Of Universe and Ancestors

The Transformation of Xe

Xe

Xerellian Press

Cover Art by Russell Sisson Inspired by Artist's impression of Ardipithecus ramidus (Credit: National Geographic Creative/Alamy)

Xerellian Press

15384 Sky Pines Road Grass Valley, CA 95949

sissonr@gmail.com

Table of Contents

FOREWORD

Talking is important. But, listening is more important.
It is by listening that we learn how to talk.

--Xe

Somewhere, out in the vast reaches of space is Xeron. We don't really know much about Xeron. We are not even sure that it exists. All we have are vague references from the past and present that seem to suggest that it does. Cave drawings on a wall. Ancestor tales from generations ago. Casual conversations held between two people in the strictness of confidence. Perhaps, only said in jest.

We presume that if there is a Xeron, then it must have inhabitants. We call them Xerellians. Humans do this a lot. It's like a form of anthropomorphism, where we try to assign human characteristics to things not human. We live on a planet, so other planets must have, or must have had sometime in the distant past, inhabitants. We usually make up some suffix that we attach to the end of the planet's name. We call those who live, or may have lived, on Mars, Martians. Those on Venus, Venusians. We try to humanize

whatever it is we do not understand. Put it in terms of our own selves. We don't know of anyone from Xeron, but if we did, we are pretty sure they would call themselves Xerellians.

We have never been able to locate Xeron. We have tried for centuries to reach out into space with a simple message that we are here. No one seems to call back. We build and rebuild, large telescopes in the hopes of seeing further and further out into space. Our telescopes and instruments are simply not powerful enough to reach such a place as Xeron. We just have this gut level feeling that it is out there. Somewhere. Maybe we are looking in all the wrong places? Is anybody really listening?

The idea that humans anthropomorphize everything can be seen in the way we have described and shaped the world around us. Things around us that we do not understand we put in the context of ourselves so that we can understand them. It just so happens that when we do this, we end up describing the world the way we want to see it. The way it really is? When we build things, we model them after our biological selves. After all, if our bodies work so well, why not? Our transportation systems are designed to act and function like the flow of blood throughout our bodies. Highways connect via arteries. Cities connect to other cities like blood vessels carrying blood to the heart. Within the blood vessel are automobiles, blood cells, that go back and forth, to and from the heart. We talk about the

brains of a computer. The heart of the city. The beat goes on.

The point is, humans want to see in others what we see in ourselves. It's how we identify with things. It's comforting. When we reach out into the Universe looking for answers, we want to find others, like ourselves, who are asking the same questions. We have generated a whole system of natural laws, based on how we think things work. To the best of our knowledge, this is how all things work. Or should. Whether of this Universe or some other universe. This image, of what it is to be human, guides the reason for our existence. An image that forms the foundation of our science and the pillars of our religions.

We have come to believe that there is some special significance to being human. The fact is, we are truly insignificant when looked at from the perspective of the Universe as a whole. We are simply the product of a star exploding some 4.5 billion years ago. The random arrangement of matter that formed our world. That formed us. We just happen to be here, as humbling as that may seem.

That does not mean there is no significance in who we are and what we have accomplished. We are extremely privileged and honored to bear witness to the fact that we think we intimately understand who we are and where we

came from. We do not understand everything. There is still so much more to learn. We just need to listen. Listen to the sky of a hundred thousand stars on a cold dark night. Way up high in the mountains. Listen from a high peak, overlooking a valley below where, long, long ago, a civilization thrived. Listen to the sound of silence. It will teach us how to talk.

If we have any expectations at all, it is that if there are others in the Universe, we hope they will be like ourselves. Searching for answers. Looking to make contact. We hope that they will follow the same natural laws that we, as humans, have discovered for ourselves. That their universe will follow the same general principles that we have laid out for our own Universe.

But what if we are wrong? What if there are no universal principles that everyone must follow? Could our laws of physics be different for different universes? Have we just made all of this up and it just so happens to be consistent with what we see? Like in some cosmic self-fulfilling prophecy? Can we just be some accidental product of our Universe forming?

It was long ago that we think we first made contact with someone who, we think, was from Xeron. As we said before, there is no real hard evidence of this. We have found some soft evidence from our physical past. We dig up

old bones. We reconstruct ancient structures. But it's hard to identify what the owner of the bones was thinking. Or what the builders of the structures were trying to tell us. Can we decipher their conversations? Thoughts are not so easily fossilized.

So, all we have to go on are those drawings on the cave wall. The stories of our ancestors that have been passed on from generation to generation. The hearsay of someone's offhanded comment. And in there, buried somewhere deep inside, is the hint of something special that happened. Something that changed the world. Someone who may have led us in a direction, not decided by us. A direction not influenced by our own self image.

Quite frankly, there is nothing that we have that can support any of this conjecture. There is no memory of someone other than ourselves influencing the direction of our species. We only think this because there is nothing to show us any different. But that doesn't mean that it doesn't exist.

We don't know for sure that Xeron exists. There is no concrete memory of anyone ever being contacted by someone from Xeron, somewhere in our past. But there might have been. Did we make contact with Xeron or did they make contact with us? Our science cannot answer that for us. It does not really know how to quantify that. It cannot

be proven or disproven. Our religions would have us believe that it could never happen. To acknowledge that would be considered heresy. It’s a real conundrum.

That is not really important any more. All we know is that we have not been the same ever since.

Preface

A Primer On The Origins Of Our Universe

We are about to engage on a journey of some of the greatest scientific discoveries of our time. We will look back at the beginnings of the Universe and follow the scientific thought that went into the conclusions that we draw on today about our Universe. We will look back at the beginnings of our human species and discover where we came from, who we are, and how we got here.

The point of view is pretty straight forward. Our Universe is best understood in the context of science. A systematic approach to the building of knowledge that is testable and predictable. Not just beliefs or stories about our origins, but instead, theories and facts that are based in physics, observations, and the laws of nature. They are repeatable and verifiable. They represent the best of everything we have been able to learn.

Over time theories have been developed, some of which have been thrown out. Simply, because they could not be verified by the accepted methods of science. But

that’s what science is all about. Finding the correct answer involves trying different scenarios. Some work. Some don’t. In either case, you keep trying until one side wins out. Then, we know what to throw out and what to keep. We learn from our failures and come up with different approaches. Approaches that are then tested again and again. Until every test ends with the same result.

Our understanding of the Universe has grown significantly since the very first days when we looked up into the sky and wondered. We wondered with fascination and awe what we did not know. We learned that what we did not know, we could understand some day. Which gave us hope that some day, we would understand why things are the way they are.

Chapter One

Of Universe and Ancestors

In order to comprehend our Universe, we must first understand ancestors. Ancestors of thoughts. Ancestors of ourselves. It is what came before that leads to what we know and who we are now. And, sometimes, what came before was nothing more than a fleeting thought. A thought that may have taken less than a blink of the eye. A thought that may have changed our world.

Scientists have been able to piece together an ancestral timeline of when the Universe began. Current physics places this beginning at around 10^-43 seconds after the Big Bang. A number that looks like 0.00000000000000000000000000000000000000001. A number way less than a second. We can't even imagine how small less of a second that is. By comparison, we can really only perceptually detect about 0.1 (one tenth) of a second.

Shortly after that fraction of a second, really shortly, a Universe one 100-billionth the size of a single particle inside

of an atom began to expand. It doubled in size every tenth of a trillionth, of a trillionth, of a trillionth of a second. Until it got to be about the size of a marble. What we see as everything in our observable Universe today was contained inside of that marble.

At this point, our Universe had this incredible burst of expansion, known as inflation. When the Universe was a mere hundredth of a billionth, of a trillionth, of a trillionth of a second in age. An expansion that was so infinitesimally small in duration that the only thing we can compare it to is that blink of an eye. Yet, even in such a short period of time, a whole Universe was created. An idea, fully germinated. An ancestor born. A heartbeat completed.

What do we do with those things that happen so fast they are essentially over before we can even understand they began? We try to capture them. Put them into something that makes more sense. For example, we say that something happened in the blink of an eye. That way, we can relate to it. We know what it is like to blink and see something different. We know what it is like to blink and have something change. To have an impact.

The impact to our lives may be hardly noticeable. The moment passes and we never think about it again. Sometimes though, it is hard not to notice the impact. It leaves an indelible, not to be forgotten, mark in history. As

for when the Universe began. Or the moment the tornado destroyed our home. Or the moment our automobile was t-boned as we passed through the intersection. Even something as seemingly innocent as opening one's eyes after a long night's sleep could have been hugely significant to one of our earliest ancestors reflecting on some soon-to-be discovery.

Whatever the case may be, events of this nature usually come at somewhat of a cost. The cost of losing one's life in an accident is very unfortunate. The immediate result is one of sadness and distress. Being born can be a very fortunate event. The result can be happiness and satisfaction. The birth of a Universe or a discovery that changes the course of human history? That's momentous. The point is cost does not always imply the loss of something. The cost of something is not always obvious in the moment.

It's curious that, even though these events occur very rapidly, we also say something happened in the blink of an eye when we refer to events that take an extremely long time to conclude. Usually, in hindsight. It can be used to describe an event that, when looked back at over an extremely long period of time, is over in an instant. An example of this would be a human lifetime. From the time we are born to the time that we die. The 80, 90 or 100 years that make up one human life seems quite long when looked at from year to year. But compare those same years to the

millions of years that have gone before us in human history and that one human life appears to be pretty insignificant.

We are born into this world in what only can be surmised as a very swift and, perhaps, rude awakening. A very significant event that we have trouble distinguishing between what we were before and what we will become. We were once there and now, well, we are just here. Leaving the comfort of the womb, traveling down the birth canal (or extracted via a c-section), we open our eyes to a brave new world. In a fraction of a second we enter a world we know nothing about. Totally dependent on others to guide and nourish us on our journey through life.

Somewhere in the middle we leave a record of who we are and what we have become. Some excel. Some flourish. Some just barely make it. Most of us have children and, by doing so, ensure that our biological selves are passed from generation to generation.

We leave this world in a similar manner to being born. A very significant event that we have trouble distinguishing between what we will become and what has just occurred. We were once here and now, well, not so much. A lifetime of living has been reduced to just a few last blinks of an eye. And, although the physical body may die, the memories of our loved ones are passed from generation to generation in some form of Darwinian social evolution.

The events of our lifetime are reported on and well documented. We have records for this and records for that. We live in an age where information, and access to that information, is readily available. When we need answers, we can search the records and try to come up with answers. But the records themselves become just a passing note in time. Sometimes kept, sometimes lost.

But what about our more existential questions, like who we are, where do we come from, and how did we get here? As far as we know, humans are the only form of life on planet Earth that have these kinds of concerns. Are these questions about the origins of life only a result of us being human? Is there some point in our past when we can identify that these questions began to be thought about? Was there a specific moment when we became aware?

In some cases, that blink of an eye moment becomes more than just a rapidly occurring event. That event may lead to another event. When we reflect back on it as an “aha” or “eureka” moment. A moment that made an impact and had a truly positive cost. Where, suddenly, something makes sense. Something clicks. The light bulb turns on and we experience that moment of clarity and understanding.

These are the kinds of moments that we hope to address in this book. With the help of science, we hope to identify what these moments of clarity were and when they might have occurred. As we examine the wealth of information collected in the name of Astronomy, Physics, Archaeology, and Anthropology, we may be able to pinpoint some of these moments. Where, in a mere hundredth of a billionth, of a trillionth, of a trillionth of a second, we transitioned to a new sense of awareness. An awareness that helped us to become who we are and better understand how we got here.

How did we get here? To help us understand that, we turn to the sciences of Astronomy and Physics for an explanation. An explanation that returns us to the beginning of the beginning. Where it all began. The Big Bang.

Chapter Two

The Big Bang

Most of us are born into a world without much choice, confined to the restrictions of a time and place that have already been predetermined for us by our parents. We gauge our waking and sleeping moments within the parameters of seconds, minutes and hours. Anything more than that goes into days, months, and years.

While we may look upon our lifetime as consuming a significant amount of these units of measure, it pales in comparison when looked at from the time spent as a species. On this planet, in this galaxy, and of this Universe. From the perspective of our Universe, we are merely a drop in the bucket. An individual's birth and death are mere blips on the radar. Homo sapiens, as a species, represents only a very small fragment of time since the Universe began. Life on Earth is, simply, a result of a process that began long, long ago. In the blink of an eye, so to speak.

To understand our place in the Universe we need to engage the expertise of scientists. Namely, those

specializing in astronomy and physics. Due to their advances in knowledge over the last few centuries, we have all benefited with a better understanding of how our Universe began, how it works, and where we fit in as humans. Unfortunately, not all of us are capable of understanding all of this the same way that these scientists do. To many of us the language they speak and the tools they use are way beyond our comprehension. Our goal is to keep the discussion as easy to understand as possible. We will try to keep our discussion geared towards the lay person and, hopefully, avoid a lot of the scientific nomenclature that can make understanding these phenomena quite difficult. But we may also dig deeper occasionally.

The general consensus among scientists today is that the Universe we all know and love came into existence as the result of a huge expansive reaction way back at the beginning of time. As a result of this reaction, the majority of matter in the Universe (galaxies, stars, planets, people, and things) was created and has been expanding ever since in a process called inflation. Included in this expansion were the physical laws of nature that we are only now fortunate enough to understand and apply to the Universe we all live in. That’s pretty much it in a nutshell. How do we know all this? Well, now we have to go into a lot more detail, but still, hopefully, keep it at a level we can all understand.

The Big Bang Theory describes an event that happened over 13 billion years ago. Through the efforts of astronomers and physicists over many years and the testing of many theories and observations, they have determined that the age of the Universe is roughly 13.8 billion years. The theory itself did not really take form until the 1920's and 1930's. Then in 1931 a Belgian physicist named Georges Lemaitre, suggested that at some point in the past our Universe arose from a single point of space and time. Today it is well accepted that, in fact, this did occur.

At this single point in time, all matter (both current and previous) was compacted into a size smaller than an atom, with very intense heat and very extreme density. It is with this condition known as singularity, that with the Big Bang, the Universe began expanding into the Universe we know today. That period of expansion is what is known as inflation. A few billionth's of a second after the Big Bang, our Universe expanded enough to have created all the necessary particles to create the observable Universe we see today.

So what, exactly, did the Big Bang do for those of us alive today? Well, to put it one way, we would not be here if it wasn't for the Big Bang. Without going into all the details yet that chronicle the events of the Big Bang, there are two important events that stand out. One, when the elements were formed that created the stars. Two, when the stars,

themselves, created all the elements necessary to create us. When we talk in terms of stars, think of our Sun and remember that our Sun is actually a star.

Before we describe these two events, it is important to get an understanding of what makes up the things we are going to be talking about. What are things made of? To figure this out, we break things down into smaller pieces. And the smallest, most basic unit of all things is the atom. We are all made up of atoms. The Universe is full of atoms. The atoms in us are the same atoms that began as stars in our Universe. The whole idea is that the things we discuss are made up of smaller things.

When we talk about elements we are talking about substances that are made up of atoms. It's what's inside of the atoms that determine what type of element it is. For example, every chemical element has its own symbol on the periodic table. We have elements such as hydrogen, helium, lithium, carbon, oxygen, nitrogen, and iron. The things that make up stars, and in turn make up our bodies, are composed of these chemical elements.

Atoms are made up of smaller things as well. Inside the atom are things called particles. Two particles called protons and neutrons are located in what is called the nucleus of the atom. Along with a third particle called an electron, which orbits the nucleus. So, for example, the

chemical element hydrogen is made up of atoms that contain only one proton. The chemical element helium is made up of atoms that contain two protons.

Can we break down the things inside of atoms (particles) into smaller pieces? As far as we know at this point, there is nothing further that an electron can be broken down to. But protons and neutrons can each be broken down into smaller units called quarks. Three each to be exact. And, as far as we know at this point, quarks cannot be broken down further. Keep in mind though, that what we know now may change. Can the electron not be broken down further simply because we don't have the technology of doing so yet?

The thing to remember is that if a particle cannot be broken down into smaller units, it is referred to as an elementary or fundamental particle. So, although there are lots of particles, only electrons and quarks (for our discussion) can be considered to be elementary or fundamental particles. Protons and neutrons are considered to be just particles.

Proceeding with our discussion of events, one second after the Big Bang the particles protons, neutrons, electrons, and others formed. During the first three minutes, the essential (lighter) elements of hydrogen, helium, and lithium formed in a process called nucleosynthesis. Thus,

the elements necessary to create stars were formed. At around 400 million years after the Big Bang, stars and galaxies formed (meaning that the first stars were formed some 13.4 billion years ago). You will find that in terms of age, we sometimes refer to a reference point of either the Big Bang or years ago. They are not the same. The first involves looking forward and the second involves looking backward. Time after the Big Bang and time as years ago before today.

Stars are made up of very hot gas that is mostly hydrogen and helium, the two lightest elements. Hydrogen is the simplest and most abundant element in the Universe. Stars shine, or burn, by turning hydrogen into helium. Helium is the second most abundant element and, together with hydrogen, makes up 99.9% of the known matter found in the Universe. Stars don't really burn these elements. That's just a convenient way to visualize the reaction. What actually occurs is a fusion of the elements. This is known as nuclear fusion. Stars are often referred to as having nuclear furnaces at their core.

The lifetime of a star is largely dependent on its size or mass. The larger the star, the hotter it burns and, consequently, the shorter its lifetime. The smaller the star, it burns less hot and its lifetime is longer. If you take our Sun as an example, it's lifetime is predicted to be somewhere around 10 billion years. Since our Sun is approximately 4.5 billion years old (and our Earth is about 4.5 billion years

old), we have another 5 billion years or so before its conversion of hydrogen into helium runs out. A star ten times the mass of our Sun will only live 20 million years before its furnace runs out of fuel, collapses, and explodes. A star that is half of the mass of our Sun will live around 20 billion years.

Stars also contain some of the heavier elements such as carbon, nitrogen, oxygen, and iron. This, then, is our second event. These heavier elements were not present at the beginning of the Universe. They only exist because of the nuclear fusion furnaces of stars. When massive stars burn themselves out, they explode and eject these heavier elements back into space. They seed the rest of the galaxy with these heavy elements that go into our Earth and into our bodies.

So what happens in the nuclear furnace of a star? Well, the main purpose of fusing nuclei in a star is to release energy. To do so, the star starts with the lightest elements and proceeds to the heaviest elements until all the elements of the periodic table are formed. The process begins with hydrogen being fused to form helium. The star then contracts, gets hotter, and fuses its supply of helium into carbon. The process repeats and carbon is fused into neon and nitrogen. Neon fuses to oxygen, which fuses to silicon. When the oxygen and silicon fuses, you are in the last day of the star’s life. Over this last day, all you have left

is iron. And iron cannot be fused into anything else. It cannot be burned. The star is out of fuel.

The massive star collapses over a period of one second, spewing off its outer core. A core that contains the bulk of all of the chemical elements ever produced by its process of nuclear fusion. Hydrogen, helium, carbon, nitrogen, oxygen, and iron. All of the elements that the star has ever created over its lifetime. The resultant shock wave that is sent out by the collapse is compressed by the gases of space, creating new stars. Stars that are orbited by other types of spewed matter, that, through gravity, form other things such as planets.

That's how the death of a star goes. But not all stars are the same. And not all stars die the same way. How a star dies depends on its mass. When stars of very large mass die, much larger than our Sun, the resulting violent explosion creates the brightest light in the Universe. Known as a supernova, they can outshine an entire galaxy for a brief period of time. Supernovae are the biggest explosions in the Universe and are the primary producers of the heavy elements. What's left behind are called black holes. Our Sun does not have enough mass to explode as a supernova. So, instead, it is called a white dwarf when it dies. White dwarfs primarily produce carbon and oxygen. And over a billion years or so, the white dwarf will substantially cool down. Until it no longer resembles at all the star it used to be.

Stars have a very important role in the Universe. They manufacture the elements heavier than hydrogen and they create and provide energy for planets and other stars. So, the important take away from this is that we would not be here if it were not for the death of stars. Because without the elements of carbon, nitrogen, oxygen, and iron, essential for all of our lives, we would simply not exist. Every atom in our body was once inside a star that exploded. It was that supernova exploding 5 billion years ago in our galaxy that created everything we see today in the form of our Sun, our planets, and ourselves. This is our cosmic connection.

Most scientists do not envision the Big Bang as an actual explosion. Most prefer to see it as a sudden acceleration. An inflation, if you will. You must remember though that the Universe did not just start inflating into space. Space did not exist yet. As such, scientists tend to describe the Big Bang as a sudden appearance with everything appearing at the same time. Then you have a process of inflation and expansion. We are still in this post Big Bang period, with the Universe continuing to expand.

You may wonder, if the Universe is still expanding, will it ever reach a point when it can become too large? Would that not signal a sudden deflation or end to our Universe? Perhaps. That is a part of our story that we will discuss

later. That is a discussion of multiverses (multiple universes) and the application of a Darwinian explanation to the existence of not only biological organisms, but to space and time itself.

The question remains what caused this sudden acceleration that we define as the Big Bang? What was the cause of this event we call the Big Bang? That is still an unanswered question but scientists do have some clues. The simple answer is, something happened to create something out of nothing. And as we shall see later, that nothing is actually something.

Chapter Three

The Transformation of Xe

Xeron is in fact a planet, in a system of planets, that is quite unique in their known universe. All the other planetary systems Xerellians know about revolve around a single star. Xeron, curiously enough, belongs to a system that revolves around two stars. Sort of like a planetary sling shot effect, where a figure eight is created when the planetary system is flung around the one star and makes its way to be flung around the other star. The two stars were born into this universe around the same time, relatively speaking, and shared a similar brightness and heat value. There was enough of a difference though that passing between the two was kind of like a change in seasons, within a change of seasons. Quite fascinating actually.

Xerellians long ago figured out the dynamics of their universe and are quite capable of explaining how things are created and the process in which that creation takes place. They completely understand the physical laws of their universe and can reliably predict with an accuracy any physicist would be proud of, their existence. This science, if you will, is readily taught to all the inhabitants of Xeron from

a very early age on. What they are taught, it turns out, does not just apply to their universe, but to all universes everywhere. What they are taught is, fundamentally, The Laws of Everything.

The science behind The Laws of Everything can get quite complicated. The language of this science and the implications of its thought take most of a Xerellian lifetime to understand. Let alone comprehend. There is a way though to grasp the concepts without having to do the science. It's kind of like the difference between understanding why one plus one equals two and just believing that the answer is two. Do we really need to know the why when it is easier to just know that it is? If all you are interested in is talking about the facts, then you don't. But if you are trying to understand the facts, then you need to listen.

Anyway, we are going to try our best to explain everything as concisely as possible. What it breaks down to is that everything is created out of nothing. Because when you really examine it, nothing is really everything you need to create something.

You are probably pretty confused right now. But this is the least complicated explanation of The Laws of Everything. All Xerellians hold these few sentences to be true and when asked, can go into all the detail behind the

words. There is no doubt. They understand the science. They don't just believe. They know.

Xe was brought up on Xeron to understand the math behind the science. From a very early age on Xe wanted to understand the universe. How did it start? How did Xe begin? Xe wanted to understand Xe. The hardest thing to learn was learning how to listen. Listen to the universe. Listen to Xe. Making sure you really understand what you have heard before attempting to talk about what it is you think you heard. Just listen. Then talk.

It was really no big deal. Given enough time, the right conditions, and the best minds, The Laws of Everything became second nature. It was like learning how to walk upright. Once your mind graduates from crawling, going upright just makes sense.

This is what guided Xe to the position of chief researcher of Quantum Field Theory (QFT). Xe grew up to be a physicist. Someone who specializes in the interactions of everything that takes place in a universe. In the position of chief researcher, Xe studies the quantum mechanical interactions among particles for the quanta of electric fields. What? In other words, Xe's studies focus on photons (virtual particles, also called virtual photons) and their ability to pop into and out of existence. There, but not there. Still don't get it? Let's just say that Xe was in charge of

everything to do about the creation of something out of nothing.

By studying their universe, the Xerellians had figured out that it all began with an exchange between electromagnetic particles. Their science told them that. Their observations confirmed it. Without going into all the details, suffice it to say that this exchange between virtual particles is what governs all in The Laws of Everything. An exchange between two particles that is really just a disturbance, temporary as it may be.

This was all ordinary stuff. What made it interesting to Xe was its conceptual extension to all other aspects of existence. Beyond the understanding of how the universe began, Xe wanted to comprehend such things as the birth of a thought or an idea.

Just as the universe began from nothing and then inflated, the birth of something begins from nothing and is inflated throughout a given period of time. Like an idea that comes out of nowhere and leads to an awareness of something more than just the sum of its parts. Or simply an “aha” moment. The Laws of Everything make it very clear that all things are related. Whether of this universe, within this universe, or in other universes. Everything relies on the same set of principles or laws.

So, for example, the Xerellians have shown that all things in all universes are based on carbon molecules. Xerellians are made up of trillions of cells, all of which have evolved from a common ancestor that used these same carbon based molecules. The same molecules that contain the same atoms.

It might help to review the hierarchy again. Molecules are made up of two or more atoms that are bound together. Atoms contain sub-atomic particles. The nucleus of the atom contains protons and neutrons, orbited by other particles called electrons. Electrons and protons can be bound together by something called a photon (an elementary particle) that creates an electromagnetic force. It is this exchange of virtual photons between two particles that results in something out of nothing. In other words, The Laws of Everything.

Xe is one of many Xerellian scientists whose work is devoted to understanding just what happens when something begins. What processes lead to the creation of something? Can these processes be controlled, directed, or guided? Xe can look back at the beginning of the universe and see the product of an exchange between particles. But what about the exchange itself? Can there be an intervention between the two particles? Furthermore, can there be an intervention between when an idea is created

and when it materializes? Or is there an insertion point between when the eyes are closed and when they are opened?

Specifically, Xe is looking for that defining moment that is related to this interaction between one virtual particle and others. Is there a sudden moment of awareness that is created? When that proverbial light bulb goes off? That “eureka” moment of special creation that was not there before. The moment that sets in motion the process of inflation, sudden growth, and expansion, that results in our birth. The birth of a universe. The death of something else.

Somewhere in the exchange of virtual particles, this moment happens. This exchange of virtual particles is happening all the time. Most of the time, the life of these virtual particles is so short that we don’t even notice that they were there. They can’t be seen, so, therefore, they don’t exist. There is nothing.

But, occasionally, this exchange results in an existence that is long enough to be seen and, perhaps, captured. These exchanges result in a bubble of inflation that continues to bubble and inflate until it can inflate no more. Then, we get something from nothing. And this, my friend, is the longer answer that is still too short to define all the specifics of The Laws of Everything. But, hopefully, you get the gist.

Xe was want to push the envelope. Xe well understood the implications of placing yourself at the center of the interaction between virtual particles. Long, long ago Xe was at the center of an experiment that involved extremely powerful and high energy collisions of particles to better understand the fundamental nature of the universe. This accelerator was so powerful that some felt there was the possibility it would inadvertently create a black hole that would swallow up Xeron. But proceed they did and fortunately, no such end to the planet resulted.

What Xe was experimenting with now was of the same magnitude. Instead of swallowing up the planet, the simple success of the theory could swallow up Xe. Xe would be at the center of an experiment whereby Xe would be inserted between the exchange of virtual particles. And, by doing so, be likewise inserted into another universe. A brand new universe or one that was already in existence. It was his choice.

If The Laws of Everything were correct, then it would make sense that there is a direction to this process. One of the takeaways from the Xerellian science of everything is that there is more than just one of everything. More than one universe. More than one Xeron. Sometimes existing at the same time. Other times, existing at different times. Thus, directing the process of virtual particle creation could

take you to these other universes. This process of creation may be more than just creation. It may also be a way of joining an existing process. And, if Xe can join another universe at any time, then Xe can also detach from that universe at any time. And, hopefully, return.

Xe was relying on a hunch that it didn't really matter which virtual particles you chose to begin the exchange process. Naturally, science had always looked to the beginning of the beginning, to the particles that existed at the time the universe was created. But, of the trillions of cells that made up Xe, each cell made up of molecules and each molecule made up of atoms and particles, Xe should be able to chose which particles to exchange. So, why not choose the cells of the brain? Xe's brain, then, becomes the source of the exchange. The insertion point becomes the brain of Xe's choosing, in whatever alternate universe. Getting back to Xe's brain after the journey was, according to Xe, going to be a piece of cake. After all, if there was a purposeful direction to the destination, there should be a purposeful direction back to the point of origin.

According to science, you try something, see what happens and then, try something else if you don't get the results you want. Seems scientific enough. But, one night Xe pushed the envelope a little too far. Xe actually succeeded beyond Xe's wildest dreams.

Virtual particles are widely accepted in the scientific world to be highly unstable and simply uncertain. Something to do with some theory called the uncertainty principle. Accordingly, there becomes a limit to what we can know about the behavior of particles. How certain was Xe that this was all going to work? Not very. But Xe knew there must be some clear cut certainty that was yet to be discovered.

Chapter Four

Xe's Arrival

As Xe's eyes open there is a cool, moist rush of air into his nostrils. After a couple of blinks to clear the sleep and presumably the cobwebs, Xe is aware of himself lying on his back looking up into a sky of early morning darkness. Not the black of night, but the dark blue of early morning. By all calculations, Xe has arrived at his destination.

Prior to Xe's departure, there were numerous calculations done to ensure that the final destination hoped for would be reached. The Xerellians have known for an extremely long time now that there were other inhabited planets out there in their universe. They also knew of others that were part of other universes, parallel to theirs. They just never thought of going there.

The calculations that Xe made were very carefully prepared to deliver Xe to a small planet in a galaxy, hundreds of thousands of light-years away, known as the Milky Way. Here, in a solar system at the edge of the galaxy, was a configuration of planets that revolved around

a single star. It was the third planet from the star, a planet called Earth, that Xe's sights were set.

The Xerellians have known about planet Earth for about 4.5 million years. They have been watching. There was an inhabitant there that first gained their attention, that long ago. These days they were called humans. Back then, they were just becoming human. So Xerellians, too, referred to them as human. Albeit, prehuman. Humans seemed to be something special, something worth following. Maybe even to watch out for. Earth was Xe's destination point specifically because of this. At 4.5 million years ago, this seemed to be a turning point in their development. Xe wanted to be a participant at that time to see what it was like. To see, first hand, a turning point.

Assuming all went well, Xe would be arriving on Earth in a place called Eastern Africa, around 4.5 million years ago. At that time, one of the earliest ancestors of human was developing. A development that would end up, millions of years later, humanizing the whole planet. That's when Xe thought the best chance was of witnessing an adaptation that would change the course of human development. One of those special events that sparks a new direction. Marks the beginning of something new. One of those moments, when something foggy, suddenly becomes clear. When a significant change occurs.

Something told Xe he was here. Lying in his nest made from the folded branches, twigs, and leaves of a heavily foliated fig tree, Xe slowly stretched and yawned his way awake. Xe lives high up in the canopy of a wooded area, on the edge of an open savanna. Mostly fig trees that not only provide shelter and food, but protection as well. Nearby is a long lake and a shoreline that borders the savanna.

After a long night, Xe is finding it hard to rouse himself from the comfort of his bed. As he does almost every morning after awakening, he spends precious moments just looking up into the sky. Listening to the sounds around him. Trying to make sense of his surroundings. What are all those small, shiny twinkling things in the early morning sky? Are they the same ones that were there when I went to sleep last night? And what is that big shiny thing that appears occasionally at night and disappears during the day? Are those the sounds of something friendly or the frightening sounds of warning in the form of one of those dangerous animals that I have seen drag a friend of mine away? As the darkness of morning starts to give way to the light of day, Xe starts to hear the rumblings of the others in his group that are also waking up to the start of a new beginning. These are the others with whom Xe shares a kinship. A kinship of kind, if not blood.

Xe sleeps with a group of six other males, each with their own nest and evenly spaced within the grove of fig trees. Xe is the oldest of the group and considered the

dominant male, although age by itself is not a determining factor. Experience and leadership have bequeathed this position on him. The others in his small group recognize this and look to him for guidance.

The rest of the larger group Xe is a part of consists of other males, females, and mothers with offspring. Mother nests are the only shared nests, occupied by mothers and their offspring. Mothers and their offspring have a very special relationship it seems. But, only as long as the offspring are being breast fed. After that, they are expected to leave the nest and fend for themselves.

Xe and the other males stay away from the mothers and their offspring most of the time. Except when social occasions call for greetings, grooming, and, of course, mating. Once the offspring is weaned, they usually may remain with the larger group. Or they may leave and start a group of their own. Not long after, the mother becomes a mother again and the whole process unfolds once more. At least this is what Xe has observed.

As Xe looks around, he notices that some of the juveniles have lost their patience and are starting to leave their mothers' nests in search of something more exciting. They are anxious to find someone, something else, to play with. They need to burn off some energy after a long night

of silence. Xe assumes, correctly, that one or two will be heading his way soon, as they often do in the mornings.

Sure enough, there's a rattling in the trees and branches around Xe, as the rambunctious youths approach from the side, above and below. Xe isn't quite as active as he used to be, but does his best to chase, rumble, and tumble with the young ones. After a short while, the other males are bombarded too. Pretty soon, all are chasing each other through the branches, making loud noises, and flailing their arms, as they engage in their favorite morning activity: roughhousing.

After some extended minutes of "tag you're it", they're done. It is time to settle down. Xe is tired, the other males are tired and the juveniles need a break. Now is the perfect time for grooming. Each of the other males, young, and old, pair off and comb each others fur. In the process they remove bugs, debris from soil, vegetation, and dead skin. Xe begins by using one hand to hold back the hair while the other hand, lips and teeth are used to remove the debris. This is how they clean one another. But, there's nothing better for removing tension, providing closeness and helping to lessen stress.

Today, one young juvenile approaches Xe hoping to be groomed. He comes up to Xe and presents his hand and even gestures by starting to groom himself. He is in the

process of being weaned from his mother and needs a little reassurance. Xe, appropriately, returns the gesture and the session begins. In cases like this the closeness is not only comforting, but helps to create a lasting bond between Xe and the youngster. Xe knows that on some future occasion, he may be able to count on this individual for support and assistance. Scratch my back and I will scratch yours.

Yesterday, one of the younger males challenged Xe's authority and was unceremoniously put back in his place. Xe knows that this is normal. Younger males are always trying to exert an influence. Today this male seeks out Xe for grooming, acknowledging that he still has a lot to learn. Xe, graciously accepts his offer, helping to reassure, resolve conflicts, and restore harmony. Being the one everyone else looks up to, Xe has learned that it is up to him to restore balance when imbalance occurs. Grooming accomplishes this. And in the process, it reinforces the structure and vitality of the group.

It's not long before Xe reassures the young lad that everything is going to be alright and gets up and walks away. The youngster is a little put off, but quickly resumes searching for some other individual he can roughhouse with, now that he has all but forgotten what brought him to Xe in the first place. Mission accomplished.

Xe has other reasons though, for ending the playing and grooming session. Although there is always room for play and social greetings every morning, he has other important activities on his mind. It is Xe's responsibility to plan the day and provide for the needs of the group, the most important of which is foraging for food. Every morning, he and his small group of male friends head out in search of food. This morning is no different from any of the others.

Xe and the other males make their way through the trees, swinging from limb to limb, as they head to a different part of the forest. Xe knows that the others of the group, particularly the females, mothers, and offspring, will be able to find their own food. When the females look for food, they do so together, but in areas of the forest closer to home. There are plenty of figs and leaves to go around within a short distance. Xe has made sure of that.

Females spend much of their time taking care of their dependent offspring. They are the primary unit. The primary family unit. It is the mother's responsibility to teach the young everything they will need to know in order to survive. But more so, to be a partner in community wherever they may live. Whereas the males, including Xe, will come and go, it is the female that brings new individuals into the community and provides for their care. The female can be just as promiscuous as the male. They don't know who the father is, just as the male doesn't know who their offspring are. That doesn't seem to matter.

Male and female roles are very well defined. Females bear the offspring, nurture them, and provide for their needs until they can do so for themselves. The males assist in this process by providing additional support, nurturance, and protection. Xe is very aware of this when he makes his rounds, greets the others, and visits with the mothers and their offspring. He will visit a mother and her offspring by choice. Bring a little food and walk away with an expectation of sexual favor later on. That's just the way it is.

Xe is about the same size, height, and body weight of the other males and females. There are no real physical differences that can cause conflict between males and other males. Sure, disagreements arise. But they are worked out. There are mechanisms in place to restore and preserve peaceful coexistence. Grooming is a prime example. Xe has no need to fight with other males over access to females for mating. Males chose their sexual partners as their sexual partners chose them and are not restricted by any kind of dominance hierarchy.

Making their way through the canopy, Xe and his friends stop every now and then to consume leaves, tender plant shoots, and flowers. Knowing when the flowers are out is pretty much a guess at this point, but there does seem to be some regularity as to when they see them. The trick is knowing what that regularity is and Xe seems to be

particularly good at it. One of the males comes across a bird's nest and, luckily for them, there are some eggs left unattended. Eggs are a good source of protein. You don't want to pass up the opportunity. It doesn't take long before the group has them fully consumed.

Soon they come across a particularly thick grove of fig trees. They haven't been this way before and it doesn't look like anyone else has either. The leaves have not been pruned. The figs are in total abundance. Figs are probably their favorite food, but palm is another one close by. Actually, they would also be happy to find some plant bulbs or tree bark. Small mammals might do too, if they can find them. This doesn't happen very often though.

This new area they have found has just about all that they like. They spend a good amount of time consuming what they have found. But Xe and the others are also thinking about how they are going to get some of this stuff back to the primary group. Particularly, how are they going to bring back some of their most prized foodstuffs to share with females of reproductive age?

Xe and the others are quite limited in their ability to bring back quantities of food. They usually navigate through the forest canopy on all fours. Swinging from branch to branch and trying to carry food is not a very easy thing to do. So, all they really can do is use their mouths to hold

uneaten food, stop occasionally to readjust, and then proceed on. Sometimes, they will try to carry something in one arm and swing from branch to branch with the other. Most of the food gets dropped along the way. Sometimes, they drop themselves. Not very efficient, actually.

Xe, for a split second, thought about the figs hanging just out of his way, higher up in the tree. He thought about how he might be able to make himself taller in order to reach the fruit. He looked down at his feet and felt the secure grasp of the branch underneath. If he could just push himself up and balance on his two feet, he might just be able to reach the figs.

Somehow his feet were shaped to not only allow him to grasp a branch, like his hands do, but lay somewhat flat on the top of a branch. As he stood up, he reached for a fig and plucked it from the branch. Being successfully rewarded, he did so again. Getting balanced was a little hard at first, but it wasn't long before he had the hang of it.

When he was finished plucking all the fruit directly above him, Xe found that it was not only easier to stand but, also, move along the branch on his feet to reach other areas of the tree where fruit was hanging just out of reach. Before he knew it, he was moving up and down the branches, harvesting a quantity of the fruit as he went.

The curious thing was that by freeing his hands, he was able to harvest more food than ever before. And that meant that he could also carry more food than ever before. Cradling food in one arm, swinging with the other, and navigating with his feet across the tops of branches gave him the added stability he needed. He was able to make it back to the home group with plenty of food to share. Xe was proud of his discovery. So were the females. Little did he know that this was to become one of humankind's most important adaptations.

After everyone returned from foraging for food, the group tired. Somehow, afternoons bring on a sleepiness and desire to simply rest and take a nap. Xe is looking around for a suitable branch to form a nest in which to do just that. He doesn't want to use the nest he made the night before. Things done during the night and early morning, such as going to the bathroom and trying to, unsuccessfully, do so over the side of the nest, necessitate the building of new nests. Especially, for an afternoon nap.

Xe is able to locate a branch, high enough off the ground to provide protection and strong enough to support his weight. Carefully building his nest, he settles in for an afternoon siesta. The others have done the same and the whole community seems to settle into a quite afternoon of solitude.

As the community wakes up, Xe and the others are ready for their afternoon snack. They just need to reach out and grab it. All around them are plenty of young leaves, making it easy to just take a handful. The group spends a couple of hours or more feeding on the young leaves, before the afternoon starts to wane and the sun starts to set. The day is almost over.

Next on Xe's agenda is making preparations for the night's sleep. Dusk is usually the time when they all settle in for the night. They all split off to find just the right spot in the trees where they can build their new nests. Everyone in their own nest, except for the mothers and an offspring, or two. The reasons they build new nests for their afternoon siesta are the same reasons they build new nests for their night. Building a new nest is a fairly simple process. Just look around. Bend over a few branches to suit your taste. And you are all set for the night.

Xe has carefully selected his spot and proceeds to build his nest by folding over branches, twigs, and leaves to form a cozy little sleeping bed. He settles in for the night, expecting tomorrow will bring a day similar to the one he had today. But, before he dozes off, he gazes, once again, up into the night sky. Those same twinkling lights are there again. Occasionally, one of them shoots across the sky

leaving a trail of light. What are those things? Where do they come from?

The next day breaks just like all the other days. Xe spends his morning moments reflecting on the things he has learned the day before. This standing up on two feet thing occupies his mind. Xe realizes that there are probably other tasks that can be applied to standing on two feet. And walking on two feet, even for a short distance, is quite fun.

As the others all wake up, they engage in the familiar morning activities of play and social greetings. Eventually, Xe and the other males in his group, take off once again in search of food. The females and young infants also take off in a different direction to do the same. They seem to be heading toward the savanna grasslands where, Xe suspects, they are going to look for termites. Foraging for termites can be a dangerous and risky business, being that it requires the females to spend some time on the ground. Xe heads back in their direction to provide some protection or at least, be on the lookout for predators.

Along the way, they find a couple of trees where water has been captured in the hollow of the trunk. Seems like a good time for a drink of water. The water is pretty far down in the hollow of the tree though, making it very difficult to just reach down and get a handful. No problem. This can be a valuable learning lesson for the juveniles. The first thing

the female does is grab a handful of leaves and begins chewing on them for a short bit. She then spits them back into her hand, as the juveniles look on intently. Sticking her hand down in the hollow, the slightly chewed leaves act like a sponge to soak up the water. When she pulls up her hand and puts the leaves back in her mouth she has just soaked up more water than she ever could have using just her bare hand. The juveniles patiently wait their turn as they try out their newly found trick.

As the females and Xe make it to the edge of the grassland, they spy the termite mounds they have been seeking. Making their way to the ground, they cautiously look around to make sure it's safe to proceed. Xe is watching too and when all looks and sounds good, he calls the all clear.

Xe's group has developed quite a technique for capturing termites. The females are particularly good at it and, more often than not, a youngster will be nearby picking up on the technique. It's not long before the juveniles, too, are fishing for termites. First, the female starts by searching for a long blade of grass or twig that can be trimmed down to form the pole. Once the twig is trimmed, she takes the pole and sticks it down the termite hole. As she slowly brings it back up and out of the hole, the termites have swarmed to the stick and are now available for extraction by running the twig sideways through the mouth. Just lick them off with your lips. Simple as that.

Xe is not sure how this started, but he does know that he learned it from his mother a long time ago. Since then, he has taught the technique to countless others who have similarly passed it on. Now, it is just something that everyone does and is expected to do. From individual to individual, from family to family, and from generation to generation.

After all of the groups have returned to home, they start settling in for their afternoon siesta. New sleeping nests are built, locations are selected, and, before you know it, the forest is quiet. Except for the sounds of the forest itself.

Xe's eyes suddenly open, as he has sensed something is different. There is this sound from down below, on the ground. The sounds of a predator lurking around on the floor below. Xe has heard these sounds before and knows that the whole group is in danger. The sounds he hears are coming from either wild dogs or saber-toothed cats, the forest's most dangerous animals. As Xe peers over the side of his nest he sees the figure of a saber-toothed cat sleuthing its way down below. Startled, he immediately sits up, starts shaking the branches around him furiously, and begins the chorus of hoots and hollers that are meant to alert the others.

As the whole forest starts to respond with the same kind of thundering chatter, Xe decides to try something a little different. Remembering how he was able to stand upright on a branch, he does so again. But this time, the affect is to make himself larger, louder, and more threatening to his adversary. Racing up and down the limbs of the tree, flailing his arms, and vocalizing his displeasure. Soon, the others are doing the same. It seems to be working. The big cat down below loses interest and decides to go some place else, a little less noisy. Some place else where it might be easier to grab a meal unnoticed.

With the threat gone, they all start to ready themselves for their afternoon snack. Their afternoon siesta all but ruined, it’s time for something to eat. Not long after that, they all once again settle into the process of getting ready for a night of sleep. They build their nests, crawl inside, and fade away into slumber.

It’s not that simple for Xe. As usual, as of late, Xe finds himself reflecting upwards, thinking about walking on two feet, and wondering, as he slowly closes his eyes.

Chapter Five

Unexpected Returns

The next day breaks with Xe returning to the thoughts he had the night before, before falling asleep. He just can't seem to get this walking thing off his mind. There's so much potential. There's so much more to do.

Unfortunately for Xe, his experimentation into walking on two feet has led him down a slippery path. It has increased his curiosity and sense of adventure. In the process of doing so, it has also made him less cautious. The act of walking on two feet, versus swinging through the branches on all fours, certainly has its advantages. The carrying of food, making oneself larger, and more threatening when faced with danger, clearly make life better. Not just for Xe, but for the others as well. But taking this path was not, necessarily, safer. Walking upright had a whole new set of risks.

As Xe was want to not just take things as they were, he was easily taken by the exhilaration and freedom of walking upright. It just seemed to feel like the right thing to do. Xe

started making it more of a habit to walk upright. He experimented more and challenged himself to go further. The others in his group started to wonder if he was doing the right thing. Was he being just a little too careless?

Xe had noticed that a lot of the fruit hanging in the trees ended up falling to the floor below. Occasionally, he and the others would wander down there on all fours, picking some of it up to bring it back up into the safety of the trees to consume. As Xe peered down below, he wondered what it must be like to walk down there. On two feet. Trying to get somewhere quickly would be easier done on two feet, he thought. Swinging through the branches would, sometimes, lead to missing a branch and falling to the ground. That could lead to broken bones, broken bodies, and death. Especially, if a predator happened to be nearby.

Foraging for termites meant spending some time on the ground. Would getting to the grassland be quicker and easier on two feet? Xe was always looking for ways to do something different. Do something better. He found that it was even more productive when out foraging to return with two arms full of food. Walking upright on the ground, freed up both hands and from a competition standpoint, put him way ahead. Seemed like the right thing to pursue.

One afternoon while Xe was sitting in the branches of his tree, he looked down and saw quite a few figs laying on

the ground. Xe saw an opportunity waiting. Slowly, he carefully made his way down to the ground and began picking up the fruit with both hands. He stood up, walked over here, then over there, and in no time, had both arms loaded with food. Suddenly, he felt the hair stand up on the back of his neck.

There were sounds close by, familiar sounds. The sounds he heard close by were the same sounds of danger he had heard many times before while up in the trees. This time though, he was by himself and on the ground. His only instinct was to drop all he had and climb up the nearest tree as fast as he could. But this time things were going to be different. He was going to stand his ground, stand on his own two feet, make himself look as large and as fierce as possible, and hopefully buy some time. It was worth the gamble.

The saber-toothed cat was not fooled. He saw that he had his prey this time and there was to be no escape. All it took was one fast and furious jump and he was upon Xe from behind. He sank his sharp fangs into the head of Xe and it was all over. The only thing that anyone would ever remember was Xe being dragged away by the big cat. Dragged away with the big cat’s fangs in his forehead.

Chapter Six

The Early Years

Ever since the dawn of humanity, we have looked up into the sky and wondered. We wondered how and why the Sun rose every day. We wondered about the moon, the planets, and all the stars that we saw every night. Just as we do today. But over the centuries, we have accumulated a vast body of knowledge about the very things that have caused us to wonder. Just like our earliest ancestors, we are attempting to make sense of our Universe.

The earliest attempts to understand our Universe took account of the fact that what we observed appeared to be governed by the motion of the Sun, stars, and planets around us. It is very easy to understand why our earliest beliefs would support such a view. The Sun rose in the east every morning and set in the west every night. The stars and planets would move across the sky in patterns. Patterns that were repeated in cycles, that implied a revolving, of sorts. A revolution of everything around Earth. Around us. Our attempts to understand this motion led to the very beginnings of superstition, religious belief, and, later, science itself.

The ancient Greeks began to notice these same patterns to the sparkling objects in the night sky. Enough so that they were able to distinguish those that were stars (like our Sun) and those that were planets. Planets seemed to behave differently. It took Greek philosopher Aristotle to propose a picture of a Universe where Earth was at the center and, around which the Sun, moon, and planets revolved. This became known as the geocentric view of our Universe. It wasn't long after that other early astronomers were able to reliably predict the concentric paths these objects took in their orbits around the Earth.

Much later, in the 15th Century, we see the beginnings of this view of the Universe changing. We see Nicolaus Copernicus supporting quite a different theory called Heliocentrism. Heliocentrism placed the Sun at the center, around which revolved the moon, Earth, and planets. Nicolaus Copernicus, a Renaissance mathematician and astronomer, around the year 1530, revolutionized our concepts of the Universe.

Prior to the time of Copernicus, the general thought was that Earth was the center of everything. It made complete sense since, if according to religious belief, God created everything in his own image, then Earth and everything on Earth must be at its center. Earth was the center of creation and all the heavens above. And humans were the pinnacle

of that creation. This was the prevailing view central to the belief of the Catholic Church at the time. The Church believed that Earth was stationary and was at the center of the solar system. The Universe was perfect and immutable, as well as eternal and incorruptible.

Copernicus challenged this thought by suggesting (but not until just before his death, so as to not face the wrath of the Catholic Church) a model of the solar system that placed the Sun at the center. Considered heresy, it challenged the authority of the Church and the structure of the Church's own existence.

Copernicus was concerned about the perfectly concentric circles that the Sun and planets were perceived to form in relationship to Earth. By moving the Sun to the center of the solar system, he was able to mathematically show that by doing so, the planets moved automatically into their correct positions in relation to one another. Copernicus also noted that the Earth itself was rotating, spinning around itself every 24 hours. The mathematical model he created is what we refer to as a Heliocentric system, wherein the Earth and planets revolve around the Sun. Through his extensive research and observations, he set in motion the beginnings of what we now know as the scientific method.

Based on the theories presented by Copernicus, Johannes Kepler, born in 1571, improved upon them. Utilizing a lifetime of night time observations, Kepler was able to show that, not only was the Sun the center of the solar system, but the paths the planets took were not perfectly concentric circles, but in fact, elliptical.

Galileo Galilei, an Italian astronomer, physicist and mathematician, is our next important contributor at the turn of the 17th Century. Following the likes of Copernicus, Galileo was able to provide proof of Heliocentrism, but, unfortunately, was not able to fend off attacks by the Church. He was tried by the Inquisition for his beliefs and forced to recant his support.

Galileo was not impeded though. His contribution to the methods of scientific research led to him being described as the father of observational astronomy. He developed a telescope that allowed him to observe the heavens much closer than ever before. Achieving a magnification of 30 times allowed him to make detailed observations and calculations of the motion of planets. It seems as if none of his observations would have come to fruition without the aid of the newly designed telescope. In doing so, he clearly demonstrated the use of tools to observe and reflect upon the nature of those observations in the formulation of the laws of nature.

Isaac Newton, also in the 17th Century, was an English physicist and mathematician. He clarified some of Kepler and Galileo's ideas that were left unanswered in a theory of gravity, which helps to explain the movement of planets and everything else in the Universe. Kepler felt that there was some strange attraction between the Sun, Earth, and the planets. How were they all able to maintain their position in relationship to one another? Galileo showed that falling objects, regardless of their mass, always fall at the same rate. What was this mysterious force that acted like a magnet to pull objects to the Earth? Could that force also be used to describe the magnetism between planets and the Sun? Newton responded that this force was gravity.

Later in Newton's life he published a book, *Mathematical Principles of Natural Philosophy*, that defines nearly all the essential concepts of a mathematically based physics. This book established three principle laws. First, that a stationary body will stay stationary unless an external force is applied to it. Second, force is equal to mass times acceleration and a change in motion is proportional to the force applied. Third, for every action, there is an equal and opposite reaction.

For our purposes we do not need to fully understand each of the three laws. What we do need to take away from this is that these three laws become the foundation from which we explain the elliptical orbits of planets, their ability to maintain their place in orbit even though being pulled by

the Sun’s gravity, how the moon revolves around the Earth, and the force that holds everything together. Gravity is not only the force that holds everything together, but is what provides order to the Universe. Finally, Newton was able to show that gravity can be described mathematically, by physics and the laws of nature.

Chapter Seven

The Later Years

By now, you should start to see a pattern developing. Previous to Copernicus, Earth and the heavens were thought to be the way they were, based purely on belief. Particularly, one's personal belief or that of an organized religion. With the advent of Copernicus, Galileo, and Newton, we start to see a much more scientific approach, guided by observation and results that can be verified. Instead of explaining our world in terms of what we believe to be true, we are starting to explain our world in terms of what can be verified to be true. We see the coming together of modern physics.

Let's summarize what we have to this point. We started off our journey believing that the Earth was the center of the solar system, as an extension of our belief that humans were also central to all of life. That view was changed when it was found that the Sun was the center of the solar system, not Earth. And that the Earth and moon and all of the other planets revolved around the Sun in perfect concentric circles. Later, that view changed again when these revolutions were proven to be elliptical, rather than

perfect circles. Further, the position of Earth, moon, and the other planets was held in place, so to speak, by the effects of the Sun's pull of gravity.

The commonly held view at this point was that the Universe had always been, would always be, and in fact was infinite. The model of this static Universe included gravity, which held everything together due to its strong force of attraction. But this too, was all about to change.

Albert Einstein is our next contributor from the 20th Century. Arguably, the most important scientist of the 20th Century, Einstein was a firm supporter of the belief that we lived in a static and infinite Universe. But the unique thing about Einstein is that his research led to conclusions that supported the complete opposite, even though Einstein himself never acknowledged this. Einstein's research led to the obvious conclusion that the Universe had a beginning and, at some point, an end.

Einstein is noted for his contribution to science and physics in two major areas, Special Relativity and General Relativity. We will spend some time discussing his theories as they have had such a huge impact on how we view our world. Some of this might get a little complicated. Some of this may not make sense. Remember, it took the mind of the most influential physicist of the 20th Century to come up with these ideas.

Before we delve into the first theory we need to discuss two concepts, space and time. Prior to Einstein, space and time were considered two separate things. It took Einstein to unify the two, such that we now consider them to be just one thing.

Space is thought of in two different ways. One, is the region that is beyond Earth. Two, is the mathematical concept where events and objects have position relative to one another. But even space beyond our Earth contains events and objects that can be understood by applying the mathematical concept. Outer space has stars and planets that are aligned relative to one another. We live in a three dimensional world. A world where objects have the dimensions of width, height, and depth. This is how we see the world. In three dimensions. Objects that have dimension are found in relationship to one another and are quantitative in nature. This is what is referred to as space.

Time is something totally different, although not completely. Time is characterized by the duration of an object's motion. The time it takes for an object in motion to get from one place to another. The duration of an event is measured in units of time. Such as seconds, minutes, hours, days, months, years, and light-years. Time is in itself a dimension. A fourth dimension.

Einstein was first noted for his theory of Special Relativity in 1905, which provided the link between the concepts of space and time. According to Special Relativity, space and time were not two separate things, but one thing called space-time. Space-time acted like a fabric or blanket, interweaving space and time. Creating a world of four dimensions. Under this theory, space and time were interchangeable and fundamentally, the same thing. Thus, space-time.

Imagine, if you will, a really large and circular kettle covered with a thin layer of spongy fabric. This spongy or stretchable fabric consists of threads of space going one way and threads of time going the other. The spongy fabric represents the space-time unification of space and time that Einstein proposed. This is the way Einstein viewed our solar system and in turn, our Universe. Surrounding all objects, including all stars and planets, was this fabric of space-time that we normally just describe as space. There are actually some other ramifications of Special Relativity we will get to in a moment, but for now, this will do.

In 1916, Einstein developed his second notable discovery, the theory of General Relativity. General Relativity modified Special Relativity to include gravity and its effect on space-time. Gravity was described instead, as a warping of space-time by massive objects. Keep in mind that massive, in the physics sense, does not mean extremely large or that it has a lot of weight. It just means

that an object has a lot of mass. A strong gravitational attraction to to other bodies.

According to General Relativity, space-time becomes curved in the presence of matter, such that space-time bends or curves around matter (or objects) and can be viewed as continuing around to the other side. This bending of space-time can result in an object being pushed toward an object, rather than being pulled into by the other object's gravity. General Relativity allowed us to better understand how objects moved through space. But more importantly, how space itself moves.

Another observation of this curvature of space-time is gravitational lensing. It is what allows scientists to see what is directly behind a bright star, for example. An example of this is Einstein's Cross, whereby a quasar (the brightest objects in the Universe) 8 billion light years away was found behind a galaxy only 400 million light years away. The intense gravity of the galaxy actually bends the light created by the quasar, allowing images of the quasar to be seen. The path of the light from the quasar is deflected, just as in the deflection of light by the lens in a pair of glasses.

Once again, imagine the covered kettle that we described earlier. If you take an object that has some mass and drop it into the middle of this kettle, it will come to rest in the center. What we notice is that surrounding this object,

the fabric tends to curl around the object, creating a depression in the fabric. The depression around the object describes Einstein's theory of General Relativity. The fabric around the object becomes curved and bends around the object. Allowing us to see the other side of the object, even though it appears that the object is blocking our view. But only if you allow for the bending of light.

As other, smaller objects are dropped upon the surface, they circle the surface surrounding the first, heavier, object. Similar to the way we describe the water that circles a drain or a toilet when it is flushed. Eventually, in our test, the smaller objects circle closer and closer to the heavier object until they crash into the heavier object. This is due to the attraction of that heavier object, that we call gravity. The heavier object gradually pulls the smaller objects closer and closer until contact is made.

But if the natural effect of gravity is to pull an object toward it, why do not the planets crash into the Sun? This is because General Relativity combines the effects of gravity and the warping of space-time. The Sun's gravity does pull on the planets. But the warping effect, the wave if you will, causes the planets to move sideways around the Sun. The motion sideways keeps the planets swinging around. According to Relativity, objects (planets) move relative to one another. Planets touch the curved point of the Sun's influence, but they never get very close to the Sun. Essentially, planets are going so fast that they cannot

escape, but they cannot fall all the way back into the Sun, either. Although, if you have heard of Black Holes, objects eventually swirl around the Black Hole, until they are finally consumed by the Black Hole. But, that's a discussion for another time.

Another curious set of circumstances occurs when, in just the right way, you cast two smaller objects onto the depressed surface at the same time. One of the smaller objects is just slightly smaller than the other. This is meant to simulate the Earth and moon. As they swirl, the smallest object (moon) tends to swirl itself around the slightly larger object (Earth) as they both swirl around the largest object (Sun).

In addition, if you cast a fistful of small objects in one direction and, at the same time, cast another fistful of small objects in the other direction, there is a demonstration of how one direction is preferred over the other. As each swirl takes place, those objects going in the wrong direction are settled out and you are left with only objects traveling in the same direction.

If you drop two heavy objects, approximately the same weight, onto the fabric, you create two depressions, each with its own gravitational influence. Then, if you cast a smaller object, in just the right way, you notice that the

smaller object takes a figure eight path inside and around the two heavier objects. Riding the wave.

What is meant by “relative”? Try to think of it this way. This is one of the consequences of Special Relativity by the way. If you are sitting on a train, reading a book, and the train is moving at a constant speed, it’s as if you are not moving. And the person sitting next to you is not moving. All of the laws of nature (physics) apply to the two of you. But if someone is standing outside of the train and watching the two of you in the compartment, it looks to them as if you are moving. All of the laws of nature apply to that person as well.

But if all of the laws of nature apply, whether you are in the train or not, then they must be inconsistent? No. Whether or not you are moving is relative to your position. And the laws of nature apply equally to all three individuals. This is Einstein’s unification of two things that appear to be inconsistent. And that is to make them consistent.

The person watching from outside the train is also moving, believe it or not. Even though they appear to be at rest, they too are moving. The Earth is in motion and is turning. The Sun is also constantly in motion, as is our galaxy, and so on, and so on, and so on. Therefore, nothing is at absolute rest or absolute motion. Things just move relative to each other.

There are a couple of other aspects of Special Relativity that we won't spend a lot of time on, mainly because they just sound crazy. These are called time dilation and length contraction. They are mainly used in order to keep the laws of physics intact for all observers, regardless of their state of motion. According to Einstein, the speed of light is constant. You can never exceed anything faster than 186,000 miles per second. Time dilation, for example, is Einstein's way of compensating for the fact that time moves slower in certain situations, thus requiring an adjustment to keep the speed of light at 186,000 miles per second.

Time dilation is a difference in elapsed time that two observers experience moving relative to each other. In other words, time actually slows down in relationship to a stationary observer. The difference in time is a result of gravity or relative velocity (motion). Think of it this way. The distance taken for a beam of light to travel up and down while moving, is greater than the distance that same beam of light travels if stationary. For the speed of light to stay the same for both, the time must be reduced (made slower) for the moving beam, relative to the time of the stationary beam.

In our everyday life, the amount of time dilation is so small that we do not even notice it. It only becomes

noticeable the faster the velocity is in comparison to the speed of light (186,000 miles per second). The closer you get to the speed of light, the greater time slows down. Until, at the speed of light (which is impossible according to Einstein), time would stop altogether.

An example of time dilation is the case where an astronaut traveling in space ages less than their counterpart back on earth. The astronaut and their counterpart back on earth each feel normal time passing. But to the astronaut who is moving, their counterpart at rest is living faster. While to the counterpart who is stationary, the moving astronaut is living slower. This is not just conjecture. This is a proven fact. In one test case, airliners were flown around the world in both directions. They carried with them atomic clocks. When they returned and compared their clocks with the official clock at the United States Naval Observatory, they were found to be in disagreement with one another. Weird, huh?

The other brain teaser of Special Relativity is length contraction. What it says is that an object at rest may be measured to be 200 feet long. That same object, moving at relativistic speeds (a significant fraction of the speed of light) relative to the observer at rest, is measured at less than 200 feet. The amount of contraction is dependent on the object’s speed relative to the observer. And contraction only occurs in the object’s direction of motion. Once again, objects at rest and objects in motion abide by the same

laws of physics, but when looked at relative to one's position, things look and act differently.

Another way to look at this, to help visualize length contraction, is to picture a one foot ruler. If you, the observer, hold the ruler out in front of you, its length is one foot. Next, picture that same ruler being held in front of a second observer who is turned slightly away from the first observer. Due to the angle of view, the first observer sees the ruler's length held by the second observer as shorter. The ruler is actually the same length for both observers. But the second observer's ruler looks shorter, relative to the position of the first observer.

In conclusion, as a consequence of Einstein's theories of General and Special Relativity, there was the revelation that we live in a dynamic Universe. Because of the effects of space-time and gravity, our Universe was shown to be expanding and contracting. Certainly not static or infinite. What it meant was that our Universe must have had a beginning and conversely, that it must at some point end. Unfortunately, Einstein simply did not have the confidence to declare this, so it was left to others who followed him to do so.

Proving whether our Universe was expanding was an important next step. Was our Universe expanding or was it contracting? Regardless, the overwhelming consensus of

most scientists was that there must be a way of getting back to the very beginnings. No matter which direction we were going.

In 1929, Edwin Hubble, an astronomer at Caltech, worked to solve the question as to whether the Universe was expanding or shrinking. Working at the Carnegie Observatories in California, Hubble successfully measured the redshifts of a number of distant galaxies. Visible light is like a rainbow, in that it is a spectrum of colors. Redshift and blueshift describe how light changes as objects such as stars and galaxies move closer or farther away from us. When an object moves away from us, the light is moved to the red end of the spectrum. When an object gets closer, the light is moved to the blue end of the spectrum. Imagine listening to the sound of a train whistle as it approaches you and then moves away. Light behaves the same way as the sound of the train whistle. What Hubble showed, was that galaxies appeared to be moving away from us, according to their redshift over time.

When Hubble plotted the results of his experiments to measure redshift and relative distance, he found that the redshift of distant galaxies increased as a function of their distance. If a star is moving closer to us the light it gives off gets squeezed together, which makes it appear bluer than it actually is. If the star is moving away from us the light gets stretched out, which makes it appear more red than it really is. If the star is also going faster all the time, or

accelerating, this effect is even greater. The redshift of distant galaxies increased as a function of their distance. In other words, what he had shown was that the Universe was expanding.

Hubble confirmed that we did, indeed, live in an expanding Universe that was finite in both time and space. A Universe that had been expanding since the moment it was created. Later researchers discovered that, not only is our Universe expanding, it is accelerating faster and faster. So much so, that the stars and galaxies that we see today will no longer be visible to us thousands of years from now. That's assuming, of course, that there will be anyone here to notice. Needless to say, Hubble provided insurmountable evidence that the Universe must have had a beginning and that if we were able to look far enough back, we would witness its creation.

Chapter Eight

Xe Returns

Xe is back in the laboratory. Sitting right in the same place before the journey began. Back on Xeron. Back to the reality that Xe had just been to a parallel universe. Stunned by the fact of witnessing a life changing event of human proportions. Xe had been a part of it. Xe had been there when, in the blink of an eye, humans started to walk on two feet.

But how did Xe get back to Xeron? The only thing that Xe could surmise is that if at first you open up a universe, then it must, in some way, eventually be closed. If you pop into existence, then you must pop out of existence. Xe had obviously figured out how to pop in. It was the popping out that needed explanation. The only way to come back was to close the portal. To end the universe that had been opened up. To end the life form that Xe had become. First you have the birth of a universe. Then, eventually, you have its death. Out of nothing comes something. And then it is gone.

Responsible scientists document everything that they do so that others can try to duplicate your experiments and get the same results. Xe spent a lot of time documenting the first successful journey to another universe, retracing the steps and triple verifying the calculations. It wasn't just the journey to a parallel universe that had been accomplished. It was the ability to inject oneself directly into the particle exchange process, at just the right moment. So that when the other universe was entered, it was done so at a particular time and place. A particular time and place that was deliberately chosen ahead of time to meet a specific goal and intention.

Doing so once was not enough to warrant a verification of the theory. The process had to be duplicated over and over again, in order to make sure the results came out the same. The process repeatable. The whole journey, verifiable. And, of course, Xe simply wanted more. The science was one thing, but the physical act of being there, of participating, was icing on the cake.

So, Xe set off on preparing for the second test of the theory. The theory that one could travel to another place and time. Become a participant in that place and time. Perhaps, be a contributor.

Xe had specific goals in mind, just like in the first journey. This time Xe wanted to be on Earth about the time

when humans were making their second set of adaptations that would lead to exponential results down the road. The time was to be 2 million years ago, about 2 million years after the first visit when becoming bipedal was just a twinkle in Xe's eye. What would Xe find? How important had it become to walk on two feet? What had it all led to?

The formulas were all reset. The virtual particles were realigned. The destination was recalculated to planet Earth in the Milky Way. The time was set to 2 million years ago. The place was South Africa. Xe was pretty confident the calculations would allow for popping into existence. Xe still wasn't quite sure of how the whole popping out of existence was going to play out. Oh well. Xe was on the way.

Xe rubbed his eyes with his left hand, an attempt to remove some dirt or debris that had flown in the direction of his face while making something from the stones he had found nearby. Or at least, that was the presumption. As he looked around, he was in a sitting position on the ground, with his legs drawn up and his back leaning against a large rock. There seemed to be some purpose in what he was doing, but he wasn't quite clear what that was.

Xe found that he was conscious of being in an environment that was quite a bit different from his earlier visit 2 million years earlier. He no longer was living in a wooded or forested area. No longer living in the trees.

Instead, he was in a vast and open grassland. What he didn't know was why or how he got here and that was a little disconcerting.

As the climate got drier the forests started to recede and, in some areas, to disappear altogether. Where there was once a lot of rain to sustain the forests, the rain was not so much anymore. The savanna was a new environment, unsuitable for those living in the trees. The savanna was very suitable for those who had learned to walk on two feet. By escaping the forests, Xe and the others like him 2 million years earlier, adapted to living out in the open. Free to follow the food, both plant and animal. Free to explore new regions, new types of foods, and face new dangers.

Xe found himself living in a new economy, with more emphasis on hunting. A greater emphasis on protein from meat and high energy substances, such as honey. That being said, the underground tubers, roots, and seeds gathered by the females and children were still a significant and important part of their sustenance.

Xe sensed that there was more of a difference in roles between males and females. A greater separation of roles and responsibilities. Yet, a greater inclusion as well. There was a family unit, usually a male, female, and children. Xe seemed to have a larger role in that unit. But responsibility

was shared among all those in the family unit. There were other family units that formed the group Xe and his family were a part of. They too were family units of shared responsibility. It was the combining of these family units though that made the band, a collective. That when banded together, became the primary focus for survival. A collective responsibility that outranked the responsibilities of the individual and family unit.

This is what Xe was thinking about as he sat with a group of other males working the rocks they had gathered into something more than a rock. Something they could use to make their lives easier and more productive. This, as Xe blinked his eyes and refocused where he was.

Chapter Nine

Rock and Flame

Xe has in his hand a rock about 10 inches long and three quarters of that size wide. There seems to be a lot of this kind of rock around. A rock that everyone seems to be holding. The goal is to take this rock and work it down a little bit so that Xe has a tool that can be used for scraping meat off of bones, skinning animals, cutting wood, or digging in the ground. The final product will be pear shaped or tear dropped, about eight inches long, sharply detailed on both sides, and held by the hand or both hands. It's called a handaxe. It requires a lot of effort and forethought. Something Xe was just beginning to acquire 2 million years earlier.

Xe starts by taking the rock core and striking it with another stone, in a downward motion to remove a flake of stone from the core. This flake has a natural sharpness to it and is used for other applications. But the core itself is what Xe generally prizes. It is used more as a hand tool, but in all truthfulness, both the core and the flakes are used. They are both further worked with other implements at Xe's disposal. These are usually additional tools made out of

bone, antler or wood. Xe uses these tools to apply further pressure to the rock edges to give it more shape and greater, more detailed, sharpness. Working around the edges, reapplying pressure from the other bone tool, alternately removing smaller flakes, and turning the stone around to do the same thing on the other side, Xe eventually creates the final product.

Things don’t always go as planned. As Xe watches the others around him there are moments when the core breaks or the flake just doesn’t flake as planned. One of Xe’s companions stops for a bit, waiting for his hand to stop bleeding from the wound that was inflicted by an errant flake. This tends to happen a lot to those who are just beginning. Just beginning to learn.

All in all though, Xe and his companions are quite fortunate to be doing what they are doing. Xe has known of this area for quite awhile. It is a place where there are a lot of these kinds of rocks to work with. It is knowledge that has been passed down from family to family. The moments spent with his companions making tools, creates bonds of friendship and mutual trust. The tool making requires long term planning, forethought, and the ability to visualize a desired end. Xe knows this is good for himself, good for the others, and good for the sustainability of the group.

As Xe and his friends are sitting around manufacturing their tools, the sky starts to change to a dark and ominous color. This doesn't look to Xe like the other sky conditions that cause water to fall from the sky. It is still very dry, but cracks of bright flashes start to fill the sky. They all look up, look around, and look very concerned. Should they get up? Should they run back to the group? Is there cover around that they can duck into?

Xe on the other hand, looks off in the direction of where the bright flashes have, apparently, reached the ground. His instincts are confirmed when he sees a puff of smoke and the dry brush start to go up in flames. He has seen the flames before, as the others have. They have learned to stay out of the way. They have learned that flames can be deadly. Xe has never seen the flames actually start before.

As the flames start to fan out, the others seek shelter in some boulders not far away. Xe on the other hand, heads toward the flame. He wants to see what it is, what it does, and is it something he can take advantage of.

As he nears the perimeter of the flames, Xe begins to feel the intense heat and starts to back away. In the process he notices a few things. One, as the flames burn, they leave behind a scarred section of land, blackened but with no more brush. Two, as the flames burn, small animals and in some cases larger animals, flee ahead of the flames

trying to escape. Three, as he approaches the scarred area, he notices small burning objects, embers, that have been left behind. Xe makes mental note of all three phenomena, knowing that they will come in handy some time in the future. Something tells him that he is supposed to know about these things.

Chapter Ten

The Modern Era

As we enter the modern era the last piece of our brief journey into how we came to understand our Universe is set in the present. Although set in the present, it is our attempt to return to the past that is our goal. Because it is in the past that we can find the best evidence of what our Universe was like when it was actually created. Finding our past will allow us to test our theories and model more data so that we can better understand how our Universe operates today.

Looking into the past requires not only the tools with which to make the journey, but an examination of the science that got us here in the first place. Without physics and the scientific method we would not be able to accurately predict that the discoveries we have made so far, are in fact true. Without the tools, we would not be able to verify what our physics tells us.

Throughout our historical review here, we have seen the steady progression of our understanding of the

Universe through the advancements of science. Advancements that have led us to describe our Universe in terms of mathematics, physics, and astronomy. We have become more comfortable accepting the results of our scientific inquiries coming from mathematical theory and modeling, because we can see how verifiable and repeatable the results are.

From the very beginnings of our human existence, we have stared up at the sky in awe and wonderment. What were we seeing? Why? And how? It was very easy to see it explained as something supernatural to ourselves while we were still in our technological infancy. We formalized our existence in terms of our personal belief system and later as our religion. That's what we accepted as the truth for hundreds of years. Until some decided to question. Question the results and even question their beliefs. It's at this point that we looked for different explanations. Something that would allow for explanation, but would also be predictable. A predictability that, no matter how many different ways you tested it, the results would always come out the same.

We gave names to the planets in our solar system. All of the names, except Earth, were given names based on Roman and Greek gods and goddesses. We situated these in a system that we called a solar system, made up of the Sun at the center and a series of planets and moons that orbited around the Sun. Next, we postulated that our solar

system was simply part of a larger number of solar systems and stars that make up a galaxy we call the Milky Way. Then we discovered even more galaxies and we wondered how far away they were and what was their status. Were they moving? Were we moving? If so, how fast and in what direction?

Direction became pivotal. Understanding that we were indeed accelerating meant that we must have left a trail. A trail that could be followed. But in order to do so we needed to change the direction of our thought. We needed to look backwards. We needed to start where we are now and recreate each step along the way until we got back to the very beginning.

By examining the present we figured out how things work today. At least as best as we could. By looking at our past we hoped we could figure out how we got here. And that, we hoped, would help us answer one of the most fundamental questions of our existence. Where did we come from?

To answer this question we need to return to the very beginning. To the start of the Big Bang. The obvious question is can we do this? The general consensus we have come to is that, based on science, the calculations of physics that define for us the laws of nature, and the observations of astronomical research, we can do this. We

do have the ability to reach back in time and observe the earliest moments of the Universe's beginning.

How do we know that the Universe is 13.8 billion years old? Basically, the Hubble Space Telescope has been able to measure the age of the Universe using two different methods. The first method involves us knowing the following things. That all the galaxies in the Universe are moving apart and, as a result, we can infer that at some point they must of have all been much closer together. This, and knowing the current speed and distances to galaxies, coupled with the rate at which the Universe is accelerating, allows us to predictably calculate the length of time it would take to reach their current position. The second method involves measuring the age of our oldest star clusters in the Milky Way (the galaxy within which our solar system resides). Star clusters are interesting in that all of the stars in the cluster formed at the same time. From the same interstellar gas. By identifying a single type of star in the cluster and knowing how long it takes for that type of star to use up all of its hydrogen, we can estimate its age. These two methods both reliably predict that our Universe is 13.8 billion years old.

So we can reliably infer that if we are to look back 13.8 billion years we would find the start of the Big Bang. But how do we look back 13.8 billion years? Can we actually look that far back? It is through our best understanding of

physics and astronomy and the laws of nature that we can even attempt to do so.

Looking out at space we see the Earth's moon. The light from the moon takes about one second for it to reach our eyes. What that means is that by the time we see the moon it is already one second old. Some of the galaxies and stars that we look at can be millions of light-years away. That also means that by the time their light reaches us, they are probably long gone. So that looking back to the beginning of the Big Bang means that anything we can see happened 13.8 billion years ago. And, as we are here and that was then, it no longer exists. But because we can see its light, we are actually looking at the conditions of the Universe that existed at that time.

The takeaway from this is that light is extremely important. Without light we are unable to know how far away something is and, thus, to know that it ever existed. So just how far back can we see? Well, at the moment it looks as if we can only see back to 380,000 years after the Big Bang. Why is this?

We can use light to view objects because light freely emits from these objects. Either through reflection (as in planets) or in self-generation (as in stars). Light can be looked at as packets of energy that we call photons. So even distant objects can be seen based on the light that

they emit. The fainter the light, the further away that object is. The further away that object is, the further back in time you are looking. It all has to do with the speed of light, which is about 186,000 miles per second. Light moves so fast that it appears to be instantaneous here on Earth. But in space, the distances between objects is so great, that the time it takes for light to travel any distance is very noticeable.

In the first second after the Big Bang, the surrounding temperature was around 10 billion degrees Fahrenheit. Only the necessary particles of neutrons, electrons, and protons existed. Everything was squashed together. Energy and matter were one and the same thing. There was no difference between light and the radiation that was being created. The conditions resembled a thick, dense, and extremely hot soupy mixture that light could not penetrate. In fact, light did not actually exist yet. There were no photons that were long-living enough to be transparent.

Photons carry no mass, are constantly moving, and travel at the speed of light. There was a lot of loose energy in the form of photons (light) and another photon-like particle called a boson. The earliest forms of bosons stored a huge amount of energy and when they broke apart, created protons and anti-protons. When the protons and anti-protons eventually lost their energy, they converted back into bosons.

Except, not all of the anti-protons converted. Instead, they became all the mass in the Universe. There was this layer of opacity that we could not see into. It was kind of like standing in a room surrounded by walls. As long as it is light inside, you can see all around the room. But the light stops at the wall. You cannot see outside of the wall because of how opaque the wall is.

When the Universe was only around 380,000 years old (approximately 380,000 years after the Big Bang), the Universe started to cool down. Proper atoms formed and the conditions changed such that light was created. What that means is that anything newer than 380,000 years (to the present day) is visible using light and tools, such as telescopes, with which to measure. Anything older than that, we cannot see. Which means that anything beginning with the Big Bang and until 380,000 years after, we cannot see using light.

But there is something coming from that time period that has been observed. It is a noise that permeates the Universe. It is referred to as the Cosmic Wave Background (CMB), starting at the very edge of our observable Universe. It is sometimes referred to as the “afterglow” of the Big Bang. It was stumbled upon by a team at Bell Telephone Laboratories, Arno Penzias and Robert Wilson, in 1965. While we are unable to see past this wall of

380,000 years after the Big Bang, we are able to see additional evidence in the form of the CMB that supports our Universe. Right after the Big Bang, accelerating faster than the speed of light.

Travel faster than the speed of light? Didn't Einstein say that nothing could travel faster than the speed of light? Yes, but there's a catch. Einstein was referring to the transmission of information, not the expansion of a Universe inflating right after the Big Bang. Remember, during the first moments after the Big Bang there was no light. No communication or transmission of information was occurring. Thus, expansion can go faster than the speed of light in this situation.

How might we be able to see past this wall? We have something else called gravitational waves that can help us out here. Gravitational waves are ripples in space-time that travel outward from a source. They were predicted by Einstein's theory of General Relativity in 1916. It takes collisions of objects of great density and size to create gravitational waves that actually can be measured. In 2014, scientists at the Harvard-Smithsonian Center for Astrophysics believe they detected a faint signal coming from the CMB. That signal could be the first evidence of gravitational waves being generated. And if so, we now have a way of looking past that 380,000 year barrier. Gravitational waves do not require light and so, can be

measured. But the verdict is still out on this one. We shall just have to wait, for now.

What might happen if we can, in fact, ever be able to look back at the actual Big Bang event? Will we be able to explain its cause? We might already have an answer. Understanding that answer is going to require a bit of knowledge about particles and electromagnetism.

What is a particle? Quantum physics says that everything is made out of particles. Within physics in general, particles are extremely small units of matter. They exist inside of atoms. Even light has particles that we call photons. Other types of particles (those that we are concerned with here) are protons, electrons, and neutrons. These are referred to as the building blocks of atoms, which are considered to be the basic units of matter.

Electromagnetism is the branch of physics involving the study of the electromagnetic force. An electromagnetic force is a type of physical interaction that occurs between electrically charged particles. Whether a positive charge or a negative one. A photon would be an example of a particle that carries this electromagnetic force. Otherwise known as a force carrier. The electromagnetic force is one of the four fundamental forces of nature. The other three being gravity, weak nuclear, and strong nuclear. Thus, there is this

interesting relationship between particles and electric charges.

Electrons have a negative charge and two electrons tend to repel each other. Protons have a positive charge and two protons also tend to repel each other. The interesting thing is that the two, electrons and protons, actually attract each other because of their unlike charge. They can be bound together by photons. Neutrons, just to be complete, have no net electric charge.

When two electrons repel each other, for example, one of the electrons emits a virtual particle called a photon. Make note of the term “virtual”. It takes away a small amount of energy and, thus, according to the conservation of energy, it can only exist for a short while. But before it violates any laws, it gets absorbed by another electron, which, in turn, causes that electron to be repelled. Thus, the electron pops into existence and out of existence in a very short period of time.

Now, why is this important? When we look at empty space or what we would call nothing, it turns out there is something there after all. Electrons repelling electrons, creating photons, causing them to become attached to other electrons and so on. Empty space is a really a mix of virtual particles that are popping into and out of existence.

They only exist for a very short period of time and, thus, there appears to be nothing there.

When you look inside of a proton you find quarks and empty space. Calculations that are done inside the space of a proton, between the quarks, show that most of the mass of the proton comes from virtual particles. Not the quarks. Virtual particles that are popping into and out of existence. Enough so, such that they create mass. In other words, we get something from nothing.

The argument is that before the Big Bang, there must have been something besides nothingness to start everything off. Some kind of intelligent designer. Because you cannot create something from nothing. But the idea that you can have virtual particles popping into and out of existence, creating mass from what appears to be nothing, lends credence to the argument that the Universe began from nothing.

Can we show this in physics? Turns out, we can. Dongshan He and his team from the Wuhan Institute of Physics and Mathematics in China have verified this. They have developed the first mathematical proof that the Big Bang could have resulted from this kind of scenario. The result of quantum fluctuations at the moment of the Big Bang can create what are referred to as true vacuum bubbles that have the chance to expand exponentially. That

bubble of true vacuum is a perfect sphere that could expand to a size that would result in the Big Bang. Notice we said “could have”. If the bubble expands, but does not expand rapidly enough, then it disappears again almost instantly. But if the bubble expands very rapidly, then a Universe can be created in a process that is irreversible.

What this shows us is that at the beginning of the Big Bang, the actual creation of the Universe, there may have been only empty space. But that’s OK. Because what was there, was something that could have sparked the Big Bang, inflation, and the acceleration of the Universe we see today. Virtual particles or virtual photons.

Now if you notice, this explanation at the moment of the Big Bang, depends heavily on the creation of virtual particles called photons. Earlier, we discussed how we cannot see past or into, the wall of hot radiation at around 380,000 years after the Big Bang due to the lack of photons and the resultant lack of light. How can that be? Turns out, there were photons at the moment of the Big Bang. It’s just that they were not in a form that we can interpret as light. At the moment of the Big Bang there were plenty of photons, electrons, and protons. But because the photons were busy popping into and out of existence, light could not be detected. It wasn’t until 380,000 years after the Big Bang (but still in the first second of its existence), when the Universe was expanding and cooling, that photons were free to exist longer and thus, become transparent.

Chapter Eleven

Harnessing the Flames

Xe and the rest of his group, live out on the open grassland. Each of the family units have their own space in whatever location they have chosen to stay in for awhile. Their homes are basically a windscreen, made out of wood and some hides, that serves to provide protection from the elements. A place to settle in. A place to call home. Water, essential for their survival, is gathered from a close by lake, or pond, or stream. The water is stored in large ostrich egg shells. As the group moves from place to place, so do the ostrich egg shells, filled with water from whatever source they can find. A convenient way of storing and transporting water in the normally dry savanna.

Xe and his group follow the food, particularly the animals. They don't stay in one place very long. They are mostly nomadic and have formed a small egalitarian band made up of several family units. Xe has his family, consisting of himself, his mate, and two children. The band is the primary focus, such that there is equal access by all to resources such as food and water. Similarly, the decision making process is a shared responsibility as well.

The windscreen type structures are sometimes packed up when the band decides to move on. They are easily rebuilt upon arrival at their new destination. In other cases, they are left behind and brand new structures are built, depending on where they end up and the available resources. Their belongings, which only amount to the basic necessities, are also packed up and carried to their new destination. For some reason, Xe keeps having these visions of building a nest in the branches of trees, over and over again. Not sure what the significance of that is.

The next day Xe is out scouting around for game to hunt. He finds himself drawn to the previous day's location where he was able to actually see the bolts of light in the sky strike the ground and create a puff of smoke. And then, a full fledged wall of flame. As he walks over the blackened area left behind, he sees that there are still some objects smoldering in the dirt. He looks down and attempts to pick one up and, suddenly, it bursts into flame. He immediately drops it to the ground and the flame continues to burn briefly, then goes out. He felt the intense heat of the object right before it burst into flame and, consequently, had to drop it. What is this stuff, he wonders?

Xe gets down on all fours and closely examines the smoldering object. It looks like the dried up droppings from a large animal, perhaps a wildebeest. Somehow, the flames

have inhabited the dung in such a way that they are left hiding inside. Waiting for just the right conditions to find their way out and create a flame that can be seen and felt. But what is it that lets it out?

Laying on the ground, his face level with the dung, Xe gently breaths in and out. He notices that with each exhale, the dung seems to glow. He blows a little harder. The dung gets brighter and it starts to smoke. He blows even harder and the smoke increases, forcing Xe to roll away and cover his eyes. He blinks his eyes to clear the sting from the smoke and the dung ignites in flame. Xe has just discovered how to make fire. In the blink of an eye.

Xe brings the others in his group over to see for themselves what he has discovered. At first they are a little skittish of what they see. The danger of experiencing something that is not understood or known. But once Xe has shown them how the fire can be created and contained, the others quickly join in.

Xe’s nomadic group has been using this technique of building fires now for a few days. Once they discovered how to transport the smoldering dung, it was easy to keep it going for days at a time. And in the process, make campfire after campfire by their shelters in the savanna. How do you transport fire?

The method Xe found was to locate a small tree trunk. Strip off the bark in a one foot section and roll this section into a cylinder or hollow tube. Next, gather up the dried dung, some dry grass, and stuff it into the tube. Lastly, ignite the dung with the smoldering dung found from a burned out grassland fire. Or if back at the campsite, embers borrowed from another campfire.

Xe found it especially helpful to assign the task of keeping the dung smoldering, the fire going so to speak, to a younger member of the band. It was their responsibility to make sure the flame did not go out. It was their job to always have a tube of smoldering dried dung available to start a fire. When the camp was packed and ready to move, the keeper of the flame did their job as well. Carrying the flame from campsite to campsite.

Xe and his group were quite impressed with their newly found control of fire. It provided warmth on cold nights. It allowed the group to stay up later and think about the day's activities longer. Plan the activities for the next day. They would sit up after dark gathered around the campfire and share moments of looking up in the sky at all the twinkling lights. If someone's dung lost its flame, they were welcomed to another member's fire where they could replenish the flame. Things were shared. Friendships strengthened. Bonds created.

Not only that, but fire seemed to scare off the wild dogs, leopards, and saber-tooth cats that lurked around their camps. Hoping to catch their prey in a moment of weakness. Xe remembered how the animals all fled when the flames erupted and the fire spread. The predators feared the fire. The predators feared the campfire. Fire was fire. Fire was something to back away from. Xe had found a way to control fire. Make it useful. But Xe thought there must be something else that fire can provide?

One day Xe and the rest of the band headed out to look for animals to hunt. This included the women and children, whose role in the hunt was just as integral as the hunter. Whereas scavenging the carcasses of kills left behind was an option, Xe and the others preferred to hunt the animals and make the kills themselves. This required the cooperation of everyone in the group. Young and old.

The group would scout out a herd of animals they wished to hunt. They would look for the older, more mature animals that appeared to be weaker. Lagging behind. More vulnerable. A small body of hunters would then assemble at a location away from the herd and away from the others. They would wait for the others in the group to flush the animals in their direction. Once the group of animals reached the small group of hunters, they would pounce upon these weaker animals and attempt to bring them down

with rocks. Sometimes even the handaxe flakes would be used, crudely attached to the end of a long pole that would serve as a poking stick or spear.

This time Xe had something else in mind. Let fire do the work of herding the animals in the direction of the hunters. The keeper of the flame was directed to follow Xe along to a point in the dry grass that was noticeably behind the group of wildebeest. Xe quickly assessed the force and direction of the wind. He had to make sure that the wind was blowing in the direction of the herd and that they were far enough away so as to not be sensed or smelled. The others were stationed upwind of the herd, in a predefined location, waiting for the anticipated bolting animals.

Xe and the keeper of the flame waited patiently for just the right moment to set the plan in motion. The wind came up a bit. Xe looked all around. The way the tall grass was bending told Xe that the moment was now. He took the smoldering dung and flung it into the dry grass. The grass smoldered for a bit. A puff of smoke arose. And the grass erupted into a wall of flame that roared off in the direction of the wildebeest.

The herd of wildebeest sensed the approaching danger. The smoke billowed up and the fire roared ever closer to the herd. Their reaction was predictable. Their response was panic. They stampeded off in the opposite direction

hoping to outrun the flames. Somehow, to escape the danger.

Unfortunately for the wildebeest, but fortunately for the band, they ran in the direction of the awaiting hunters. As predicted. Little did they know that they were being funneled into a trap. The hunters were waiting in a narrow passageway, lined with boulders, and overhung with some trees. Others in the group lined the passageway forming a funnel, forcing the animals in the direction of the hunters by waving their arms, running around, and making lots of noise.

The goal was not to kill as many wildebeest as they could. The goal was to only kill the older, more mature adults. Really, only what they needed. The young, the females, and the other adults were to be spared.

As the herd entered the passageway, the hunters began to throw their rocks and thrust their spears. Some in the overhung branches, waited for just the right moment to drop down and wrestle the weakened and wounded animals to the ground. As the herd rushed through and the onslaught ended, only a few of the wildebeest lay dying or dead on the path. Now came the time of honoring the death of the wildebeests. Showing appreciation for their sacrifice. Nothing more, really, than a moment of silence.

As Xe and the keeper of the flame completed their journey back to the kill site, they arrived to find the painstaking process of cleaning, skinning, and quartering the dead animals for their meat had already begun. Everyone was busily stripping the meat from the bones. Using the tools they had made specifically for this. Making sure that the window for breaking the animals down was as short as possible. The longer the process took, the easier it was for the flies to infest the meat with their eggs. To make spoil of the food they had all worked so hard to gain.

As the butchering process was going on, Xe and some of the others decided that it was time to move the camp closer to the kill site. The meat from the wildebeest would last them quite a while and it would be easier to move the camp, rather than haul all the meat back to the old camp. So the decision was made to send some of the others back to the old camp and start the process of gathering up all that would be needed to establish a new camp. Somewhere near where they were now. A few of the others, Xe included, set out to scout around for a place to set up a new campsite.

Chapter Twelve

Finding Xe's Way Home

Xe and the others examined their surroundings and chose to go in the direction of some nearby rock outcroppings. They were not very far from the kill site and it looked as if the rocks might have the added benefit of providing greater protection. As they made their way closer to the rock face, Xe noticed that there appeared to be some opening or hole in the side of the rock outcropping. It was a very faint opening, covered with a lot of brush and vegetation. Nevertheless, as they got closer, it was definitely an opening. An opening to what?

They cautiously approached the opening, not knowing if some thing or some unknown, might be lurking inside. Ready to pounce on whomever might venture to come inside. Carefully, they removed some of the brush from around the opening and peered inside. It was quite dark and they could only see so far inside. But it didn't look or sound as if anything was inside. If only they could see further in.

Xe summoned the keeper of the flame. He gathered up as much dry grass and brush as he could and placed it as far back in the opening as he could safely go. When the keeper of the flame arrived, Xe took out some of the glowing dung and flung it inside to where the pile of grass and brush were stacked. Once again, there was the expected smell of smoke, followed by the familiar glow and ignition of flame. Suddenly, the whole inside of the cave was lit up with the glowing light from a campfire started with the imagination and forethought of Xe. As they made their way inside, they concluded that all was good. They had found their new camp.

Over the days that followed, the band turned the cave into a very comfortable abode. It was more than they had ever hoped for. Xe and the others had gradually made their way further back into the cave, exploring all the nooks and crannies. Finding evidence that there had in fact been other residents here in the past. Evidence of animal bones, scattered all about. Presumably, all that was left of some predator dragging their victims in for a final meal. Evidence that, at any moment that same predator may be coming back. So it was, that the keeper of the flame's job became all that more important. The fire must be kept going at all times. The fire that would keep the band safe and secure. The fire that would keep the predators away.

Xe discovered that over time, fire also brought with it other changes to the band. The way they lived. The way

they thought about each other. There was quite a concern created one day when one of the hunters sustained an injury that was very serious. He was out hunting with the others, in position to make the kill, when he was suddenly distracted by the sight of others off in the distance. Others, he had never seen before. From what he could tell, they didn't look like they looked. They didn't walk or run like they did. They were us, but not like us. Anyway, distracted, he jumped down for the kill but was a little too early. The wildebeest sidestepped and he missed. But the wildebeest thundering behind him did not. The hunter was left trampled on the ground writhing in pain.

Alive and doing the best he could, he hobbled his way back to the cave. The injury prevented him from participating in the usual activities of the group. The activities that were expected by living in a group. The activities that kept you and the group alive. The others were not quite sure what to do. The hunter was not quite sure of his fate.

As the days went by, it was more and more obvious that this individual would succumb to their injury if something were not done. The others began something they had never done before. They began to provide this individual with bits of food, hides for warmth, and ostrich shells filled with water. It's as if an emotional attachment had been created between the members of the group that went beyond mere cooperation while hunting or cooperation

while gathering. This was a cooperation of being. Sharing what you can with those less fortunate than yourself. Caring for others, old and weak. Compassionate social behavior.

Something else the use of fire provided came about quite unexpectedly. The cooking of meat. One of the mothers had laid out her strips of raw meat by the edge of the campfire for drying. As she got up to go tend to one of her young ones, she inadvertently knocked a couple of the strips into the coals at the edge of the fire. When she returned an hour or so later, she and her mate were greeted with the site of two strips of meat that had been cooked, not dried. And an aroma that was different, yet enticing. They looked at each other not sure what to do. Unwilling to waste the meat, they decided to try and take a bite. They were both quite surprised and, perplexed. The meat was not as chewy as it was when it was eaten raw and not as tough as when they would eat it dried. It was actually easier to chew, faster to consume, and seemed much more satisfying.

The next morning they found that they had even digested the cooked meat better. There wasn't that hardened, full feeling in their stomachs. There wasn't much feeling in the gut at all. Except that they wanted more of the cooked meat. Was it just their imagination or did they actually seem to feel more energetic? Could this have come from eating meat that had been cooked and not dried?

When they showed the others what they had done, they were all too eager to try the newly found technique. They also found cooked meat more satisfying. More pleasing. Soon, they were all experimenting with the different ways of cooking the meat over an open flame. Overall, the group seemed to notice that they had more energy, leading them to want more meat in their diet. They just felt, better.

Concern for Xe grew more and more each day. He was not eating or drinking much. He slept more each day. He was in a lot of pain. He was not getting better. He was getting worse, just as they had feared. There was always someone by his side, in case he needed something or just wanted to be comforted. But it didn't seem to be enough.

On his last morning, the others knew. They had gathered by his side to express their support as well as their grief. Their, not wanting to let go. Xe looked up into their eyes, as if to say goodbye. As if to say, "It's OK. It will be alright. I, somehow, know I will be fine. I know, but I just don't understand". And with that, Xe closed his eyes and was gone.

Chapter Thirteen

Multiverses

We tend to define the word universe as all that there is or all that exists. In which case, when we refer to our Universe we have always described it as only one universe. The Universe that has allowed us to be created within it.

A hot topic in physics, astronomy, and cosmology these days is the multiverse. A multiverse is a hypothetical set of possible universes. Notice we said, hypothetical. That is because, even though there is a lot of support within the scientific community endorsing this possibility, it cannot be tested at this point and, thus, according to scientific standards cannot be proven false.

A multiverse comprises everything that exists, including our own Universe. These are often referred to as parallel, other, or alternative universes. Each one contains their own space, time, matter, energy, and all of the physical laws of nature that we find supported by physics. They might for the sake of argument, not even have the same laws of nature. They may not have physics. But then again, some may and

some may not. Taken together, the multiverse comprises everything that exists. How could these alternative universes come about? There are multiple possibilities of how this could occur.

One possibility is that there are actually an infinite number of these alternative universes. We know that our own Universe had its beginning in something called the Big Bang. We know it has been expanding ever since and in fact is accelerating. The assumption being that we live in a finite Universe that has a beginning and has an end.

So what happens before the beginning and what happens after the end? In a multiverse of infinite universes, as one universe is born, another one dies out. And when one universe dies, another one is born. Potentially, with a Big Bang. In other words, space-time before the Big Bang can be considered to be its own separate universe. And space-time after our Universe stops inflating, the Big Crunch, contains a different universe altogether.

The idea of parallel universes follows this same scenario. Instead of one universe waiting for another universe to begin or end, there are actually multiple universes existing all at the same time. Even within our own Universe there may be pockets of inflation where some have stopped inflating and others, where inflation still continues to occur. Each of these pockets may be

considered to be separate universes. Some have even theorized that these other parallel universes are simply mirrors of our own Universe. One may contain the version of you that exists in our Universe. While at the same time, there are versions of you in all the other universes. Some where you look and act the same. Some where you are completely different.

We may even be living in a multiverse that has a different conception of dimensions. We, in our Universe, tend to think of things in terms of three dimensions. But these other universes may live outside of our three dimensional model. They may all be living in a fourth dimension, or more. A dimension we know nothing about. Think of it as the difference between what we see in three dimensions versus that same scene captured by a camera. The camera can only capture a two dimensional image. So what photographers have to try to do, is add depth to make it look like there is a third dimension. Same is true for painters, who have attempted to add perspective in their paintings since the 13th Century. But at least we know what a third dimension is supposed to look like.

The idea of extra dimensions goes back to Einstein, where space and time were considered to be two separate things. In other words, a three dimensional Universe was made up of width, height, and depth. By unifying space and time together as space-time, the need to describe dimensions in terms of three (width, height, and depth) went

away and was replaced with just space. Three dimensions of space. With the added dimension of time, we now had a four dimensional Universe.

What's extremely interesting about the multiverse is that each of these universes may be living under a completely different set of physical laws. The physics of one universe may not be the same physics of another. Space may be different. Gravity may be different. Our view of reality may be totally different, depending on which universe we are in.

But testing all these different theories is not for the faint of heart. If these other universes exist, they would be moving away from us at the speed of light. Each of them a self contained unit, like our own Universe, inflating, expanding and ever so greatly accelerating. In that case, we will never be able to travel to them. We will never be able to catch up with them. At some point in the far distant future, they may disappear altogether.

The idea of a multiverse is immense beyond all comprehension. Some may even say that it is truly bizarre. But we once thought it was totally bizarre to think that the Earth was not at the center of the solar system.

Chapter Fourteen

Our Place In The Universe

What is our place in this expanding Universe? How did we get here? Wither have we wandered? To find out, we need to start with a man named Darwin.

Charles Darwin was an English naturalist, who in 1831 embarked on a journey that led him to developing a theory to explain biological change. Prior to the time of Darwin, it was believed that species were created at the beginning of time and remained much the same throughout. Darwin's studies from all around the world led him to believe that there was actually variation in species and, furthermore, that they had all evolved from common ancestors. Instead of staying the same, species changed over time.

Species survived through what Darwin called Natural Selection, in which species that were successful at adapting to their environments survived and those that were not, did not reproduce and did not survive. In 1859 Darwin published his now famous book *On The Origin of Species by Means of Natural Selection*. It was not until after 1930

that it became widely supported that Natural Selection was the basic mechanism of evolution. Darwin has since been described as one of the most influential figures of our time.

Furthermore, Darwinian evolution and Natural Selection is the basis of our understanding of our own human origins. With the publication in 1871 of his book *The Descent of Man, and Selection in Relation to Sex*, Darwin successfully argued the application of evolutionary theory to human evolution. Human evolution describes an evolving process that leads to the emergence of modern humans. Through a process of tracing backwards from modern humans, through a list of last common ancestors, we can trace our heritage back to a time approximately 4.5 or more million years ago. A point where we start to distinguish ourselves and split off from, modern and extinct Great Apes.

An important part of our understanding of humans comes from the field of Anthropology, the study of human beings. Anthropology is made up of the sub-fields Physical, Cultural, Linguistics, and Archaeology. Although all play a role in understanding our human origins, it is Archaeology that we turn to when trying to piece together our human cultural and physical past. And it is to another, newer sub-field of Anthropology, Paleoanthropology, that we turn to for the scientific study of human evolution.

When we look at human evolution, we see that it has been a lengthy process comprising by some estimates, around 6 million years. It is a process that takes us all the way back to our apelike ancestors. We will be discussing each of our most common ancestors at length, but bear in mind that the farther back we go, the less of a record there is. New discoveries are happening on an ongoing basis and what we know now, will more than likely be revised later.

The process of evolution is one of gradual change that causes species to arise, adapt, and eventually become extinct. Only to arise again as something slightly different. All organisms originate through a gradual process of biological evolution. Evolution occurs when there is a change in the genetic material, or DNA, through the process of reproduction and mutation of genes. Nature, selecting for the most advantageous changes, leads to a survival of the fittest. It is important to note that evolution does not change individuals. Through the process of inheritance, it changes whole populations. And that is why the effects of evolution can only be seen over extremely long periods of time.

Why is Darwin so important to our discussion? Because he defined for us what to look for in our human origins. It is by looking at our past that we can find clues as to who we are and how we got here. Understanding human evolution relies on knowing and finding out who our previous ancestors were. Darwin showed us the process of how we

change. It is up to us to find the evidence of this change in the fossil record.

Darwin’s explanations of evolution through Natural Selection were biological in nature. But just as Darwin’s theories became the standard explanation for life on this planet, by extension, they reflect how we have approached our study of the Universe. We look back at the beginning of the Universe to find the way forward. Just as we look back at the last common ancestor to find out who we are. Humans have evolved. The Universe has inflated.

Chapter Fifteen

Becoming Bipedal

One of the earliest behaviors that defines us as human is becoming bipedal. In other words, the ability to walk upright on two legs. There are a number of theories purporting to explain the origins of bipedalism and we will discuss these. But becoming bipedal was an essential adaptation in human evolution. It gave our earliest ancestors an advantage. One that was driven by the selective advantage described by Darwin's Natural Selection.

We must make the point that there was no one single factor that originated bipedalism. It wasn't as if one day we just decided it was time to stand up. Although it could have played a part. As with most things in Nature, there were a combination of events that, when totaled up, led to its continuance as a beneficial trait.

One of the models that gained support early on for the advent of bipedalism has to do with the open savanna. As our earliest ancestors left the safety of the woodland

forests, they were forced to adapt to an open savanna for their livelihood. Walking on two feet would have been very beneficial in hunting and predator awareness. Being able to stand upright, allowed our ancestors to look out over the tall grasses. To be able to see far distances would have been extremely beneficial in spotting sources of food, let alone sources of danger.

The open savanna theory still has its supporters, but has fallen out of favor due to accumulating evidence that bipedalism was actually a characteristic much earlier on, when our ancestors were still tree dwelling. We will see an example of this later on when we discuss the Ardipithecines. There are some theorists willing to state that bipedalism actually evolved in the trees.

A second model that has been presented has more to do with the posture of our early ancestors in their regular feeding habits. If we look at the eating habits of our closest living ancestors, the great apes, we can see how their eating behaviors may have resembled the eating behaviors of our earliest ancestors. Chimpanzees can be seen reaching up and extending out to grab the fruit hanging from the trees. Orangutans are frequently seen using their hands to create a better sense of balance while navigating. So the thought is that what started out as simple changes in body posture for collecting food and navigating the branches of trees, evolved over time into the bipedal

walking posture that became so important in our evolutionary history.

A third model to be considered is one that uses the threat from predators as cause. As a defense strategy, our earliest ancestors realized that by making themselves look as big as possible, they became more threatening themselves. Thus, the threat from a predator was reduced. Equally so, the more noise you could make and the greater your body gyrations, there would be a reduction in threat. The bigger and badder you appeared, the less a predator would want to tangle with you. Once again though, this would not be a direct cause of bipedalism, but, rather, one that could be seen evolving over time.

To sum up this discussion of bipedalism, it is important to reiterate that there probably was no one cause of our earliest ancestors walking upright. All of the above models could be correct and all of them probably did work together to encourage this evolution to a walking upright behavior.

The importance of becoming bipedal is twofold. One, it freed our hands. It gave us the ability to collect and carry more food supplies. And as our species evolved it encouraged greater and greater use of our hands in not only gathering food, but in the development of tools and new ideas and ways of extending our hands into the world around us. Two, becoming bipedal led us out of the forest

canopy and onto the floor. Initially, these terrestrial visits were probably fairly innocent, more exploratory. Maybe, even more accidental, as swinging from branch to branch (brachiating), may have led to occasional falls to the ground. Long term adaptation to living on the ground brought us out of the forest and onto the savannas. A whole new world of exploration and innovation awaited.

As we became more terrestrial and not arboreal, bipedalism continued to evolve along the lines of our human ancestry. The great apes evolved over time with a greater reliance on an arboreal way of life and less emphasis on adapting bipedally. So, even though we see today a mixture of arboreal and bipedal behaviors, they have remained pretty limited to a treed environment.

Chapter Sixteen

The Domestication of Xe

Xe woke up again, back on Xeron. Being away for so long, Xe was quite groggy and disoriented. It took awhile before Xe was back, truly back. Xe had a lot to process. Being away for so long? It only seemed like, in the blink of an eye.

Xe had proven once again, that retracing the steps of another life form, in another universe, was not only plausible, but confirmed and verifiable. Executing the calculations that were posited, under the right conditions, allowed Xe to telepathically travel to a time and place, predetermined and surgically implanted into the brain of another being. More importantly, Xe showed for a second time, that the process could be reversed. Xe could be returned safely, with only a small bit of confusion, depending on the length of stay.

As a scientist, Xe was confident that others could reproduce the findings. Others would confirm what Xe already knew, that telepathically traveling to an alternate

universe was possible. That was the scientist in Xe. The non-scientist in Xe was not finished. Xe had been transfixed by not only the journey, but the exchange of life forms as well. Xe had been bitten by the bug. Kind of like the first time you stand and take a few steps. When you stand next to the warmth of a campfire. When you take that first bite of something that transforms your world of food.

Xe was not only a physicist. Xe had begun studies in the field of anthropology, cultural anthropology to be specific. One of the first things you learn in cultural anthropology is whenever you do field work, do not go native. In other words, in order to remain objective, one must be a participant observer. The goal of participant observation is to immerse yourself in the local environment as much as possible without becoming native yourself. Thereby losing your objectivity. Gain the trust of the culture or people you are working with and you will be treated to behavior unaffected by your presence. The research is live and the results are real.

Xe was bordering on going native. Xe was excited with playing the part of the native. Xe, for a short period of time (and we all know time is relative), was the native. Xe was ready for another trip. Not for the sake of science and physics. For the sake of Xe.

Xe was curious, no, obsessed, with what would come next for humans. What would follow the discovery and control of fire? The advancing technology of tool making? Xe, set in motion another plan to return to Earth.

This time, Xe was heading to a place on Earth called Turkey. Events were occurring there about 10,000 years ago, that, once again, would shape the course of human development forever. In one instance of time. In just the blink of an eye. Xe was on his way.

Inside of a round, dark, rectangular structure, Xeyuk is making her way up a latter to the top of the roof. As she reaches the top, the brightness of the sunlight temporarily blinds her vision. Causing her to stop and cover her eyes. Taking a moment to blink a few times, her eyes gradually adjust to the brightness of daylight. She heads out onto the roof with her stones and bag of seeds. Xeyuk finds it much easier to grind her grains on the top of her house. There's more room, better light, and it's just good to get out and smell the fresh air. This is the only way into and out of her house anyway.

Xeyuk starts with a handful of seeds, straw, and chaff, gathered from the cereal grain grown outside the settlement. Throwing a handful into the air, over and over again, helps to remove the straw and chaff from the mixture. She then takes the cleaned mixture and places it

onto a long, flat stone. Taking a smaller stone, she moves it back and forth over the seeds until a fine powder is created, which she then places in a container for later cooking down below. It can take a while to grind enough of the wheat for her uses, but it also gives her a reason to stay up top longer. When she is done, she heads back down the ladder to start the meal preparation that will include bread and the meat from their pigs.

The settlement has so many houses these days, they are packed very close together. The only way of getting around is by walking over the roof tops. The houses are built out of timber and mud. The mud is gathered from the nearby marshes, which is then made into bricks. The roofs are made out of wood and reeds, which are then plastered with the mud from the marshes.

Xeyuk and her extended family live in a house, very much like all the other houses. Access to the house is through the roof and then, down a latter to the inside of the house. Xeyuk is the matriarch of the family. Her two daughters, their partners, and their children, live with Xeyuk, totaling about ten people. Climbing down the ladder leads to a multi chambered room, where the family lives. The smaller of the chambers has an oven built into the plastered wall and an open hearth close by. The larger chamber contains raised platforms for sitting and sleeping. This is where the bulk of the daily activity of living, eating, and sleeping take place. The walls are decorated with

murals of revered birds and animals. There are plaster animal heads, mainly bulls, jutting out of the walls and reliefs that seem to have a very spiritual meaning and value.

The settlement Xeyuk lives in has begun to master the taming of plants and animals. Outside the settlement boundaries, they grow various types of plants, including emmer wheat, peas, lentils, and other cereals. They have also learned to tame animals, such as goats, sheep, and pigs. Occasionally, they will still gather wild plants and hunt wild animals to supplement their diet.

Today is a very special day for Xeyuk. It is the day of her birth. The family has planned a full day of festive activities and meals, ending with the storytelling that always accompanies the celebration of the mother. And the mother's mother. And, ultimately, the Mother Goddess.

After the final traces of the meal have been consumed, the storytelling phase begins. Xeyuk quietly walks over to one of the raised platforms, removes the matting material from the top and proceeds to open up the platform to reveal its contents. The children have seen this ritual before and have heard the stories many times over the years, but each time is special. Each time they learn about their past. Each time they listen.

They know that it is customary to place the bones of your ancestors beneath the sleeping platforms. There are even special platforms that contain the bones of your oldest ancestors. They understand that prior to placing the bones, the bodies are placed outside so that the vultures can deflesh the body. Finally, the skull is separated from the skeleton and buried under the sleeping platform, so that it can be removed at some point in the future for ceremonial purposes.

This is just what Xeyuk has done. She has removed the skull of the family's most ancient matriarch from its platform resting place. The family's Mother Goddess. It is she who will reveal the secrets of the past. The time before the plants were welcomed to our soil and the animals were tamed. The time when the Mother Goddess herself, was learning how to do such things.

Xeyuk holds the skull in her hands and raises it up for all to see. The rest of the family and the children watch, mesmerized, as its eyes start to light up with the glow from another universe. As if it is becoming alive. As if, they have just popped into existence. It is a light from the distant past. Xeyuk welcomes the Mother Goddess into her home on this very special occasion. The Mother Goddess begins to speak.

Chapter Seventeen

The Mother Goddess

My name is Xe. I am the mother of your mothers and all the mothers that came before. I am the one that taught all the plants and animals to be our friend. To trust that we would take care of them and, in return, they would take care of us. We have learned to honor their sacred existence, as we have learned to honor all of those who have come before us. That is why I, Xe, am the Mother Goddess. That is why we honor your mother, Xeyuk, today.

I come from a time, long, long ago, when there were not as many of us as there are now. We lived quite differently then. I was part of just a few families that lived together in small bands that never stayed in one place for very long. We followed the plants and animals, as this was our source of food. We watched their ways and learned to trust that this was the right thing to do.

We would run into other groups like us, every now and then. They too, would follow the run of the animals. The growth of the plants. We spent many a day, many a night,

talking with our new found friends about this special, almost sacred, relationship. We would camp together for days at a time and then, just as quickly as we had met, we would head our separate ways.

Over time we found our paths crossing more frequently. In the same place and around the same time of our nomadic cycle. We would share the same stories, over and over again. About the plants and animals, but also about our ancestors. As we did so, we found ourselves spending more and more time together. We created social relationships that, over time, developed into relationships of reverence and honor. We came together not just for companionship, but for honoring the spirits of our being. There was a reason for us to be together.

As we spent more of our time together living in close proximity, some of us became less and less nomadic. We lived in an area that was abundant with the foods we needed to survive. We didn't have to travel far to find wild cereal grasses, such as einkorn, wheat, rye, and barley. We were in the migration paths of wild animals, such as birds, bulls, boars, pigs, goats, sheep, foxes, and gazelles. We still needed to hunt and gather. We just didn't need to pull up our lives to do so.

The longer we stayed, the more permanent our housing became. We used the rocks around us to build small, oval,

stone structures. One house became a few houses, as a core group of us decided to become more settled. We built our houses to hold our families. We would bury the bones of the dead beneath the floors. It wasn't long before we started building a house to worship our ancestors. To worship the plants and animals we depended on, so that they would return and honor us with their presence.

A large circular structure served as the place where we would collectively, gather and talk about our lives. Our families. Our days looking for food. But we also found ourselves sharing our beliefs. How important it was to honor our ancestors and the other things we depended on daily. All of the houses of the settlement were built to surround this structure and it became the center of our social and spiritual existence.

The few of us who remained long term, built the ritual center as an extension of the small oval, stone structures we lived in. But of course, much larger. Inside, we assembled tall, stone pillars to represent our ancestors. All of our ancestors. Each pillar was to represent an ancestor's body, complete with arms, legs, and clothing, carefully carved into its surface. But each pillar had other things, delicately, carved into the stone that represented the plants and animals that were also worshiped. The thought seemed to be that by paying homage to them all, there was the hope that they would continue to come around. Continue to come back into our lives. Our community continued to grow

and more round spiritual centers were built, surrounded by the smaller, stone structures that housed those who had built them.

But there was always a part of the community that never settled down. They were the ones that continued to live their lives as nomadic hunters and gatherers of food. They would only stay for a short while and then, off they would go. Only to return when their cycles crossed paths with us again. To visit with friends. Talk about their lives. Bury a few bones.

Why did I, Xe, decide to stay here? I had my own beliefs as to the way things should be. I settled here in this village because I was tired of always moving around. Here there were other people, like myself, who enjoyed having others around with which to socialize. People who were not relatives, that shared stories, shared their experiences and shared some of their deepest held beliefs about their relationship to the unknown. An unknown that was common to us all. An unknown that became more comforting knowing that others shared that same feeling.

That is why I helped build our spiritual center. Collectively, we could meet in the center of our community, share food, and talk about our lives. This was a place where we could worship our ancestors and the other important things in our lives. Like the birds, bulls, boars,

pigs, goats, sheep, foxes, and gazelles. The cereal grasses of einkorn, wheat, rye, and barley. The foods that I was so thankful for.

Living in a settled village was not easy. It was totally dependent on somehow providing a stable source of food to sustain ourselves. Although the area we lived in was abundant with life for food, hunting and gathering could only sustain a certain number of people. I knew that at some point in the future, the food would run out. There would be no more food. We would have to move out. Move on. I didn’t want to do that.

I began to look for ways to provide for our future. What could we do to encourage the plants and animals to always be here? What did they need from us to make that possible? This is how I became your Mother Goddess.

Chapter Eighteen

Taming the Plants

Everyday I and the other mothers and children, would walk down the same path to gather the cereal plants that we needed to feed our families. At certain times in our cycle, and in certain locations, we would find some of our foodstuffs were ready to be harvested and some were not. Sometimes, the plants were too small or they were not fully developed. There were no flowers. There were no seeds yet. Sometimes, they were not even there at all. But then, they would start to reappear again and the cycle of growth would occur again. Yes, the cycle of growth would occur again.

As I thought about this, it appeared they had a cycle of growth just like we did. We are born, we grow old, and then we die. But, we don't just go away. We are remembered. We are honored. We are worshiped. We become ancestors. The same is true for the plants. They are born from the soil, they grow until old, and then they die. But how are they remembered? What encourages them to come back?

If not them, then it could be us. We must remember them. We must honor and worship them. We must do so, as we remember our own ancestors. That is why we include them in our spiritual center. They are as important to us as our own ancestors. We want them to come back. We want them to live on, forever.

I also understand though that there is another side to the story. As much as we may worship them, something else had to happen for them to have come into existence in the first place. We have not always worshiped them. Yet, they were obviously here before us. What is it that caused them to exist in the first place?

If they are truly like us, then I thought, they must begin as we begin. With a seed. A seed that is planted and continues to grow, as long as it is nourished and supported. It is the seed that is key. The seed that we consume is one and the same as the seed that begins us all. And just as there is a spiritual side to us all that we must satisfy, there is a secular side of us that must be nourished and supported. So my conclusion was there were three things needed in order for us to have a reliable source of plants. Seeds, support, and the spiritual relationship that surrounds us all.

Day after day we travel the same path to the grasses. Back and forth we trudge, carrying sacks of grain and

seeds. As I looked down along the path on our way back home one day, I started to see little sprouts of wheat starting to make their way to the surface. Seeds that were, undoubtedly, dropped by us at some point in the past, as we made our way back to the village. Nourished by the rains, the seeds were sprouting. They were sprouting somewhere else then we normally see them.

All this makes me wonder what would happen if we intentionally planted the seeds closer to our village? Would they not, in fact, also grow? Of course we would have to nourish them. Water them, if needed. Take care of them, as if they were our own children. Honor them in our center of worship. Assuredly they would grow as our children grow. They could be depended on to provide for us. As long as we treated them with the respect they deserve.

So that is what we did. We started small, with just a few plants. Some of the einkorn and the barley. We planted some of the seeds we had gathered. We supported them with the food and water that all of life requires. They grew and, they grew and they were harvested. The next cycle, we did the same. But with even more plants. We were soon coming to the realization that we did, in fact, have a dependable source of food that could be relied on to come back, cycle after cycle. We were not going anywhere. We would be able to stay put.

Chapter Nineteen

Taming the Animals

Much of what we learned about the plants was applied to the animals as well. Hunting was, primarily, the responsibility of the men and young boys of age. It was for me to supply the guidance. It was for them to be guided by it.

Animals, such as boars, pigs, goats, and sheep are not plants. They do not just sprout out of the ground. But just like plants and humans, once they are born, they must be nourished and supported until they can fend for themselves. The animals needed to be observed. What was their cycle of life?

Before a hunt the animals were always scouted. They needed to decide which ones to kill and which ones to leave alone. Which ones were still needed to keep the herd alive. The men had a preference for not hunting the young or the females. They understood that it was the female that created new life. Added more to the herd. It was the young that would make the herd ever larger. The older, more

mature, males were fair game. They, for all the right reasons, had served their purpose. They had started the seed of the females.

The men knew that to apply the lessons learned from the women and their plants, they needed to be able to provide the support and nourishment of the animals. It was the herd that cared for and provided for its protection. What is it that the animals needed in order for them to supplant that support with the support of humans? In other words, what would make a goat want to stay around us and not want to run away?

I knew that we already had an example of just how to do this. Since our village was formed, since we settled down, there were wild dogs that found it easier and easier to find food and support from the waste and extras we left behind. Over time, they became less skittish. More willing to venture into the village and accept handouts. The longer they would stay, the more we would reward them, with more food, grooming, and respect. They would stay by our sides, providing comfort and, in some cases, protection. They would even help out on the hunts, by flushing out other animals and herding the sheep and goats. They became a part of our history, our legend. Our lore.

This then, was to be our model. The men observed more of what the animals they hunted were eating. They

needed to find something that would help the animals trust them. Knowing that, they would be able to make offerings of food that might entice the animals to come close. Come in their direction. To be directed to a certain place. A place that would have more of the food they needed. The support they required to be settled. Just like us. But you can not just plant a single seed. You need to have more than just one animal. An animal by itself will just die.

What you need are enough animals to recreate the herd that the hunters saw in the wild. You needed a male and a female to start everything off. But why start there? Why not try to start with the whole herd? Moving the whole herd to a more controlled location where they are provided with food and water, would make a lot more sense. Create a house for them to live in and they will come. With a little bribing.

Oh. Let us not forget to honor and revere their spirits. Just as we do our own. Because they are us. They are to be inscribed on the pillars of our ancestors and the ancestors to come. Worshiped, in the ritual center of our community. They are to be welcomed to come in, look around, and stay for a very long time.

And so, the experiment began. At first, we would take handfuls of the grasses they enjoy and slowly, very slowly, offer it to the sheep. As they gained our trust, they would

take the offering and linger for awhile as they chewed. Soon, others would gather and they too, would take handfuls of grass. It wasn't long before we were surrounded by the sheep, waiting for us to feed them.

We did this for a number of days, until one day we decided to move ourselves as we fed the herd. As we moved in one direction, they would follow. As we moved in the opposite direction, they would follow. As we moved ourselves ever so much closer to the village, they would still follow. Once we reached the village, we moved them in the direction of some small pens we had created to contain the sheep. The dogs helped in herding the animals into the pens. Just as the sheep were rewarded for their efforts, the dogs were promptly rewarded as well.

As long as we attended to their needs, as long as we fed and watered them, the sheep were content to stay within the confines of their pen. The mothers took care of their young. The young grew older. The cycle continued. They became quite the stable source of milk and meat, as long as we were able to keep the proper balance of those living and those dying.

We were able to adopt the same process for taming the pigs and goats. The wild boars, on the other hand, were much more difficult. We were never really able to control their behavior. Or to put it another way, they were never

willing to be controlled by us. All in all, we were quite successful with the taming of animals, such that, we were reliably supplied with their meat and byproducts for quite the foreseeable future.

When I look back at everything that was accomplished, I am comforted to know that for all my children to come, there will be a place to call home. There will be plenty of food to go around. There will be room to grow and thrive. But my children, we must never forget how we got here. We must never forget who got us here, today.

Continue to honor and revere the ancestors of your past. Continue to respect all of what life brings you. Encourage the land to support you with her bounty. Summon the spirits of those to whom you owe allegiance and keep them forever by your side. Continue to summon me, your Mother Goddess, to remind you of who you are and what you may some day become.

With that, the light from Xe's eyes slowly faded away. Her voice trailed away. Became just a memory, in a room full of her children who didn't want to let her go. Who couldn't let her go. Who would never let her go.

As their eyes began to adjust to the gathering darkness, Xeyuk slowly lowered Xe's skull and, reverently, placed it

back beneath the platform. Back to the darkness of another universe, far, far away.

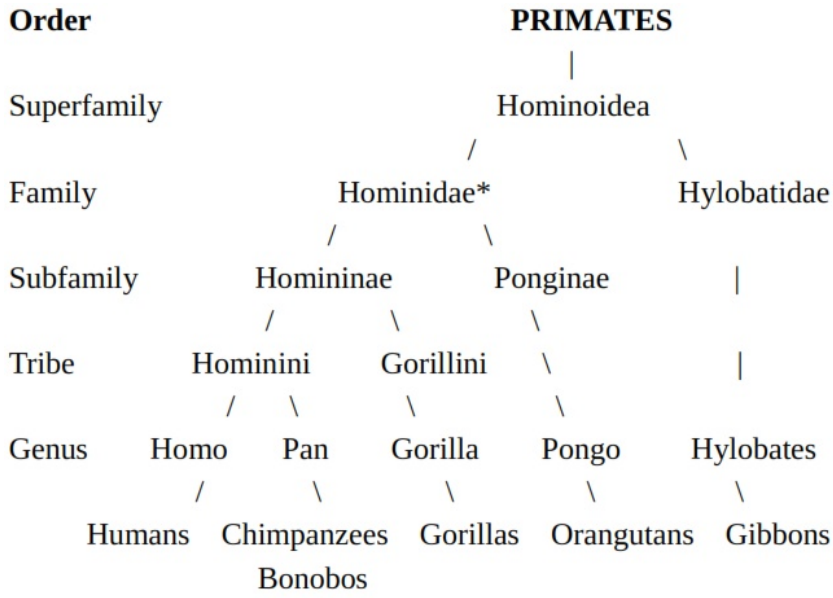
Chapter Twenty

Our Primate Family

First and foremost, humans are primates. Homo sapiens is the primate species, of genus Homo, of which modern humans are classified. We have another close relative of primate in the great apes (including chimpanzees, bonobos, gorillas, and orangutans), in both Africa and Asia. We share a common ancestor that goes back 8 to 6 million years ago. We first evolved in Africa and much of our past remains rooted in Africa. As our focus is on humans, we won't cover the great apes, although we understand how important they are to our own ancestry.

Biologists group living organisms according to a process. Referred to as a taxonomy, this process groups biological organisms according to shared characteristics. The biological classification of primates is presented here, in order to better understand the relationships presented further on. The genus Homo includes the species sapiens, as well as its subspecies sapiens sapiens. You will see them both as Homo sapiens and Homo sapiens sapiens, respectively.

Primates Table



* Includes all humans and great apes

Now, let's trace the path of our human ancestors. We won't cover them all, but will look at what are believed to be the most important. We can look at the chapters that follow as a tree with branches. Evolution is a process of branching. But it does not mean that there is always a clear linear process involved as we move from branch to branch. We prefer to think of it more like a bush. A bush made up of many branches. Although fossil evidence may indicate

transitional characteristics between different groupings, they are not transitional in the sense that a direct link is implied. Very early on in our discussion of evolution we discussed how it does not change individuals. Instead, it changes populations. It's at the population level that we see the effects of evolution. Even then, it is over a long period of time. The same holds true here. Branches of our ancestral groups came into being and went out of being. They may have lived in the same time period or they may have not. They may have even lived in the same place at the same time. But in doing so, they contributed to the biological and behavioral characteristics of the branches that followed.

In some cases we have a very limited number of fossils that have been found. It only makes sense that the further back we go, the less evidence remains for us to find of our ancestors. But whether just a few bones or a few thousand, we are still able to draw conclusions about what they looked like, how they acted, and how they adapted to the varying environments in which they lived.

We will start with the oldest evidence we have in the story of human evolution. Looking way back, we have the Universe beginning at 13.8 billion years ago. We have our Sun forming 4.5 billion years ago. Our solar system and Earth also form around 4.5 billion years ago. Life begins on Earth between 4.3 and 3.7 billion years ago. Finally, our human story begins about 6 million years ago when we find

evidence of what is considered to be, our earliest human ancestors.

Chapter Twenty One

Ardipithecus

5.8 and 4.4 million years ago

Ardipithecus is a genus of an extinct Hominidae (all humans and greater apes) that can be described as one of our earliest ancestors after we diverged from the main ape lineage. They lived between 5.8 and 4.4 million years ago in the area of Eastern Africa. Ardipithecus consists of two different species, kadabba (between 5.8 and 5.2 million years ago) and ramidus (about 4.4 million years ago).

Ardipithecus kadabba

Ardipithecus kadabba fossils were first discovered in Ethiopia in 1997. Examining the many bone fragments that were found, led to the conclusion that kadabba appeared to have the ability to walk upright. Kadabba was about the size of a modern chimpanzee, lived in a wooded area and was surrounded by a lot of grass and fresh water. Their diet is thought to have consisted mainly of nuts, due to the evidence of broad back teeth. Eating nuts instead of fruits,

would have led to these back teeth being the primary chewing area.

Ardipithecus ramidus

In 1994 evidence of Ardipithecus ramidus was found, although it was not until much later that a complete analysis was finished. It is in ramidus that we seem to find the greatest possibility of a human-African ape ancestor that was not chimpanzee.

In 2009, scientists announced the discovery of a partial skeleton they nicknamed “Ardi”. Ardi was found in association with faunal remains, indicating that she lived in a wooded environment similar to kadabba. Her big toe splays out from her foot like an ape’s. This allowed her greater ability to grasp tree limbs as she searched for food and possibly escaped from predators. But the foot bones also indicate a rigid foot that was presumably passed down from earlier ancestors. Combined with her other toes, this bone would also have helped Ardi walk bipedally on the ground. The upper pelvis had a flare that could allow her to walk without the lurching from side to side that we see today in chimpanzees. The lower pelvis could accommodate huge hind limb muscles used in climbing. Thus, supporting the finding that Ardi was a biped on the ground, but a quadruped in the trees.

Ardi weighed approximately 110 pounds and stood about four feet tall. Through the sampling of other bones from other individuals, males were found to be of a similar size and weight. Overall, researchers found more than 125 pieces of the skeleton, including much of the feet and all of the hands. Sampling of canine teeth from other individuals show that there was very little difference in size between males and females, agreeing with the size and weight evidence. The most interesting part about ramidus is the difference in diet between ramidus and kadabba, as seen in the wear and tear of the teeth. Ramidus was more likely an omnivore, eating a variety of food sources such as fruits, leaves, and even meat. But the evidence does not show any reliance on eating nuts, as in the case of kadabba.

So what else do we know, or at least can infer, about Ardipithecus ramidus, based on the fossil evidence that has been uncovered? There were some six thousand other animal fossils found in association with the findings of Ardi. She lived in a moist woodland that may have had adjoining savanna type grasslands. There were antelope and other types of monkey species, as well as forest dwelling birds and seeds from fig and palm trees. Wear patterns on the teeth indicated a diet of fruits and other types of forest foods, although, again, based on the wear patterns of the teeth, no real evidence of a reliance on nuts.

The assumed bipedal behavior of Ardipithecus is possibly, the earliest form of this behavior that has been

discovered. That bipedal behavior may be associated with their overall sexual behavior. Almost all apes and monkeys tend to have long upper canine teeth, associated with fighting and the attraction of females for mating. The canines of Ardipithecus were very reduced in size and males and females were of approximately the same size as well. This leads to the conclusion that, instead of fighting for access to females, they, instead chose females and their offspring. This, in an attempt to gain sexual access. Thus, being bipedal and having free hands, would allow Ardipithecus the opportunity to carry larger amounts of food and result in a greater attraction to more females.

The evidence of the teeth, size and weight can also lead to some other conclusions. In addition to reduced male-to-male conflict, there may have also been increased pair bonding and investment in more of a family like structure. This is all conjecture at this point, but the importance of Ardipithecus and, specifically Ardipithecus ramidus, cannot be overstated.

There are two other members of the Ardipithecus group, even though they are considered to be of another genus. One, is Orrorin tugenesis (6.2 and 5.8 million years ago) and the other is Sahelanthropus tchadensis (6 and 7 million years ago). These are both much older than ramidus and kadabba and also appear to be bipedal. But there simply is not much other evidence found. Even so, there

are some that believe Sahelanthropus tchadensis to be our earliest possible human ancestor.

Chapter Twenty Two

Australopithecus

4.2 and 1.9 million years ago

Australopithecus is the best evidence we have of a continuation from the adaptations of Ardipithecus. Although there are many species of Australopithecus, the Australopithecines are generally divided into two different types. The gracile species (of slender build) and the robust species (strong and muscular). The genus of Australopithecus is generally comprised of five gracile species, although we will not be discussing them all. The genus of Paranthropus is comprised of three robust species.

The five species of the genus Australopithecus are hard to define as a group. Each has their own special characteristics. Each has some characteristics that they share with each other. For our purposes here, we will generalize those characteristics to the group as a whole. They consist of **Australopithecus anamensis** (4.2 and 3.9 million years ago), **Australopithecus afarensis** (3.85 and 2.95 million years ago), **Australopithecus africanus** (3.3

and 2.1 million years ago), **Australopithecus garhi** (2.5 million years ago) and **Australopithecus sediba** (1.98 and 1.97 million years ago).

Australopithecines tend to be found in two general areas of Africa. Eastern Africa (Kenya, Ethiopia, and Tanzania) and Southern Africa (South Africa). They have largely been found in what were once, forests and woodlands in close proximity to lakes and streams.

The fossil evidence suggests that Australopithecus had a number of traits in common to both humans and apes. Their leg and foot bones indicate they were bipedal, but their forearms and wrists indicate that they were capable of climbing trees as well. This again, provides further evidence that our ancestors did not become bipedal in open savannas, but instead, developed this ability while still somewhat living in an arboreal environment. Over time, Australopithecus became more reliant on walking on two feet and less so on living in the trees.

Australopithecus had very strong jaws and teeth with thickened enamel, indicating their tolerance for tough foods such as nuts. Heavily enameled teeth is a characteristic of all our later, human ancestors. They had small canine teeth (both male and female), as in their earlier ancestors.

They tended to subsist on soft, plant type foods, although, during rough times they probably relied on hard foods such as nuts. Typically, their diet was probably very similar to modern chimpanzees, consisting of fruit, plants, nuts, seeds, roots, insects, and eggs. Australopithecines may have eaten meat, but they should not be looked at as the hunters of meat. In most cases, meat was probably scavenged from the kill of other predators. In other words, their diet was not largely meat based.

Cranial capacity ranged from 350 cubic centimeters to 600 cubic centimeters (if you include Paranthropus). The general trend is for cranial capacity to increase as human evolution has progressed toward Homo. The overall cranial capacity should only be considered with respect to overall body mass. It should not be used to support cognitive ability.

The evidence indicates that at least some Australopithecines (including Paranthropus) may have used bone tools and possibly, stone tools. Some evidence can be dated back to at least 2.6 million years ago.

The males are larger and heavier than the females, suggesting a degree of sexual dimorphism. Generally, the higher the degree of sexual dimorphism, the higher the incidence of male-male competition. If you compare the relationship of sexual dimorphism and social behavior of

modern great apes, it would indicate that Australopithecus most likely lived in small family groups with a single dominant male and numerous breeding females. A reduction in the size of the canines could also be used as an argument that Australopithecus afarensis was monogamous. Sexual dimorphism is evidenced in females through an examination of the lumbar spine and bipedalism. Females began an adaptation to bear more of a load on the lumbar column during pregnancy. Non-bipedal primates do not need this adaptation.

The three species of the genus Paranthropus share a lot of their characteristics. In order of their appearance they are **Paranthropus aethiopicus** (2.5 million years ago), **Paranthropus boisei** (2.0 and 1.4 million years ago) and **Paranthropus robustus** (2.0 and 1.4 million years ago).

They all had specialized skull adaptations that allowed for heavy chewing. They had a large sagittal crest on the top of the skull for attaching the huge chewing muscles. Although, some argue the sagittal crest also served as a sexual signaling. They had a strongly protruding face, very large teeth with thick dental enamel, and a very powerful jaw.

It is possible that we start to see the use of bone tools. Presumably, these bone tools could have been used by Paranthropus robustus to dig into termite mounds. There

may also be other evidence of stone tool use, but their evidence is found in association with stratigraphic layers also occupied by later Homo species. So it is not clear who made the stone tools, Paranthropus or Homo.

Chapter Twenty Three

Homo

2.4 million years ago to present

The genus Homo includes the species sapiens and subspecies sapiens (Homo sapiens sapiens), which in turn, comprises all of who we know as modern humans today. But just like with our earlier ancestors, Homo also includes a number of species that are now extinct. Extinct, but have evolved into what we see today as Homo sapiens sapiens.

It is with the earliest species of Homo and the later species of Australopithecus that we start to see our ancestry in the shape of a true bush and not the linear nature of a tree. The more evidence we have, the more single branches spread out. Multiple species were living together, interbreeding, and exchanging genes. The more fossils we find, the more we realize that there were multiple attempts at adaptation occurring. Each one a contributing factor. No single one, a direct link to modern Homo sapiens.

The species of Homo, extinct and not, consist of **Homo habilis** (2.4 and 1.4 million years ago), **Homo rudolfensis** (1.9 and 1.8 million years ago), **Homo erectus** (1.89 million and 143,000 years ago), **Homo heidelbergensis** (700,000 and 200,000 years ago), **Homo neanderthalensis** (400,000 and 40,000 years ago), **Homo naledi** (335,000 and 236,000 years ago), **Homo floresiensis** (100,000 and 50,000 years ago) and, finally, **Homo sapiens** (200,000 to present).

Homo is believed to have been derived from Australopithecus and the first species of Homo we see comes with the appearance of Homo habilis. Homo habilis was fairly short, had long arms, and a less protruding face than their predecessor Australopithecines. They were found in Eastern and Southern Africa. The cranial capacity was slightly larger than Australopithecus, but quite a bit smaller than modern humans.

It is with Homo habilis that we see our first concrete evidence of tool use, specifically stone flakes for butchering animals. Their diet was particularly generalized and omnivorous in nature. Instead of being hunters, they scavenged for food and were more often than not, the meals of predators. Habilis also preferred walking on two feet and so was almost, fully bipedal. Although, foot evidence suggests there still was the ability for climbing trees. Homo habilis is seen as the forebearer of our next,

more modern looking ancestor Homo erectus, with whom they may have coexisted.

Homo erectus is known as “upright man”. He is special in that he provides us with the first evidence we have of an ancestor having a similar body size to modern humans and spanning a large geographic area. Limb and torso proportions were like those we see in modern humans. These are the kind of adaptations we see related to living on the ground. Presumably, at this stage, they have lost their earlier tree climbing abilities and are living in open grasslands.

They lived in numerous geographic areas of the world, including Northern, Eastern and Southern Africa, Spain, China, and Indonesia. Their complex use of stone tools has advanced to the point of handaxes and cleavers. In other words, they were using large cutting devices. A major innovation of stone tool use and behavior. Their use of stone tools became a factor in their diet, in that there was an increased reliance on eating meat and other high protein foods such as honey. This made it possible to absorb nutrients more quickly, making energy available faster. This in turn, helped to meet the increased energy demands of taller bodies and larger brains.

Homo erectus also provides us with the first direct evidence of our human ancestors creating and using fire.

Hearths have been discovered that were obviously used for cooking and sharing food. Cooking meat allowed for easier chewing and digestion. This in turn, would lead to a significant increase in meat consumption and calorie intake, helping to meet their increased energy demands. Hearths and campfires also served as a common place for social interaction. A common place to share a meal, share the warmth, and protect the group from predators.

How do we know that Homo erectus built fires? The evidence indicates that the ashes detected and in some cases bones, were burned at a certain temperature. Grass or wildfires (perhaps started by lightening), burn at a lower temperature that campfires. Campfires burn at a higher temperature which is more consistent with hearths and cooking food. And that is what we find.

Homo neanderthalensis follows erectus in our ancestral story. Yes, there are other species identified that we haven't talked about, but these are the main characters. There is quite a bit of debate as to whether Homo neanderthalensis is even a separate species. Some scientists view neanderthalensis as a subspecies to Homo sapiens. Regardless, there are some interesting observations that need to be discussed.

Homo neanderthalensis is believed to have originated in Africa, but migrated out of Africa to Eurasia before Homo

sapiens made that journey. Neanderthals lived mainly in cold climates, which helps to explain their physical appearance. They were short and stocky, with thick, heavy bones that were well adapted to the climate they lived in. As a result, they were probably extremely strong individuals, living in what we now refer to as the “Ice Age”. They often took up residence in limestone caves to escape the extreme cold and, as such, are often called “cave men”. They are known to have worn fitted clothing and slept between blankets of mammoth skins. Obviously, hunting very large animals. They utilized fire for cooking, warmth, and socializing. But they also learned how to dry and store meat. This added to their ability to live in the harsh conditions in which they were placed.

Neanderthals lived in nuclear families and evidence indicates that they took care of those who were not able to take care of themselves. A reverence for others as well as those who had died. It is well accepted that they buried their dead. There is no real evidence that they buried their dead along with gifts though. That would imply burial in terms of a more spiritual nature. The stone tools they made were advanced beyond earlier technologies and included blades and scrapers made from stone flakes. Their advancements came in the refinement of bone and antler tools. Evidence exists that they attached stone tips to wooden shafts to form spears for hunting mammoth, for example. Finally, neanderthals were primarily carnivorous.

The really interesting thing about Homo neanderthalensis is that they were contemporaneous at times with Homo erectus and Homo sapiens (who we will talk about next). The suggestions are that neanderthalensis freely interbred with erectus and sapiens. Modern genetics has shown that as Homo sapiens migrated their way out of Africa (where they originated) and into the areas of Eurasia occupied by neanderthals, there was frequent interbreeding going on. Furthermore, through computer simulations to kind of reverse-engineer human DNA, it can be shown that Homo sapiens interbred with other Homo species living in Africa contemporaneously. Thus, conclusions can be drawn that Homo neanderthalensis gene pools mixed into the gene pools that eventually became dominant in Homo sapiens.

The only surviving species of Homo is sapiens. Around 200,000 years ago they were living contemporaneously with neanderthalensis and more than likely evolved from Homo heidelbergensis. Living primarily in Eastern Africa, by 100,000 years ago they had expanded into Southwest Asia and were heading out of Africa by about 60,000 years ago. The one thing to keep in mind is that as they migrated to other regions, they probably interbred with other similar species of Homo along the way. As we have already seen with neanderthalensis. Thus, we continue to see more of a mixing of the gene pool versus a replacement, as some have suggested. Homo sapiens have, typically, a lighter skeletal build and larger brains, averaging around 1300 cubic centimeters with some variance between the sexes.

As Homo sapiens migrated, they hunted and gathered on their way. Venturing out of Africa about 100,000 years ago, they eventually made their way to Asia around 60,000 years ago. A large part of the day was spent gathering plants, hunting, and scavenging for food. There does not appear to be just one mass migration out of Africa. It is presumed that climate change may have been a leading cause. About every 20,000 years or so the climate changed so much that multiple migrations out of Africa occurred. The numerous warm and wet periods over the last 100,000 years created lush environments that attracted both mammals and hunters and gatherers.

Around 10,000 years ago Homo sapiens began producing their own food. They found that they could control certain animal and plant populations. It wasn't long before Homo sapiens acquired further control of their environment through farming and the herding of animals. The domestication of both plants and animals led to more settled populations, larger in size and greater in scope. In turn, this led to increased sophistication of tool use, advancements in technologies, and the creation of vast social networks. It is about this time that Homo sapiens created a turning point in their life on Earth. A turning point that has resulted in Homo sapiens now occupying virtually every continent on the planet. For better or worse.

This brings us to the end of our discussion of human ancestors. What are the important events to note? Well, one has to do with where humans find their origins. That seems to be Africa. Another has to do with becoming bipedal. Learning to walk upright, on two feet, brought us out of the trees and onto the open grasslands. Wide open, new frontiers to be explored. Next, we have the control of fire. With the harnessing of fire, we were able to improve our diet, provide greater protection from predators, live in more environments with a wider range of temperatures, and enhance our abilities as social animals. We learned how to control our food supply, through the domestication of plants and animals. Thus, allowing us to increase our range and further enhance our social nature. We migrated out of Africa. When Homo sapiens left their homeland to colonize the rest of the world, it brought us to a position of dominance that has never been relinquished. It also brought to extinction our other Homo species, our cousins so to speak, such as neanderthal and erectus.

Arguably, one of the most important events in human history has to do with our ability to create and use tools. It's not that humans are the only animals that create and use tools. We see this kind of behavior in our closest living relatives, the chimpanzees. It's the complexity and the competitive advantage that tool use has afforded us. Ever since we freed our hands by walking upright, on two feet, we have freed our minds of what to do with this new found freedom.

Human history can be said to be divided into generally three ages. Dividing human history into an organized system of events was mainly used by historians and anthropologists as a way to classify artifacts according to the material of which they were made. Interestingly enough, the idea came from noticing the position of artifacts found in archaeological sites. The deepest layers always contained stone tools. Bronze tools seemed to always be found on top of the deepest layers. Iron made artifacts were found closest to the surface. This classification of human history based on tool use works quite well when considering human development in Europe. But, not so well outside of Europe. Still, it is widely used today to organize human history according to the development of tools and their associated materials.

Starting long ago, over 2 million years ago and lasting until around 3,000 years ago, is the Stone Age. During this period, we see the production of stone implements. Over this period, we see increasing complexity, not only in the tools themselves, but in the techniques used to produce them. The Bronze Age is next, lasting until about 1,000 years ago. This is followed by the Iron Age, that continues to the present. These two ages represent the change in tool production from stone to metal. By mixing together various metals, such as copper and tin, a new type of tool was created that made stone tool technology obsolete.

But there are others that believe there are more than three. There is a fourth age, called the Industrial Age. It describes how we manufacture things. The Industrial Revolution describes the transition from creating things by hand, to those created by machine. Then there is a fifth age, the one we are currently in, called the Information Age. This age describes the shift from an economy based on industry to an economy based on information computerization.

It is in the age of computerization that we find all of humanity's hopes and desires placed. It is during this age that we become further dependent on computers and robots to supplement the activities of humans. In some cases, even replacing those activities of humans. Will it bring us to the start of a new age of discovery? Are we witnessing the advent of a new evolutionary step? Or will it lead to our total destruction and the end of Homo sapiens sapiens. Only time will tell.

Homo sapiens has been in its evolutionary process of adaptation for around 200,000 years now. Certainly, these are just round numbers and we can easily see this number rise closer to over 300,000 years ago or more, as we continue to find older and older evidence of our existence. Over this period of time we have seen the rapid expansion of our species, geographically, socially, and technically. You could almost say that we experienced our own Big Bang moment. Followed by a period of inflation that

continues to this day. Just like that moment 380,000 years after the Big Bang, when suddenly, all became clear and light shown through.

Homo Extinct Ancestors Table

What does the view look like from here? What do we see as the relationship between our extinct ancestors? Although, there are a few representations out there, this one will do.

YEARS AGO	GENUS/SPECIES
5 million	Ardipithecus ramidus
4 million	|__Australopithecus anamensis
	|__Australopithecus afarensis
	|__Australopithecus africanus
	|__Australopithecus garhi
	|__Australopithecus sediba
2 million	|
	|__Paranthropus aethiopicus
	| |__Paranthropus boisei
	| |
	| |__Paranthropus robustus
	|__Homo (modern humans)
present	|__sapiens sapiens

Chapter Twenty Four

Finding Xe

Xe is finding it harder and harder to adjust to the return trips from Earth. Xe is not sure anymore if it is the length of the stay that is causing the fogginess and the confusion upon the return. It's kind of like the feeling of being milk drunk after being breast fed. You are so fulfilled, so complete, that for a short period of time nothing else matters. It just is.

Xe has become completely obsessed with the humans on Earth. After all, Xe has been a participant in their development for 4 million years now. Through all their steps forward, Xe has been there at their side. A small step for Xe, but a huge step for humankind. Steps should not be taken for granted. Stepping forward is the direction that all forms take. Xe is no exception.

Xerellians know that the beginning of their universe set in motion a forward progress that continues to this day. All things are in a state of expansion. All things continue to inflate. Until one can inflate no more. This is a universal

concept of The Laws of Everything. Universes inflate. Universes stop inflating. Stars burn brightly, until they burn themselves out and, well, just explode. Even Xerellians inflate. Xe, included.

The Laws of Everything remind us though that when something ends, something begins anew. When a star explodes, it creates new stars, new planets, and new energy. When a universe stops inflating, it collapses into a hole where nothing escapes. Nothing can be seen. Nothing is there. Except, as all Xerellians know, nothing is something. Out of nothing comes something. Always.

Xe has been told that the cause of the fogginess and confusion is not a result of travel. Rather, it is a result of Xe's inflation. Xe is like all things and like all things described in The Laws of Everything, all inflate. Until they can inflate no more. Xe is reaching the point of inflation ending. Xe's inflation ending. On Xeron.

Xe sits alone in the laboratory where it all began and listens. Listens to the sounds of silence. The nothingness all around. The something that can be. Xe's theory and experimentation has proven that telepathic time travel to another time and place, to another being, is real. Popping into existence, even for a short period of time, can be controlled. Harnessed. To return, simply end the connection. Death of the destination, signals the particle's

pop out of existence. Out of there. Out of Africa. Out of Turkey. Back to Xeron.

Xe’s condition worsens. During the final moments, fading in and out of consciousness, Xe reflects on what may happen next. What will popping out of Xeron mean? Where will Xe pop into? Does the end here on Xeron really mean starting over somewhere else? Some other universe? Does it work this way? All of Xe’s experiments say it does. The Laws of Everything agree.

Chapter Twenty Five

Xe's Final Resting Place

As Xe's eyes open there is a cool, moist rush of air into her nostrils. After a couple of blinks to clear the sleep and presumably the cobwebs, Xe is aware of herself lying on her back on a grassy knoll staring up into a bright blue sky. Xe has arrived. Just where she has arrived, she is not sure.

Xe has an acute awareness of where she has been. What she once was. An eerie understanding of before. This transformation has been different than the others. In the others, Xe arrives as a guest of the host. There, but just riding along. This time Xe feels that she is the host. Not just riding along, but doing the driving. It's a bit disorienting, almost frightening.

Suddenly, she has this driven desire to find out where she is and what she is doing here. Dragging herself up off the ground and up on her two feet, Xe makes her way across the grassy knoll towards a group of buildings that look familiar. Almost as if the buildings were drawing her in.

A group of buildings that she hopes, will give her the clues she needs to answer the many questions that she has.

As she enters the building, she looks around to see a flight of stairs that seem to welcome her and encourage her to climb. Making her way up the stairs, she enters a long hallway that leads to a number of doors on alternate sides. Each one is different. A different color. A uniqueness. Xe stops at each one to get the feel. To get a sense. To read the information on the door. As she reaches the fourth door on the left, she reads the word “Xe”, written on a label and taped to the front. She turns the handle, opens the door and squeamishly peeks in, before taking her first step inside.

Off in the corner, to the left, is a bed. Nice, but simple. The covers have been thrown back. The pillow shoved in the corner. Directly ahead sits a desk, with a wooden chair partially parked underneath. On the desk is a computer and keyboard, the kind Xe has experience using, but a long time ago. The computer is logged into some network of information that Xe is sure will be helpful in finding her way. The top of the desk is covered with papers scribbled with notes and drawings that look familiar and comforting. Above the desk is a window that looks out to the grassy knoll, where she had been resting. Where she woke up. On the opposite wall is a bookshelf, full of numerous books. Books about science, physics, astronomy, and anthropology. Subjects of which Xe, already, has intimate knowledge.

Xe slowly walks up to the chair in front of the computer and sits herself down. On the monitor, the first thing she sees is a date and time, prominently displayed at the bottom. Accordingly, it places Xe in the year 2000. Placing her hand on the keyboard, she searches with her fingers until she finds a GPS application to identify where it is she has transformed. With trembling hands, she starts the application. Xe looks away from the screen, momentarily. Almost afraid to look, she forces a glance back to find that she is in a place called Cambridge, Massachusetts. It's not Africa or Turkey, but it is someplace on Earth. But 2000? Is that 2000 years ago? 2000 years ago from what?

Xe remembers from her research that modern, current day, humans choose to number their years in terms of a calendar year. They chose a particular point in time and started counting from there. Hoping to standardize how everyone views time, she supposed. They chose the Gregorian calendar to be specific, which is a reflection of a religious interpretation of how to number years based upon the birth of one Jesus Christ. So, the designations of before Christ (BC) and anno Domini (AD) were appended to the year. 2000 AD would place Xe 2000 years after the birth of Christ.

It would take Xe a few days to adjust to her new environment. Figure out the significance of why she was

here. The role she was playing. Why she was here on Earth, modern day, at this time, and in this place?

It wasn't long before it became abundantly clear that Xe's placement here was not accidental. Xe was in her final year of study at a place called Harvard University. She was in a doctoral program, specializing in the field of physics. Thus, all the books on the bookshelf dedicated to science and physics. She had spent the last three years of her life doing nothing but physics. Experimental physics, to be exact. She was tired. Worn out. In need of a break from her studies. She decided to take a leave of absence and travel out west to a place in California. There, she would take time off to reflect. To listen. To find her inner voice.

She found herself a job for a year teaching physics at a local junior college. She held regular office hours just like most of the other professors. Just like most of the other professors, she found that her students rarely visited. So she and the other professors would cross paths quite frequently. They would visit each others offices to exchange conversation, drink coffee, and talk about the things that they really wanted to talk about. Throw out ideas. Be daring.

One day Xe dared a little too much. Spending so much time alone, she found herself listening to herself. Intently listening. To an inner self that wanted to be let out. Be set

free. So one thing led to another and she found herself ready to open up about Xeron. Xeron had been on her mind a lot and she thought it safe to bring this inner, hidden side of her to life. So she threw it out there. Xeron. Xerellians. A planet in another universe, another galaxy, far, far away. The whole bit.

It wasn't long before she realized she had made a huge mistake. The look on the face of the professor she confided in was of total shock. Disbelief. His response, "Are you serious?", was enough to end the conversation before it had ever really started. Xe quickly retreated and navigated an end to the subject by replying that she was only joking. Just trying to get a response. After that, it became the joke whenever the two would talk. They both would get a good laugh out of it.

It wasn't long after, that Xe finished her year of teaching and headed back to Harvard. She continued in her PhD curriculum, specializing in the fields of particle and experimental physics. Her doctoral thesis proposed the existence of a space-time symmetry, something called supersymmetry. Supersymmetry posits that every particle in nature has a partner, almost a mirror image. This includes partners of space-time. In other words, space-time itself has other dimensions. Dimensions we cannot see and truly do not understand. Xe was extremely interested in the supersymmetry between electrically charged particles.

Electromagnetic forces being one of the four fundamental forces of nature.

The interaction goes something like this. When two types of particles, for example electrons, repel each other, one of the electrons emits a virtual particle called a photon. A small amount of energy is released and thus, according to the conservation of energy, can only exist for a short while. Thus, the electron pops into and out of existence in a very short period of time. Kind of like watching a bubble pop as it reaches its maximum point of aperture. One second it is there. The next second it is gone. Her research was enough to earn her a PhD. But more importantly, it led to her recognition by a group of scientists in Switzerland and an invitation to participate in the greatest scientific experiment in the history of humankind.

The Large Hadron Collider (LHC) is the most complex experimental machine ever built. The purpose of the LHC is to examine the tiniest particles in the Universe and thus, understand the workings of the Universe. Including when it all began. The LHC is located near Geneva, Switzerland near the border of France and Switzerland. It is buried over 300 feet underground and is over 17 miles in circumference. The LHC is the most complicated piece of machinery in human history. It took thousands of the world's scientists, technicians and engineers, from all over the planet, decades to fund and build.

One of those scientists was Xe. The LHC is a particle accelerator. Inside of which, particles travel at close to the speed of light. In opposite directions. To force a collision. All in the hopes of studying the byproduct of these collisions. To understand the structure of the subatomic world of particles and the laws of nature that govern them. These collisions are so powerful, particles only survive for a very short period of time. They are only noticed for the effects they leave behind.

This is where Xe comes in. Xe was chosen because of her work with space-time symmetry and supersymmetry. She was chosen to use the LHC to search for the elementary particles of nature and their mirror like, virtual, partners. The particles of nature that are the fabric of everything. The particles that hold everything together. The super partners that give added dimensions to our Universe.

It took Xe and her team of many hundreds, a number of years to provide proof of the existence of these invisible processes. What had hitherto been considered to be in physics only hypothetical particles, were confirmed to actually exist. What it meant to Xe, was that humans were one step closer to understanding that there was a unique relationship between the particles of nature. One step closer to participating in that exchange between virtual particles and harnessing its power.

After Xe's accomplishments at Hadron, she felt confident that they were heading in the right direction. That they were threading the eye of the needle. Threading the Universe. Priming themselves for the concept of a multiverse. She decided it was time to return to California and continue her teaching.

Her prior year of teaching in California had taught her that not all students were as excited about physics as she was. She learned to teach to those who were. These tended to be the younger ones, whose eyes were wider. Their visions longer. They were the eager ones who raised their hands and asked the pertinent questions. They listened to the answers. Without judgment and without pretext.

It was during this time that Xe's inner self started to take over again. Stop making excuses and examine her past as it really was. She knew there was more to her story than face value revealed. Something in her gut told her to look deeper into the relationship of the interaction between virtual particles. She experimented with identifying the exact point of interaction. What happens during that brief moment of existence? Though it appears as if there is nothing, they come and go so fast, is there actually something there? Somewhere lingering inside, Xeron was trying to push itself up again. Somehow, she knew all this stuff.

One night, while over at a friends house for dinner, Xe and ten or so other people were gathered around the dinner table. Sitting down to dinner, they were lightly conversing with one another. The host, hoping to liven up the discussion a bit, decided to play a little game. Everyone was to turn to the person on their right and whisper into their ear something they had never confided in anyone ever before. Something that they had been holding as a secret. After everyone was finished, one person was designated to start by revealing what it was that the person to their left had whispered.

Xe was at a loss as to what to say. Should she just play the game and make up something cute? Everyone would get a good chuckle, there would probably be a brief moment of embarrassment and then things would move on. Xe thought about Xeron. She had exposed herself once before. The results were not pleasing. Did she dare try it again? Maybe times had changed. People might be more understanding now. People might take the time to listen. Running out of time, she decided to once again throw caution to the wind. She whispered in her partner's ear and, after a few minutes, the game began.

Fortunately, or maybe unfortunately, Xe was chosen to start the game by revealing what the person to her left had confided. Slowly, the revelations made their way around the

table. Some discussion took place and as predicted, some embarrassments exposed. Finally, they made their way to the person on Xe's right. Her partner. He looked a little flustered. He wasn't quite sure how or where to start. Then, it came out.

He said that Xe had told him that she was from the planet Xeron. That she was not really the person they saw sitting before them. That she was a Xerellian in a human body. Here on Earth for, well, who knows. As long as it takes. To watch, observe and in some cases direct.

The silence was deafening. They all looked incredulous. They, almost looked scared, concerned for Xe's welfare. Then, one or two, started to ask questions. Not deep questions. Surface questions. Meant to break the silence. To allow for everyone to breathe. Keeping the discussion at the surface allowed Xe to gently back out of the commitment. To once again, pretend as if it was all just a joke. Something to laugh about. And then move on. Sometimes, it's best just to let it go. And that's just what happened.

As the years went by, Xe began to wonder what her life had been all about. It had been a great life. Nothing to really complain about. Over her lifetime she had achieved quite a bit. Working to understand the origins of the Universe and, thus, all of life, was no simple accomplishment. She had

fought with those religious, to repel their thoughts of hypocrisy and doubt. She had earned the total respect of her colleagues and the scientific community regarding her research and dedication in the support of science. She had unquestionably, advanced humanity's understanding of their place in the Universe.

At least, the Universe they knew of. In the general scheme of things, what humans call their physical laws of nature, became widely known and accepted. Only an adaptation of what Xe already understood, in her heart and soul, as The Laws of Everything.

Still, Xe often wonders what happens when you die. What will happen when she dies? Sometimes, late at night, she remembers her past and what she's been through. Her thoughts are tied to a song that she has listened to many times. Over and over. It ends with, "Now she has a place; that she knows she can; Can, come home to".

Xe lets out a long and mournful sigh. She wonders if she will ever again, see Xeron.

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