the breath of His mouth all their host.**

### **Psalm 89:37**

**"It shall be established forever like the moon, And the witness in the sky is faithful." Selah.**

Until about 100 years ago our ability to study the universe was limited. During the 19<sup>th</sup> and 20<sup>th</sup> century our instruments improved rapidly. During the last 100 years we have discovered that stars are clustered in what we now call galaxies. Our solar system is part of a typical spiral galaxy – ours is named the Milky Way Galaxy.

A galaxy is a celestial object that is made up of about 100 billion stars ( $10^{11}$  stars = 100,000,000,000) and has a diameter of about 100,000 light-years. A light year is a measure of distance. It is the distance that a beam of light travels in a year. Light travels at 186,282 miles per second so a light year is about 5.88 trillion miles or  $5.88 \times 10^{12} = 5,880,000,000,000$  miles.

Since we live in the Milky Way Galaxy we can't see it except for a soft fuzzy white band across the sky (if you are away from the lights of a city). However, we can see other galaxies and there is evidence that our galaxy is similar to spiral galaxies that we can see. Our solar system is located about 2/3 from the center to the edge of the galaxy. Recent evidence suggests that our galaxy and probably most, if not all, galaxies have a spinning Black Hole at the center. We'll talk more about Black Holes later.

The Hubble Space Telescope (put up in 1990) is located outside of Earth's atmosphere and provides us with far better observations than can be made using earth bound telescopes due to the absorption and distortions caused by Earth's atmosphere.

The Hubble can see objects as far away as 15 billion light years (15,000,000,000 light-years) and has verified that there appear to be about 100 billion galaxies in our range of view! So the total number of stars in the observable universe is estimated to be  $10^{22} = 10,000,000,000,000,000,000,000$  which is 10 billion trillion.

### **Edwin Hubble's Measurements**

Early in the 20<sup>th</sup> century Edwin Hubble made a series of astronomical observations that were groundbreaking. Although Hubble was not a Christian or even a believer in God his astronomical observations and measurements overwhelmingly indicated that the Earth appears to be located at the center of the universe! The observations were: 1) uniform distribution of stars around us, 2) red-shift measurements.

- 1) **Uniform Distribution of Stars** - As we look around us in all directions as deep as possible (now even as deep as 15 billion light years) we notice a strange thing. Stars and galaxies appear to be evenly distributed around us in all directions. There are local areas of variation but when you average over large volumes of space the distribution of stars and galaxies is unexpectedly even or uniform. This seems to indicate that the Earth is within no more than a million light years of being at the very center of the universe. If we were close to the edge of the universe we would expect to see part of the sky densely filled with stars and galaxies and part of the sky almost completely empty – but that is not the case. In fact, the uniformity is so good that it indicates we must be at the center of the universe. (Our instruments are only good enough to tell that we are somewhere within 1 million light-years of the center of the universe).
- 2) **Red-Shift Measurements** - Einstein's special theory of relativity says that objects moving away from us will have the frequency of the light they emit shifted to longer or "redder" wavelengths and objects moving toward us will have the frequency of the light they emit shifted to shorter or "bluer" wavelengths. (Although the physics is not the same we can think of it as being similar to how a train with its whistle blowing or a car with its horn blowing sounds higher in pitch as it approaches you and lower in pitch as it passes you and speeds away). Shortly after the theory of special relativity was published, Edwin Hubble became the first to measure these frequency shifts of other galaxies in the universe and found that most galaxies are red-shifted (they are moving away from us). The Hubble Law says that the farther away an object is from the Earth the more "red-shifted" the frequency of its light is. Hubble also discovered that if we backtrack the paths that the galaxies appear to be moving away on, they all point to one place where the universe began. That place appears to be our location!

*The shocking result of Hubble's measurements and observations is that the Earth, or at least our galaxy, appears to be located at the place where the universe began – at least within 1 million light years of the center of the universe.*

### **What are the odds that Earth would be located at the center of the universe based on random chance ?**

The first question we need to look at is, "if the Earth is located at the center of the universe could it have happened just by pure dumb luck?" (what scientists call "random chance"). We can calculate this probability if we know the total volume of the observable universe (radius equals 15 billion light-years) compared to the volume of a sphere with a radius of a million light years (our instrument error).

As all you Algebra students know the equation for the enclosed volume of a sphere is:  $V = \frac{4}{3}\pi r^3$ .

So, the volume of the observable universe in cubic light years is =  $1.33 \times 3.14 \times 15 \times 15 \times 15 \times 10^{27} = 1.4 \times 10^{34}$

And the volume of a sphere within a million light years of the center of the universe in cubic light years is =  $1.33 \times 3.14 \times 1 \times 1 \times 1 \times 10^{18} = 4.2 \times 10^{18}$

So, the probability that the Earth would be at the center of the universe by chance is =  $4.2 \times 10^{18} / 1.4 \times 10^{34}$

Or, 1 chance out of  $3 \times 10^{16}$  which is: **1 chance out of 30 million billion!** (1 out of 30,000,000,000,000,000)

So, the probability that the Earth would be located at the center of the universe based on pure dumb luck or random chance is one chance out of 30 million billion.

*Both Christians and atheists agree that this number is so small it is effectively zero. In other words, it is impossible for the Earth to be located this close to the center of the universe based on pure dumb luck.*

As Christians we read Genesis 1.

### **Genesis 1:1-2**

**In the beginning God created the heavens and the earth. The earth was formless and void, and darkness was over the surface of the deep, and the Spirit of God was moving over the surface of the waters.**

Genesis 1 says that the location of the creation event was Earth. Therefore, we would expect the Earth to still be located relatively close to the center of the universe today. Hubble's measurements confirm that the Earth is at the center of the universe – so us Christians – we're in good shape.

But the atheists have a serious problem. Their philosophy is that there is no god and therefore everything happens by random chance – pure dumb luck. Their observations and their philosophy directly conflict with each other. Their measurements say we are at the center of the universe but their philosophy (random chance) says that we can't be. So, what do you think the atheists did?

**At this point atheistic scientists have a choice:**

- 1) Believe there is a God and the starting point of creation was the Earth as stated in the Bible.
- 2) They can look for some way to explain how we appear to be at the center of the universe but we really are not. This is not based on science it is based on ideology – unproven ideas.

**Science chose number 2**

In physics there are two types of scientists, theoretical physicists and experimental physicists. The theoretical physicists come up with a new idea, then they see if they can develop a mathematical model (set of equations) that shows that their new idea does not violate any mathematical rules. They then see what the implications of the mathematical model are in the real world. In other words the model will tell them that their idea will work but only if the following things are also true. Experimental physicists then run actual experiments to see if they can gather evidence that proves or disproves the mathematical model and its implications.

Science decided to use this approach to deal with the conflict between Hubble's measurements and their godless philosophy of random chance. They got their big brains together and decided to try to create a mathematical model that would allow observations from the Earth to indicate Earth was at the center of the universe, but not be, both at the same time. To get around God they came up with the Big Bang theory. The Big Bang is not what you think. Most people think it is an explosion and expansion of matter from a single point in 3 dimensional space – this is not true. It is actually a very strange idea.

**The Big Bang Theory**

The Big Bang theory was proposed in 1922 by the Russian mathematician and meteorologist Alexander Friedmann to explain how the earth can appear to be at the center of the universe, but not be. There is no evidence for it – it is just a way to get around the idea of God.

Friedmann asserted (to insist without evidence) that for such a model to be created it must be true that every location in the universe would appear that it was the center of the universe if Hubble's measurements were taken from those locations, yet none of the locations would actually be the center of the universe. In other words, "the Earth cannot be in a special place". There are no data or observations to support this statement – it is merely an assertion.

The assertion that the Earth is not in a special place even has a name – they call it the "Cosmological Principle," or more recently the "Copernican Principle" but its nothing more than an assertion based on a godless ideology.

***Quote from Edwin Hubble after finding his measurements indicated Earth is at the center of universe:***

"Such a condition would imply that we occupy a unique position in the universe... But the unwelcome supposition of a favored location must be avoided at all costs....Such a favored position, of course, is intolerable." (Hubble, E.P., *The Observational Approach to Cosmology*, pp. 50–59, Clarendon, Oxford, 1937.)

***Quote from George Ellis, South African cosmologist, October 1995 issue of Scientific American:***

"People need to be aware that there is a range of models that could explain the observations. For instance, I can construct for you a spherically symmetrical universe with the Earth at its center, and you cannot disprove it based on observations. You can only exclude it on philosophical grounds. In my view there is absolutely nothing wrong in that. What I want to bring into the open is the fact that we are using philosophical criteria in choosing our models. A lot of cosmology tries to hide that."

(W. Wayt Gibbs, "Profile: George F. R. Ellis," *Scientific American*, October 1995, Vol. 273, No.4, p. 55.)

Friedmann was able to construct a mathematical model that met these requirements without violating the equations of General Relativity. However, the model required that a fourth dimension of space would also have to exist. In order to get the model (what today is called the Big Bang Theory) to work he had to assert that space must have a fourth dimension that we can't detect. It is the only way his model works. We, of course, live in 3 dimensional space (height, length, and width) and are not able to detect a fourth dimension (although scientists today are continuing to try to detect this fourth dimension using particle accelerators such as the Large Hadron Collider).

I will now try to explain the actual Big Bang Theory. Get ready because its really confusing! But when you are running away from God things get complicated in a hurry.

In the 'closed' big bang (the most favored version), they imagine the three-dimensional space we can see as being merely the surface of a four-dimensional 'balloon' expanding out into a 'hyperspace' of four dimensions (none of these dimensions is time).

They picture the galaxies like buttons all over the surface of a balloon. No galaxies would be inside the balloon. As the expansion proceeds, the rubber (representing the 'fabric' of space itself) stretches outward. This spreads the buttons apart. From the viewpoint of each button, the others move away from it, but no button can claim to be the center of the expansion. On the surface of the balloon, there is no center. The center of the expansion would be in the air inside the balloon, which represents 'hyperspace'. There is no way to detect or prove the existence of this 4th dimension of space – but it is necessary for the model to get around God. Instead of the Big Bang a better name for this idea would be the Big Balloon. (To demonstrate this concept blow up a balloon and draw galaxies on it and then let the air out. You can blow the balloon up in front of the kids to let them see the idea).

Here's another way to look at the concept. If you could travel infinitely fast in any particular direction, they claim you would never encounter any large volume of space unpopulated with galaxies and you would end up right back at the place you started from. You would not be able to define an 'edge' or boundary around all the galaxies, and so you could not define a geometric center. You'd be like a bug walking on the surface of the balloon – if you walked in a straight line long enough you would end up back where you started.

You will occasionally hear scientists (or a PBS commercial) say that "the universe has no center and no edge" as if it was proven fact. But these are just unproven assertions that result from believing in the big bang idea.

*Why do people want to believe in a fourth dimension of space they cannot detect instead of believing in God? Because a fourth dimension of space is not going to judge you and send you to Hell – but God might.*

### **Romans 1:18-23**

**For the wrath of God is revealed from heaven against all ungodliness and unrighteousness of men who suppress the truth in unrighteousness, 19because that which is known about God is evident within them; for God made it evident to them. 20For since the creation of the world His invisible attributes, His eternal power and divine nature, have been clearly seen, being understood through what has been made, so that they are without excuse. 21For even though they knew God, they did not honor Him as God or give thanks, but they became futile in their speculations, and their foolish heart was darkened. 22Professing to be wise, they became fools, 23and exchanged the glory of the incorruptible God for an image in the form of corruptible man and of birds and four-footed animals and crawling creatures.**

### **The Big Bang Assertion Creates a Big Problem**

The Big Bang is a complicated idea that requires the existence of a fourth dimension of space that we cannot detect . Its purpose is to allow atheists to not have to believe in a God who put us intentionally at the center of the universe as the Bible says He did and as Hubble's measurements indicate.

But the Big Bang also has implications in it that create other, really big problems. You see, a universe with no edge and, therefore, no center also has no gravitational gradient. In other words, mass would be evenly distributed in all directions (on the balloon) and so the gravitational effects of all that mass averaged over the entire universe cancel out resulting in no significant gravitational slope or gradient. But according to General

Relativity, if there is no gravitational gradient then there is also no gravitational time dilation and gravitational time dilation (which has been experimentally proven many times) is the key to understanding the starlight problem. (We'll talk more about gravitational time dilation next week).

Instead of going through all these mental gymnastics to get around God if we just believe that our observations and the Bible are true and that we are, in fact, at the center of the universe things are much clearer and easier to understand.

Side Note: Another variation of the Big Bang Theory (open version) asserts that the universe is only 3 dimensional but that the even distribution of stars and galaxies continues in all directions to infinity. Few atheists believe this version now because an infinite universe full of stars would fill the Earth's night sky with solid stars (no gaps in between) but since we do not see that effect in our sky this idea has been abandoned by most people. The closed (balloon) model allows for a finite universe which matches what we see in our sky but requires belief in a fourth dimension to space which has never been detected.

The Bible also says that mass in the universe is not infinite.

**Psalm 147:4 - He counts the number of the stars; He gives names to all of them.**

**Isaiah 40:26**

**Lift up your eyes on high And see who has created these stars, The One who leads forth their host by number, He calls them all by name; Because of the greatness of His might and the strength of His power, Not one of them is missing.**

Before we go any farther we need to understand Einstein's two theories of Relativity. These things are a little difficult to understand but its important that we make the effort. Unlike the Big Bang, Special and General Relativity have both been experimentally proven and verified many times over the last century.

### **Special Relativity**

The theory of special relativity was proposed in 1905 by Albert Einstein in his article "On the Electrodynamics of Moving Bodies". The theory was called "special" because it applies the idea of relativity only to things that are moving. Galileo had stated that all motion was relative, and that there was no well-defined state of rest; a person on the deck of a ship may be at rest in his opinion, but someone observing from the shore would say he was moving. Einstein generalized Galileo's relativity to all laws of physics.

Einstein also added a second idea - that all observers will always measure the speed of light to be the same no matter what their state of constant, straight line motion is. For this to be true time and space would have to be relative to the observer – time and space would be different depending on who the observer was.

Imagine someone travelling in a straight line at half the speed of light compared to another person who is standing still (the observer). The traveler now switches on a laser beam ahead of him in the direction of travel. According to Galileo the traveler should see the edge of the beam of the laser light move away from him at the speed of light and the person standing still (observer) should see the beam of light move at 1.5 times the speed of light. According to special relativity the traveler will see the laser light move away from him at the speed of light but the observer will also see the laser light move at the same speed of light. Since speed is just distance divided by time this can only be true if distance, time or both change. Special Relativity says that in this case the traveler will appear to the observer to have shrunk in length and to be moving in slow motion in terms of body motions and the watch on the traveler's wrist. From the traveler's viewpoint everything seems normal to him. Time is ticking at a normal rate, lengths are normal. In other words time is not a constant. It ticks at different rates depending on how fast something is moving.

Special Relativity has a number of strange implications, all of which have been proven experimentally. Special relativity changed Newtonian (Sir Isaac Newton) ideas of space and time by stating that distance and time depend on the observer, and that time and space are perceived differently, depending on the observer. Special Relativity agrees with Newton in experiments where velocities are small compared to the speed of light.

Special relativity reveals that  $c$  is a fundamental characteristic of the way space and time are tied together. Special relativity states that it is impossible for any object to be accelerated to the speed of light because as you approach the speed of light:

Length shortens:  $L = L_0 \sqrt{1-v^2/c^2}$  (Space distorts)

Time slows down:  $T = T_0 \sqrt{1-v^2/c^2}$  (Time is variable)

Mass increases:  $M = M_0 / \sqrt{1-v^2/c^2}$  (Mass changes)

Special Relativity has been experimentally proven many times. Have you ever wondered why particle accelerators are so enormous and require the use of the most powerful, supercooled magnets known to man? These machines are used to accelerate tiny particles smaller than a molecule around and around in circular paths that are many miles in diameter through tunnels surrounded by the world's strongest electromagnets. In fact the newest accelerator (Large Hadron Collider) being developed by CERN in Europe will be required to shut down during the winter because the magnets draw enormous amounts of electricity and if they ran it during the winter the electric grid would not be able to provide enough power to all the other customers it has to serve. What is going on? Why such a massive, energy consuming machine, just to accelerate a few particles that are so tiny you can't even see them? (The CERN particle accelerator straddles the border of France and Switzerland and has a circular acceleration tunnel that is 27 kilometers long. It will become operational in 2009 and will be the largest supercooled particle accelerator in the world.)

Special Relativity says that as you accelerate these particles very close to the speed of light their effective mass increases rapidly and time slows down and that is exactly what happens. These tiny particles take on enormous mass and in order to control such massive particles and keep them moving in a circle, huge magnets are needed. Special Relativity says that the particle can never actually reach the speed of light because if it did the particle would have the mass of the entire universe and it would take all the energy in the universe to control its motion!

In addition, radioactive particles decay at very well known rates. Experiments have been done where these huge particle accelerators have measured the slowdown in radioactive decay (time slows down) of accelerated particles. As the radioactive particles approach the speed of light the radioactive decay slows to a near stop – in other words time comes almost to a complete stop for the particle, just as predicted by Special Relativity.

### **General Relativity**

In 1915 Einstein published another paper titled, "The Field Equations of Gravitation" which introduced the theory of General Relativity. The key idea of general relativity, called the equivalence principle, is that gravity pulling in one direction is completely equivalent to an acceleration in the opposite direction.

Einstein used the example of a rocket ship that, when it accelerates, pushes you against its floor just like gravity does on Earth and an elevator that if it were to fall at 32 feet per second would make you feel weightless just like in a rocket ship that was not accelerating (at least until you hit the basement).

If gravity is equivalent to acceleration, and if motion affects measurements of time and space (as shown in special relativity), then it follows that gravity does so as well.

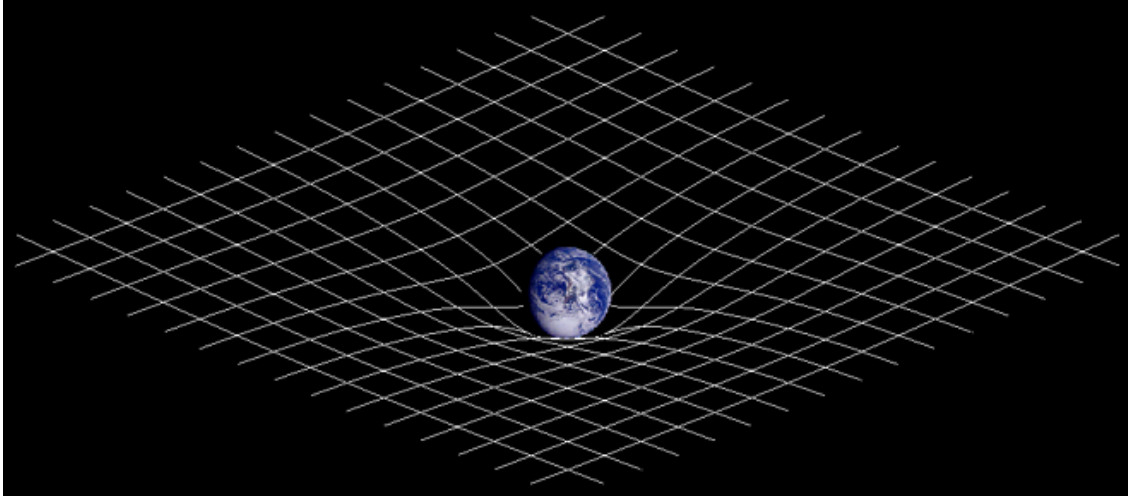
In General Relativity Einstein showed that gravitational fields distort time and space, massive gravitational fields massively distort time and space, and at the event horizon of a Black Hole (the most powerful gravitational field that we can observe) time comes to a complete stop!

### **END OF PART 1**

## **BEGIN PART 2**

In General Relativity Einstein showed that mass distorts time and space - the denser the mass the more severe the distortion.

The equations of general relativity are similar in form to equations describing the deformation of a rubber sheet when heavy balls are placed on it. The rubber sheet represents the fabric of what Einstein called "spacetime". The rubber sheet is a 2 dimensional analogy to the 3 dimensional effect of mass on spacetime.

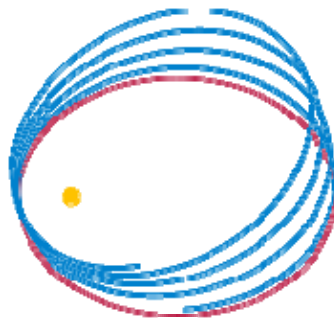


[http://www.thebestlinks.com/General\\_relativity.html](http://www.thebestlinks.com/General_relativity.html)

Einstein concluded that gravity was not so much the attraction of massive bodies as it was the distortion of space and time caused by mass. In other words the presence of mass distorts space and time and distortions of space and time, in turn, affect the motion of mass.

### **Experimental Proofs of Space Distortion Predicted by General Relativity**

1) In 1869, just a few years after the end of the U.S. Civil War, astronomers were measuring the orbits of the planets and comparing them to the orbits predicted by Sir Isaac Newton's equations of motion, developed in the 1600's. What they found was that all the planets known at the time, except for one, had orbits that were perfectly predicted by Newton's equations. A tiny precession in Mercury's orbit (43 arc seconds per century) was not predicted by Newton's equations. General Relativity not only exactly predicted the orbits of all the other planets but also exactly predicted Mercury's orbit as well. Because Mercury is very close to a massive object (the Sun), the distortion of space near the Sun was large enough that it showed up in Mercury's orbit.



Mercury's Orbit Around the Sun (Purple=Newton, Blue=Einstein)  
[http://en.wikipedia.org/wiki/General\\_relativity](http://en.wikipedia.org/wiki/General_relativity)

2) A solar eclipse provided an opportunity to verify General Relativity. As the moon passed in front of the Sun and blocked its light, measurements were taken of the starlight from stars located behind the edge of the Sun. Newton's equations predicted the mass of the Sun would bend the starlight a certain amount. General Relativity predicted the light would be bent about twice as much and General Relativity was found to be true.

## Experimental Proofs of Gravitational Time Dilation of General Relativity

- 1) According to General Relativity clocks at a low altitude should tick more slowly than clocks at a high altitude and observations confirm this effect, called *gravitational time dilation*.

One experiment that confirmed gravitational time dilation was made possible by the invention of the atomic clock. Atomic clocks are accurate to about one microsecond per year (a millionth of one second). According to General Relativity if two identical atomic clocks were located in different gravitational fields you should be able to see the difference in time in the clocks. There happens to be such a situation with an atomic clock at the Royal Observatory in Greenwich, England and an identical one at the National Bureau of Standards in Boulder, Colorado. The one in England is located at sea level and the one in Colorado is located about a mile above sea level. Since the Earth's gravitational field gets weaker the higher above sea level you are, we would expect the clock in Colorado to tick along at a faster rate. General relativity predicts that the clock in Colorado will tick 5 microseconds faster per year than the one at sea level and that is exactly what is observed to happen. Many other experiments have been done that have also verified that gravitational time dilation, as predicted by General Relativity, is real.

(W. Rindler, *Essential Relativity*, 1977, Revised Second Edition, Springer-Verlag, New York, p. 21).

Its important to understand that not only clocks are affected. Time itself is moving at a different rate. For example, how fast you age, the decay rate of atomic nuclei, the speed of nerve impulses in your body, everything is experiencing time moving at a modified rate. Because of this, the effect of time slowing down is unnoticeable locally. It is only when you compare clocks in different gravitational fields that you can see a difference.

- 2) The Global Positioning System requires extremely precise measurements of time in order to provide accurate location information - which is why each satellite has an ultra-precise atomic clock on it. The reason each satellite must have the most accurate clock known to man on it is because in the GPS system, 10 nanoseconds of time error results in 3 meters of location error. The clocks on the GPS satellites are affected by their speed (special relativity) as well as their altitude (general relativity). General relativity predicts that the atomic clocks at GPS orbital altitudes (12,600 miles) will tick more rapidly, by about 45.9 microseconds per day, because they are in a weaker gravitational field than clocks on Earth's surface. Special relativity predicts that atomic clocks moving at GPS orbital speeds will tick more slowly than stationary ground clocks by about 7.2 microseconds per day (a microsecond is 1 millionth of a second). When combined, the discrepancy is about 38 microseconds per day – which corresponds to a location error on the Earth of about 7 miles (11,400 meters) if not corrected. To account for this, the frequency standard onboard each satellite is given a rate offset prior to launch, making it run slightly slower than the desired frequency on Earth; specifically, at 10.22999999543 MHz instead of 10.23 MHz. If not corrected for the effects of Special and General relativity the GPS system would be completely unusable!

## Black Holes

One of the predictions of general relativity is the existence of black holes. A black hole is a region of space whose gravitational force is so intense that nothing, not even light can escape. A black hole would thus appear black from the outside. It is believed that black holes form from the collapse of stars. As long as they are emitting heat and light into space, stars are able to support themselves against their own gravity with the outward pressure generated by heat from nuclear reactions deep in their interiors.

## I Corinthians 15:40-41

**There are also heavenly bodies and earthly bodies, but the glory of the heavenly is one, and the glory of the earthly is another. 41There is one glory of the sun, and another glory of the moon, and another glory of the stars; for star differs from star in glory.**

According to General Relativity if a star having a mass greater than about 3 times the mass of our Sun burns out, the star will collapse and form a black hole. The size of the black hole is proportional to the mass of the star; a black hole with a mass of 3 solar masses would end up with a diameter of about 10 miles.

The possibility that stars could collapse to black holes was first realized by J. Robert Oppenheimer and Hartland Snyder in 1939, who were manipulating the equations of General Relativity. The first real black hole discovered was Cygnus X-1, which is a mere 7,000 light-years from Earth.

At a certain distance from the center of the black hole gravity is just strong enough to keep a light beam from escaping. This distance is called the Event Horizon. At the event horizon time and space are both massively distorted. In fact, to an observer far away from the black hole time appears to stop at the event horizon.

***The following discussion is based on the White Hole Cosmology developed by D. Russell Humphreys (see reference, page 1).***

### **Event Horizons and Time**

In his popular book *A Brief History of Time* (Bantam Books, 1988, p. 87), Stephen Hawking tells the story of an imaginary astronaut, falling toward the event horizon of a black hole:

“The astronaut is scheduled to reach the event horizon at 12:00 noon, as measured by his watch. As he falls toward it, a dark sphere blocking off the starry background, an astronomer watching him from far away sees that the astronaut’s watch is ticking slower and slower. By the astronomer’s wall clock, it takes an hour for the astronaut’s watch to go from 11:57 am to 11:58. And then *a day* to reach 11:59! The astronomer never does see the astronaut’s watch reach 12:00. Instead, he sees the motionless images of the astronaut and his watch getting redder and dimmer, finally fading from view completely.”

From the viewpoint of the astronaut looking back at the astronomer the astronomer would appear to be experiencing time moving faster and faster. As the astronaut fell closer and closer toward the event horizon of the black hole he would see the astronomer moving faster and faster and the astronomer’s wall clock spinning faster and faster. As the astronaut crosses the event horizon exactly at 12:00 the astronomer and his clock are moving so fast they are just a blur. During the whole episode the astronaut feels normal and his watch ticks along at a normal rate.

The point is, *time literally stands still at the event horizon* and near the event horizon time ticks along very slowly compared to locations far away from it.

### **Black Holes and Event Horizons**

If we took the known mass in the universe and put it into a volume about  $1/50^{\text{th}}$  or smaller of what it currently is, General Relativity says that the universe would be in one of only two possible states. This smaller universe would either be inside a huge Black Hole or inside a huge White Hole. In either case the Hole would have an event horizon at least one billion light-years in diameter. Remember, the event horizon is that distance away from a black or white hole where light cannot escape. But since the “speed” of light is a constant the light beam must be able to escape at the speed of light. The only way both of these can be true is that time comes to a stop at the event horizon.

The diameter of an event horizon depends on the amount of matter inside it. For a black hole this means that as matter and energy enter the black hole the event horizon will move out farther and will increase.

Matter and light can exist inside a black hole but General Relativity requires that they must fall inward. But the observational evidence indicates that the universe has expanded and is not currently falling inward toward a “Big Crunch”. Therefore, the universe cannot now be in a black hole.

### **White Holes**

The other possibility allowed by General Relativity is that the universe was once in a White Hole. A White Hole is essentially a Black Hole running in reverse. The equations of General Relativity allow for the existence of White Holes but do not require their existence. At the present time we have not seen a White Hole in the real universe. However, if all the matter in the universe was put in a universe 50 times smaller than what we see today it would meet the requirements of being in a White Hole. It may be that the only White Hole that ever existed was the one from which God created the universe.

Like a black hole, a white hole would also have an event horizon. Matter and light would exist inside its event horizon. Unlike a Black Hole, White Holes do not have to have a singularity at their center but light and matter inside the event horizon of a White Hole must expand outward.

Since the diameter of an event horizon is proportional to the amount of matter inside it, the event horizon of a White Hole would shrink as matter passes through it and out of the white hole. As matter continued to leave the white hole the event horizon would collapse to nothing and disappear. There would be no more white hole, just matter moving away from a central location. This is what we observe today.

The evidence indicates that the universe (with the earth roughly at its center) must have expanded out of a white hole which no longer exists. This means that the event horizon shrank down to zero.

If you were standing on the earth as the event horizon arrived, distant objects in the universe would age billions of years in a single day of your time. And there would be ample time for their light to reach you.

### **What Clock Does the Bible Use?**

In a bounded universe, time moves along at different rates in different parts of the universe. So which set of clocks is the Bible referring to when it says that God made the universe in six days? Since the Bible was written for people living on Earth, the days that God refers to are days as experienced by clocks on the Earth.

### **A Possible Scenario based on the scriptures**

Below is a possible scenario from the reference cited on page 1 that attempts to put together the White Hole Cosmology and the Biblical account of creation. Since no people were there to observe creation (just God and the angels) it is speculative in nature.

#### **Genesis 1:1-5 (Day 1)**

**In the beginning God created the heavens and the earth. 2The earth was formless and void, and darkness was over the surface of the deep, and the Spirit of God was moving over the surface of the waters. 3Then God said, "Let there be light"; and there was light. 4God saw that the light was good; and God separated the light from the darkness. 5God called the light day, and the darkness He called night And there was evening and there was morning, one day.**

#### **Job 26:7**

**"He stretches out the north over empty space And hangs the earth on nothing.**

#### **Job 26:10**

**He has inscribed a circle on the surface of the waters At the boundary of light and darkness.**

#### **Proverbs 8:12, 22-31**

**"I, wisdom, dwell with prudence, And I find knowledge and discretion. 22"The LORD possessed me at the beginning of His way, Before His works of old. 23"From everlasting I was established, From the beginning, from the earliest times of the earth. 24"When there were no depths I was brought forth, When there were no springs abounding with water. 25"Before the mountains were settled, Before the hills I was brought forth; 26While He had not yet made the earth and the fields, Nor the first dust of the world. 27"When He established the heavens, I was there, When He inscribed a circle on the face of the deep, 28When He made firm the skies above, When the springs of the deep became fixed, 29When He set for the sea its boundary So that the water would not transgress His command, When He marked out the foundations of the earth; 30Then I was beside Him, as a master workman; And I was daily His delight, Rejoicing always before Him, 31Rejoicing in the world, His earth, And having my delight in the sons of men.**

All the mass of the universe is located together in the form of water. This ball of water would be about 2 light-years in diameter and would be liquid water. The laws of gravitation would not yet be in effect. Such a ball of water would create a black hole with an event horizon at 500 million light-years away. God then initiates the current laws of gravity. The ball of water rapidly collapses on itself tearing apart the molecules and initiating thermonuclear fusion.

### **Genesis 1:6-8 (Day 2)**

**Then God said, "Let there be an expanse in the midst of the waters, and let it separate the waters from the waters." 7God made the expanse, and separated the waters which were below the expanse from the waters which were above the expanse; and it was so. 8God called the expanse heaven. And there was evening and there was morning, a second day.**

God begins stretching out space causing the ball of matter to expand rapidly – changing the black hole to a white hole. During Day 1 and 2 God himself is the light source. As matter expands out in all directions the event horizon of the white hole stays fixed at 500 million light-years away. It won't start collapsing toward Earth until matter passes through it as leaves the white hole.

(See the attached appendix on "waters above the heavens" for more info on this topic).

### **Genesis 1:9-13 (Day 3)**

**Then God said, "Let the waters below the heavens be gathered into one place, and let the dry land appear"; and it was so. 10God called the dry land earth, and the gathering of the waters He called seas; and God saw that it was good. 11Then God said, "Let the earth sprout vegetation, plants yielding seed, and fruit trees on the earth bearing fruit after their kind with seed in them"; and it was so. 12The earth brought forth vegetation, plants yielding seed after their kind, and trees bearing fruit with seed in them, after their kind; and God saw that it was good. 13There was evening and there was morning, a third day.**

### **Psalms 104:5-8**

**5He established the earth upon its foundations, So that it will not totter forever and ever. 6You covered it with the deep as with a garment; The waters were standing above the mountains. 7At Your rebuke they fled, At the sound of Your thunder they hurried away. 8The mountains rose; the valleys sank down To the place which You established for them.**

Dry land forms and plants are created. There are no stars yet. As the white hole sends out matter beyond the event horizon the event horizon rapidly collapses toward Earth.

### **Genesis 1:14-19 (Day 4)**

**Then God said, "Let there be lights in the expanse of the heavens to separate the day from the night, and let them be for signs and for seasons and for days and years; 15and let them be for lights in the expanse of the heavens to give light on the earth"; and it was so. 16God made the two great lights, the greater light to govern the day, and the lesser light to govern the night; He made the stars also. 17God placed them in the expanse of the heavens to give light on the earth, 18and to govern the day and the night, and to separate the light from the darkness; and God saw that it was good. 19There was evening and there was morning, a fourth day.**

The collapsing event horizon reaches Earth early on the fourth day. During this ordinary day, as measured on Earth, billions of years worth of physical processes take place in the distant cosmos, the stars and galaxies are formed and their light has plenty of time to reach the earth. The White Hole is now gone, massive gravitational time dilation ends, but the universe continues its expansion.

### **Genesis 1:20-23 (Day 5)**

**Then God said, "Let the waters teem with swarms of living creatures, and let birds fly above the earth in the open expanse of the heavens." 21God created the great sea monsters and every living creature that moves, with which the waters swarmed after their kind, and every winged bird after its kind; and God saw that it was good. 22God blessed them, saying, "Be fruitful and multiply, and fill the waters in the seas, and let birds multiply on the earth." 23There was evening and there was morning, a fifth day.**

Fish, birds, and great sea monsters are created on Day 5.

## **Genesis 1:24-31 (Day 6)**

**24**Then God said, "Let the earth bring forth living creatures after their kind: cattle and creeping things and beasts of the earth after their kind"; and it was so. **25**God made the beasts of the earth after their kind, and the cattle after their kind, and everything that creeps on the ground after its kind; and God saw that it was good. **26**Then God said, "Let Us make man in Our image, according to Our likeness; and let them rule over the fish of the sea and over the birds of the sky and over the cattle and over all the earth, and over every creeping thing that creeps on the earth." **27**God created man in His own image, in the image of God He created him; male and female He created them. **28**God blessed them; and God said to them, "Be fruitful and multiply, and fill the earth, and subdue it; and rule over the fish of the sea and over the birds of the sky and over every living thing that moves on the earth." **29**Then God said, "Behold, I have given you every plant yielding seed that is on the surface of all the earth, and every tree which has fruit yielding seed; it shall be food for you; **30**and to every beast of the earth and to every bird of the sky and to every thing that moves on the earth which has life, I have given every green plant for food"; and it was so. **31**God saw all that He had made, and behold, it was very good. And there was evening and there was morning, the sixth day.

Animals and people are created on Day 6. By the time Adam and Eve are able to look up at the sky all the stars and galaxies have been formed and are in their places.

## **Conclusion**

The idea of the universe being created by God from a White Hole is consistent with the astronomical observations of Edwin Hubble and the physics of Special and General Relativity developed by Einstein (which have been experimentally proven many times over the last 90 years). It also appears to be consistent with the account of Genesis 1. It is certainly more scientific and consistent with measurement, observation, and experimental data than the Big Bang Theory which is based on multiple assertions including the need for a 4<sup>th</sup> dimension of space that no one has been able to detect.

The day by day description of creation based on a White Hole Cosmology is a little more fanciful in the sense that we may have some of the details wrong since we have no observational experience with White Holes. None are known to exist today and, although the equations of General Relativity allow for their existence it may be that the only one that ever existed was at the act of creation and has since disappeared.

## **Links to Recommended Pictures**

1. Artist's conception of the Milky Way Galaxy viewed from 200,000 light-years away  
[http://www.news.wisc.edu/news/images/Milky\\_Way\\_galaxy\\_sun05.jpg](http://www.news.wisc.edu/news/images/Milky_Way_galaxy_sun05.jpg)
2. Photo of the Hubble Space Telescope  
<http://www.flickr.com/photos/wolf2roger/141491195/>
3. Quantized Distribution of Galaxies  
<http://www.answersingenesis.org/tj/v16/i2/galaxy.asp>
4. Balloon Representation of 4<sup>th</sup> Dimension of "Hyperspace" with Galaxies on the Balloon Surface  
<http://www.answersingenesis.org/tj/v16/i2/galaxy.asp>
5. 2 Dimensional Analogy of the Fabric of Spacetime  
[http://www.thebestlinks.com/General\\_relativity.html](http://www.thebestlinks.com/General_relativity.html)
6. Mercury's Orbit Around the Sun (Purple=Newton, Blue=Einstein)  
[http://en.wikipedia.org/wiki/General\\_relativity](http://en.wikipedia.org/wiki/General_relativity)
7. Artist's Conception of a Black Hole with the Milky Way in the Background  
<http://www.spacetimetravel.org/expeditions/expeditions.html>

### Links to Additional Information

1. Special Relativity (Stanford Linear Accelerator)  
<http://www2.slac.stanford.edu/vvc/theory/relativity.html>
2. How Particle Accelerators Work (FermiLab Tevatron)  
<http://www.fnal.gov/pub/inquiring/physics/accelerators/accelerate.html>
3. General Relativity  
[http://en.wikipedia.org/wiki/Introduction\\_to\\_general\\_relativity](http://en.wikipedia.org/wiki/Introduction_to_general_relativity)
4. Quantized Red-Shifts / Quantized Distribution of Galaxies (more evidence for Earth's central location)  
<http://creationontheweb.com/content/view/1570>
5. Cosmic Microwave Background (evidence incompatible with Big Bang Cosmology)  
<http://www.answersingenesis.org/tj/v15/i1/microwave.asp>
6. Supermassive (Low Density) Black Holes  
[http://en.wikipedia.org/wiki/Supermassive\\_black\\_hole](http://en.wikipedia.org/wiki/Supermassive_black_hole)

### Appendix on "Waters Above the Heavens"

#### Genesis 1:6-8 (Day 2)

**Then God said, "Let there be an expanse in the midst of the waters, and let it separate the waters from the waters." 7God made the expanse, and separated the waters which were below the expanse from the waters which were above the expanse; and it was so. 8God called the expanse heaven. And there was evening and there was morning, a second day.**

On Day 2 the initial ball of water was divided into two parts with the expanse of heaven in between. As a result the Bible is indicating that a significant portion of this mass that was initially water currently exists at the boundary of the universe that is so far away we cannot currently detect it.

#### Psalms 148:1-6

**Praise the LORD! Praise the LORD from the heavens; Praise Him in the heights! 2Praise Him, all His angels; Praise Him, all His hosts! 3Praise Him, sun and moon; Praise Him, all stars of light! 4Praise Him, highest heavens, And the waters that are above the heavens! 5Let them praise the name of the LORD, For He commanded and they were created. 6He has also established them forever and ever; He has made a decree which will not pass away.**

This verse confirms that there are waters above the heavens (universe) or mass beyond the observable universe. It is interesting to note that science currently believes that most of the mass in the universe is "dark matter". Dark matter is mass that we can't detect but appears to have gravitational effects on mass that we can see. Perhaps this "water above the heavens" plays a role.

#### Jeremiah 31:35-37

**Thus says the LORD, Who gives the sun for light by day And the fixed order of the moon and the stars for light by night, Who stirs up the sea so that its waves roar; The LORD of hosts is His name: 36" If this fixed order departs From before Me," declares the LORD, "Then the offspring of Israel also will cease From being a nation before Me forever." 37Thus says the LORD, "If the heavens above can be measured And the foundations of the earth searched out below, Then I will also cast off all the offspring of Israel For all that they have done," declares the LORD.**

This verse implies that the universe (heavens) is too large for us to measure. We know from other verses that the universe is not infinite. It has a finite size and mass. But this verse says that although the universe is not infinite it is too large for us to be able to measure from Earth. In other words it is unlikely that we will be able to measure this "water above the heavens" and may not be able to even detect it.

## Appendix on the Fabric of Spacetime

Einstein's General Theory of Relativity showed that unlike a Doppler Effect (the train whistle or car horn example) the red-shift in the frequency of light of stars moving away from us was caused by the "stretching" of the "fabric" of space itself or what Einstein referred to as "spacetime". Although the idea of space and time acting like a fabric that has been stretching since the beginning of the universe was considered one of Einstein's greatest scientific discoveries, the Bible mentioned it thousands of years ago. See the verses below:

### Job 9:7-9

Who commands the sun not to shine, And sets a seal upon the stars; 8Who alone stretches out the heavens And tramples down the waves of the sea; 9Who makes the Bear, Orion and the Pleiades, And the chambers of the south;

### Psalms 104:1-2

Bless the LORD, O my soul! O LORD my God, You are very great; You are clothed with splendor and majesty, 2Covering Yourself with light as with a cloak, Stretching out heaven like a tent curtain.

### Isaiah 40:22

It is He who sits above the circle of the earth, And its inhabitants are like grasshoppers, Who stretches out the heavens like a curtain And spreads them out like a tent to dwell in.

### Isaiah 42:5

Thus says God the LORD, Who created the heavens and stretched them out, Who spread out the earth and its offspring, Who gives breath to the people on it And spirit to those who walk in it,

### Isaiah 44:24-25

Thus says the LORD, your Redeemer, and the one who formed you from the womb, "I, the LORD, am the maker of all things, Stretching out the heavens by Myself And spreading out the earth all alone, 25Causing the omens of boasters to fail, Making fools out of diviners, Causing wise men to draw back And turning their knowledge into foolishness,

### Isaiah 45:12

"It is I who made the earth, and created man upon it I stretched out the heavens with My hands And I ordained all their host.

### Isaiah 48:13

Surely My hand founded the earth, And My right hand spread out the heavens; When I call to them, they stand together.

### Isaiah 51:13

That you have forgotten the LORD your Maker, Who stretched out the heavens And laid the foundations of the earth, That you fear continually all day long because of the fury of the oppressor, As he makes ready to destroy? But where is the fury of the oppressor?

### Jeremiah 10:11-12

Thus you shall say to them, "The gods that did not make the heavens and the earth will perish from the earth and from under the heavens." 12It is He who made the earth by His power, Who established the world by His wisdom; And by His understanding He has stretched out the heavens.

### Jeremiah 51:15

It is He who made the earth by His power, Who established the world by His wisdom, And by His understanding He stretched out the heavens.

### Zechariah 12:1

The burden of the word of the LORD concerning Israel. Thus declares the LORD who stretches out the heavens, lays the foundation of the earth, and forms the spirit of man within him,

**QUIET TIMES ALONE WITH GOD**

**JEREMIAH 15:16**

**THEME: *Starlight in a 6000 Year Old Universe***

**PASSAGE FOR MEDITATION: *Isaiah 45:18, Exodus 20:11, Exodus 31:16-18, Colossians 2:8-9***

**How does this passage relate to the theme?**

**When I reflect on this passage, does it primarily convict, encourage or challenge me? Explain why:**

**How will I apply this passage to my life in the coming week and is there anything I can do today to make this passage a part of my Christian life?**

**PASSAGE FOR MEDITATION: *Job 22:12, Psalm 19:1, Psalm 33:6, Psalm 89:37***

**How does this passage relate to the theme?**

**When I reflect on this passage, does it primarily convict, encourage or challenge me? Explain why:**

**How will I apply this passage to my life in the coming week and is there anything I can do today to make this passage a part of my Christian life?**

**PASSAGE FOR MEDITATION: *Romans 1:18-32***

**How does this passage relate to the theme?**

**When I reflect on this passage, does it primarily convict, encourage or challenge me? Explain why:**

**How will I apply this passage to my life in the coming week and is there anything I can do today to make this passage a part of my Christian life?**

**QUIET TIMES ALONE WITH GOD**

**JEREMIAH 15:16**

**THEME: *Starlight in a 6000 Year Old Universe***

**PASSAGE FOR MEDITATION: *Psalm 147:4, Isaiah 40:26***

**How does this passage relate to the theme?**

**When I reflect on this passage, does it primarily convict, encourage or challenge me? Explain why:**

**How will I apply this passage to my life in the coming week and is there anything I can do today to make this passage a part of my Christian life?**

**PASSAGE FOR MEDITATION: *I Corinthians 15:40-41***

**How does this passage relate to the theme?**

**When I reflect on this passage, does it primarily convict, encourage or challenge me? Explain why:**

**How will I apply this passage to my life in the coming week and is there anything I can do today to make this passage a part of my Christian life?**

**PASSAGE FOR MEDITATION: *Genesis 1:1-5, Job 26:7, Job 26:10, Proverbs 8:12,22-31***

**How does this passage relate to the theme?**

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**QUIET TIMES ALONE WITH GOD**

**JEREMIAH 15:16**

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**PASSAGE FOR MEDITATION: *Genesis 1:6-8, Psalm 148:1-6, Jeremiah 31:35-37***

**How does this passage relate to the theme?**

**When I reflect on this passage, does it primarily convict, encourage or challenge me? Explain why:**

**How will I apply this passage to my life in the coming week and is there anything I can do today to make this passage a part of my Christian life?**

**PASSAGE FOR MEDITATION: *Genesis 1:9-13, Psalm 104:5-8***

**How does this passage relate to the theme?**

**When I reflect on this passage, does it primarily convict, encourage or challenge me? Explain why:**

**How will I apply this passage to my life in the coming week and is there anything I can do today to make this passage a part of my Christian life?**

**PASSAGE FOR MEDITATION: *Genesis 1:14-19, Genesis 1:20-23, Genesis 1:24-31***

**How does this passage relate to the theme?**

**When I reflect on this passage, does it primarily convict, encourage or challenge me? Explain why:**

**How will I apply this passage to my life in the coming week and is there anything I can do today to make this passage a part of my Christian life?**

**QUIET TIMES ALONE WITH GOD**

***JEREMIAH 15:16***

**THEME: *Starlight in a 6000 Year Old Universe***

**PASSAGE FOR MEDITATION: *Job 9:7-9, Psalm 104:1-2, Isaiah 40:22, Isaiah 42:5***

**How does this passage relate to the theme?**

**When I reflect on this passage, does it primarily convict, encourage or challenge me? Explain why:**

**How will I apply this passage to my life in the coming week and is there anything I can do today to make this passage a part of my Christian life?**

**PASSAGE FOR MEDITATION: *Isaiah 44:24-25, Isaiah 45:12, Isaiah 48:13, Isaiah 51:13***

**How does this passage relate to the theme?**

**When I reflect on this passage, does it primarily convict, encourage or challenge me? Explain why:**

**How will I apply this passage to my life in the coming week and is there anything I can do today to make this passage a part of my Christian life?**

**PASSAGE FOR MEDITATION: *Jeremiah 10:11-12, Jeremiah 51:15, Zechariah 12:1***

**How does this passage relate to the theme?**

**When I reflect on this passage, does it primarily convict, encourage or challenge me? Explain why:**

**How will I apply this passage to my life in the coming week and is there anything I can do today to make this passage a part of my Christian life?**