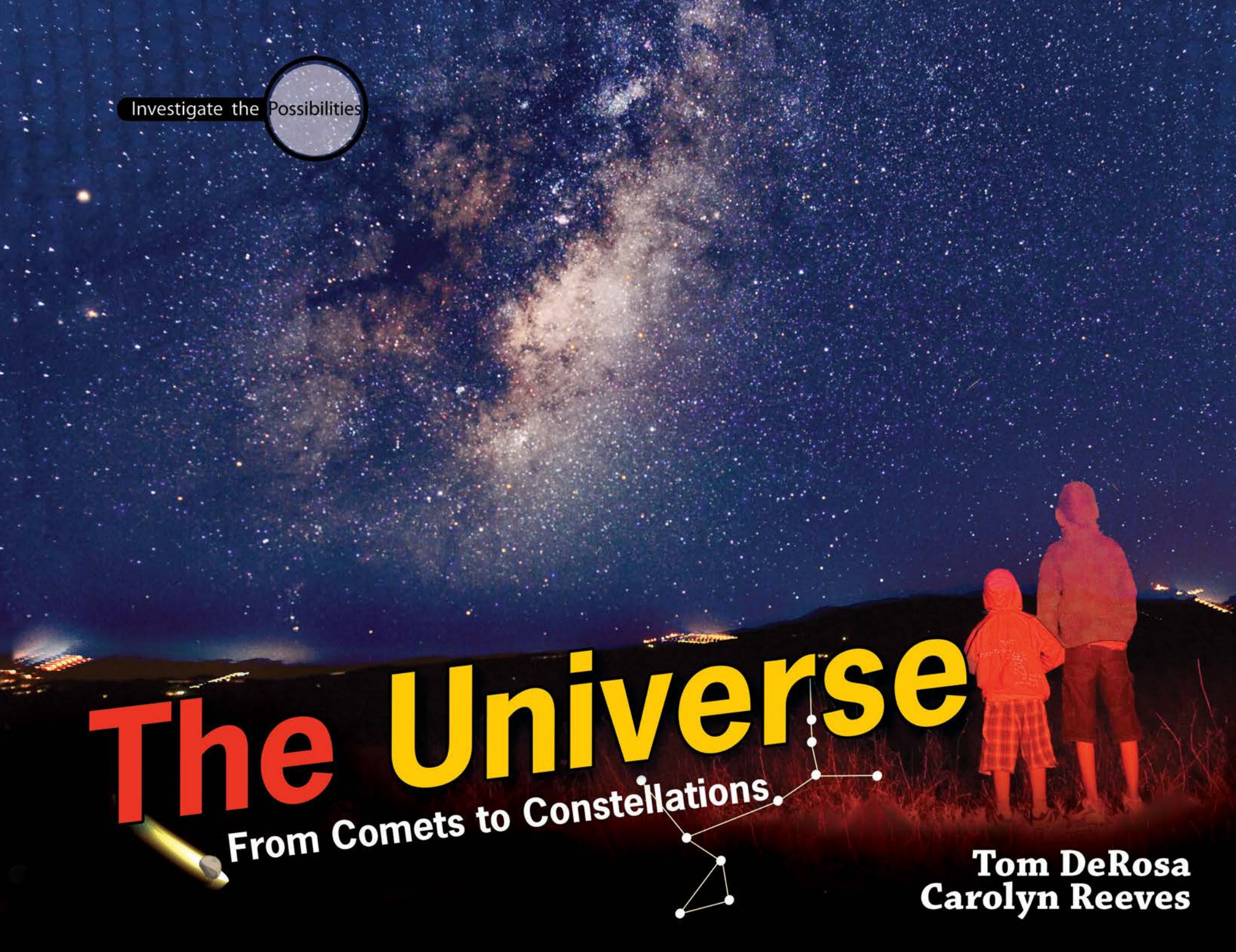
Investigate the Possibilities
The Universe
From Comets to Constellations
Tom DeRosa
Carolyn Reeves

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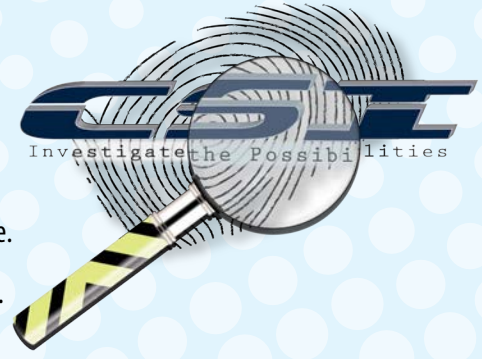

Unless otherwise noted, Scripture quotations are from the New International Version of the Bible.

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About the Authors

Tom DeRosa, as an experienced science educator and a committed creationist, has incorporated both his passions in the founding and the directing of the Creation Studies Institute, a growing national creation organization whose chief focus is education. His wealth of experience in the public school, Christian school, and homeschool markets for over 35 years has given special insights into what really works in engaging young minds. He holds a master's degree in education, with the emphasis of science curriculum. He is an author and sought-out, enthusiastic creation speaker who has a genuine love for the education of our next generation.

Carolyn Reeves is especially skilled at creating ways to help students develop a greater understanding of not just scientific concepts, but also how these are applied within the world around us. Carolyn retired after a 30-year career as a science teacher, finished a doctoral degree in science education, and began a new venture as a writer and an educational consultant. She and her husband make their home in Oxford, Mississippi, where they are active members of North Oxford Baptist Church. The Reeves have three children, three in-law children, and ten grandchildren.

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Introduction

"What do you mean thousands of years old? Are you crazy?" Uncle Benjamin bellowed at his nephew Ken.

Everyone at the family reunion turned to see what had gotten Uncle Benjamin so riled up.

Ken was a professional geologist, who specialized in studying and mapping underground water reserves. He had just made a comment that he thought the universe was not billions of years old, but was only thousands of years old. Ken was used to people being surprised that he believed the earth and the universe were so young. He laughed good-naturedly and asked, "Why would you think it's not?"

"Why, everybody knows the universe is billions of years old," Uncle Benjamin said, notching up his volume even more. "Didn't you learn that at the university?"

"Sure, I learned all the standard geology assumptions and theories about the earth and the universe. But then I began to realize that these assumptions were based more on naturalism and uniformitarian views than on scientific evidence."

This was the first time Ken's cousin, Jerry, had ever heard anyone with a degree in geology say such a thing. He had just assumed that the universe was billions of years old, because all of his textbooks and his teachers said so. Jerry, who was suddenly very interested in this conversation, still didn't understand why Uncle Benjamin's face was turning red as he talked.

"What's so hard about believing that God supernaturally created light on the first day of creation, and then designed and created the sun, moon, and stars on the fourth day? If you're going to study the Bible, at some point you're going to read about supernatural events," Ken continued. "Are you going to believe God supernaturally raised Jesus from the dead and then not believe He supernaturally created the earth, living things, and the first man?"

Jerry couldn't wait to ask Ken a question he had wanted to ask someone for a long time. "My science books say the universe began with the big bang billions of years ago and all the life on earth evolved over millions of years. Haven't all the things in our science books been scientifically proven?"

"These ideas are far from being proven," Ken replied. "They are not even supported by strong evidence. The basic reason for believing in billions of years has to do with our worldviews. Most worldviews start with how one answers the question, 'Where did I come from?' Either the world and the universe were planned and created by God or everything just evolved from energy and particles and random natural processes over a very long time."

"Jerry, the scientists who wrote your textbooks are naturalists. They believe everything that happens in nature must be caused by natural processes. They don't even consider the possibility that God supernaturally created the heavens and the earth in the beginning. They start with an assumption that cosmic evolution and Darwinian evolution really happened by means of slow, gradual natural changes. The evolutionary material in your book about geology and astronomy and evolution are possible explanations for where everything came from, but it is based on a limited amount of evidence and a lot of assumptions."

"But, why would they print things that aren't true?" Jerry asked.

"That's not anyone's intention," Ken answered. "Most scientists try to find explanations based on natural laws and processes to explain their research. That works well for most kinds of research, but it does not always work when trying to learn about things in the past that can't be repeated and where there were no witnesses."

"If a scientist believes that evolution is true, then he/she must also believe that from the beginning of time until now billions of years have passed. Obviously, the slow random evolution of all living things could not have occurred in a few thousand years, so many scientists chose to believe in gradual stepwise processes that took millions and billions of years. I choose to believe the Bible account of a supernatural creation."

Do you ever feel like Jerry, the young character in the story, and wonder why most books and scientists claim that the universe is billions of years old? Do you have questions about how the world and the universe got started? For thousands of years, people all over the earth have been asking questions to understand how the stars, the sun, and the moon came to be in their places and move in predictable patterns.

You will be amazed as you learn that the universe is so huge, no one has ever seen the end of it. What is even more amazing is that God chose to make man in His own image to have fellowship with Him. He prepared a single, special place for man to live. That was on the earth, which is only a tiny speck compared to the whole universe. His love for mankind far exceeds His love for anything else that was created. He considers every person on earth to be of great value and worthy of redemption.

HOW TO USE THIS BOOK

Each investigation gives students a chance to learn more about some part of God's creation. To get the most out of this book, students should do each section in order. Many science educators believe science is best learned when students begin with an investigation that raises questions about why or how things happen, rather than beginning with the explanation. The learning progression recommended for this book is: engage, investigate, explain, apply, expand, and assess. In each lesson, students will be introduced to something that is interesting, they will do an investigation, they will find a scientific explanation for what happened, they will be able to apply this knowledge to other situations and ideas, they will have opportunities to expand what they learned, and there will be multiple assessments.

Think about This (Engage) — Students should make a note of what they know or have experienced about the topic. If this is a new topic, they could write some questions about what they would like to learn.

The Investigative Problem(s) — Students should be sure to read this so they will know what to be looking for during the investigation.

Gather These Things — Having everything ready before starting the investigation will help students be more organized and ready to begin.

Procedures and Observations (Investigate) — Students should first follow the instructions given and make observations of what happens. There will usually be opportunities for students to be more creative later.

The Science Stuff (Explain) — This section will help students understand the science behind what they observed in the investigation. The explanations will make more sense if they do the investigation first.

Making Connections (Apply) — Knowledge becomes more permanent and meaningful when it is related to other situations and ideas.

Dig Deeper (Expand) — This is an opportunity for students to expand what they have learned. Since different students will have different interests, having choices in topics and learning styles is very motivating. All students should aim to complete one "Dig Deeper" project each week, but the teacher may want older students to do more. Generally, students will do at least one project from each lesson, but this is not essential. It is all right for students to do more than one project from one lesson and none from another.

What Did You Learn? (Assessment) — The questions, the investigations, and the projects are all different types of assessments. For "What Did You Learn?" questions, students should first look for answers on their own, but they should be sure to correct answers that might not be accurate.

Additional opportunities for creative projects and contests are found throughout the book. For grading purposes, they can be counted as extra credit or like a "Dig Deeper" project.

Nurture Wisdom and Expression

Each book contains information about early scientists and engineers. Students need to see that they were regular people who had personal dreams and who struggled with problems that came into their lives. Students may be surprised to realize how many of the early scientists believed that understanding the natural world gave glory to God and showed His wisdom and power.

In addition to the science part, students will find creation apologetics and Bible mini-lessons. The apologetics will clear up many of the misconceptions students have about what science is and how it works. Both the apologetics and Bible lessons should lead to worthwhile discussions that will help students as they form their personal worldviews.

Students with artistic and other creative interests will have opportunities to express themselves. For example, some of the apologetics are written in narrative form and are suitable for drama presentations. As scientists are introduced and researched, students can also present what they have learned as time-dated interviews or news accounts. Remember, if the scientists are included in a drama presentation, they should be represented as professionals, not as stereotyped, weird-looking people.

These experiments require adult supervision. They have been specifically designed for educational purposes, with materials that are readily available. At their conclusion, please appropriately dispose of any by-products or food items included in the experiments.

Please note that the Investigate the Possibilites website carries many of the items needed for experiments.

What Is the Universe?

Think about This

Michael and Alex alternated between catching fireflies in their back yard and trying to count the stars in the sky. Their parents had set up a refracting telescope to do some star watching, since the night was unusually clear. "Do you want to see something that looks like one star, but it's really many, many stars?" Mom asked.

"No way," Michael said doubtfully, as he hurried over to see. "It just looks like a funny-shaped fuzzy star to me."

"You're actually looking at about a billion stars that are incredibly far, far away from the earth," his mom continued. "They look like they are concentrated together. The truth is they are not close together at all, but just look like that way from earth."

Do you think the boys were seeing the very end of the universe? Do you think scientists have been able to locate the end of the universe by using powerful telescopes?

The Investigative Problems

How big is the solar system? How big is the universe? Can we make a model to help us understand these very large distances?

Gather These Things:

- ✔ 3 sheets of 8½ X 11 typing paper
- ✔ Clear tape
- ✔ 40 pennies
- ✔ Pen or pencil
- ✔ Ruler or straight edge

Procedure & Observations

In this model we won't try to show the sizes of the planets and the sun. We will only show the distances between the planets. The sizes of the planets are very tiny compared to these huge distances. Draw short vertical lines to show the positions of the planets and the sun. Start with 3 sheets of 8½ x 11 paper and tape them together crosswise. Make a short vertical line near the edge of the paper with your ruler to represent the sun. Write the word "sun" above the line. Put a penny next to the line. Draw another vertical line on the opposite side of the penny and label this line "earth." Put 40 pennies in a straight line. Draw a vertical line after the last penny and label this line "Pluto."

1. Each penny represents a distance of 1 AU (astronomical unit). Use the following chart to find the approximate distance of each planet from the sun. Write the names of the rest of the planets next to a vertical mark showing their distance from the sun. (Hint: The distances of Mercury, Venus, and Earth to the sun will all be represented by the diameter of one penny.)

Mercury	0.4 AU	Saturn	9 AU
Venus	0.7 AU	Uranus	19 AU
Earth	1.0 AU	Neptune	30 AU
Mars	1.5 AU	*Pluto	40 AU
Jupiter	5 AU		

*Pluto used to be classified as a planet, but it is now classified as a Trans-Neptunian Object or TNO. It is located in an area where there are many rocks of various sizes.

2. Predict how many pennies it would take to represent the distance to the nearest star to our solar system.

The Science Stuff

The first four planets, Mercury, Venus, Earth, and Mars, are rocky planets. They are much closer to the sun than the four outer gas planets, Jupiter, Saturn, Uranus, and Neptune. Between Mars and Jupiter there is an asteroid belt composed of rocks of various sizes that are in orbit around the sun. Beyond Neptune, there is another belt of rocks, known as Trans-Neptunian Objects (or TNOs), which is where Pluto is found. Many of these rocky objects, like Pluto, have moons that orbit them.

You may be wondering why Pluto is no longer classified as a planet. Recently, two TNOs larger than Pluto were discovered, and it is likely that other larger TNOs will also be discovered in the future. So there is no reason to give special status to Pluto.

The penny model you made should help you better understand some things about the size of our solar system and how far apart the planets are. Like most models, it represents something too big or too complex to be seen, but it isn't perfect. For example, you probably know the planets are not in a row all on the same side of the sun.

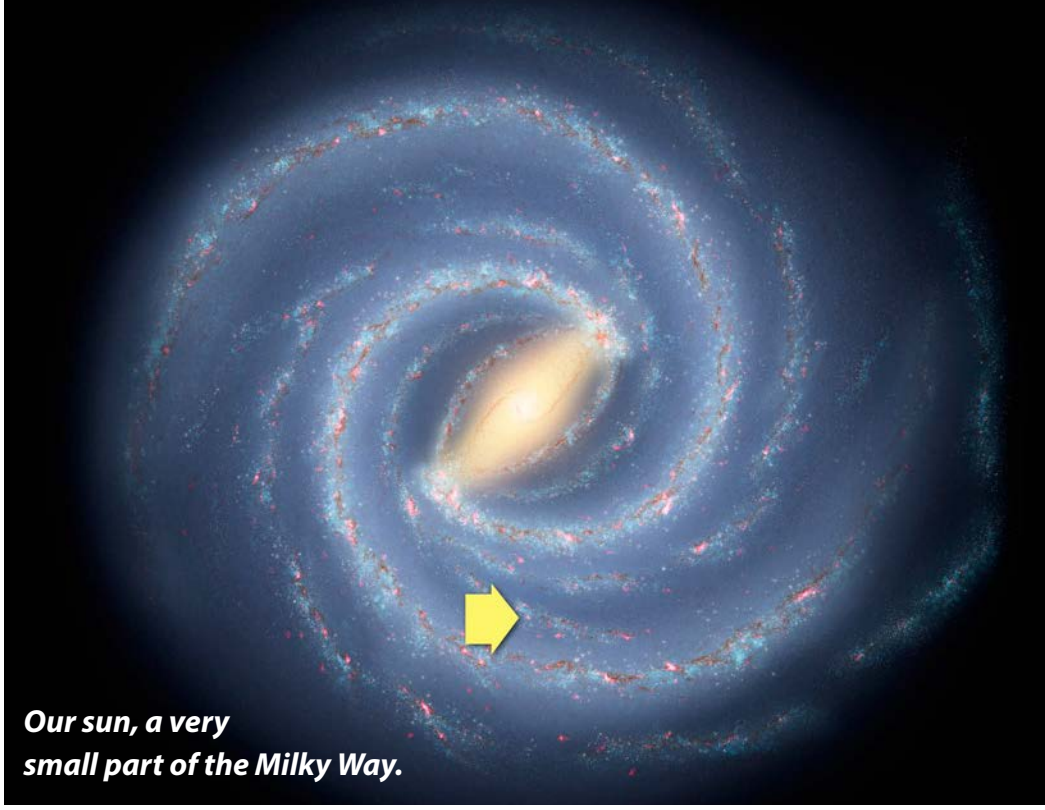
Here are some important concepts the model can help you understand: The sun is 93,000,000 miles (150,000,000 km) away from Earth and is represented by one penny. This distance is also referred to as 1 astronomical unit (AU). Forty pennies represents about 4,000,000,000 miles (6,000,000,000 km) or 40 AU.

Incredibly, when we observe objects outside of our solar system, AU units are too small to work well. For these extremely large distances, astronomers use a different unit called a light-year. This is the distance that light travels in one year. One light year is equal to about 6,250,000,000,000 miles (10,000,000,000,000 km).

For comparison, think about these examples. Light can travel about 186,000 miles (300,000 km) in one second. It takes about 8 minutes for light to travel from the sun to the earth. It takes an average of about 5.5 hours for light to travel from the sun to Pluto. Look at the penny model again to see the distances that are represented.

The next nearest star to our sun is actually a star system made up of a pair (possibly triple set) of stars, known as the Alpha Centauri system. These stars are more than 4 light years away. Using our penny model, we would need a line of pennies a little over 3 miles (4.8 km) long to show where this pair of stars is.

Our sun and the Alpha Centauri pair are only 3 of the stars in our Milky Way Galaxy. Some astronomers have estimated that there may be more than 300 billion stars in our Milky Way Galaxy. We would have to use the entire Pacific Ocean to extend the penny model and make an accurate model of the whole galaxy!



Our sun, a very small part of the Milky Way.

Galaxies are organized into clusters of galaxies. Our Milky Way Galaxy is part of a group of 30 or more galaxies that are bound together by mutual gravitational attraction. This group is known as the Local Group.

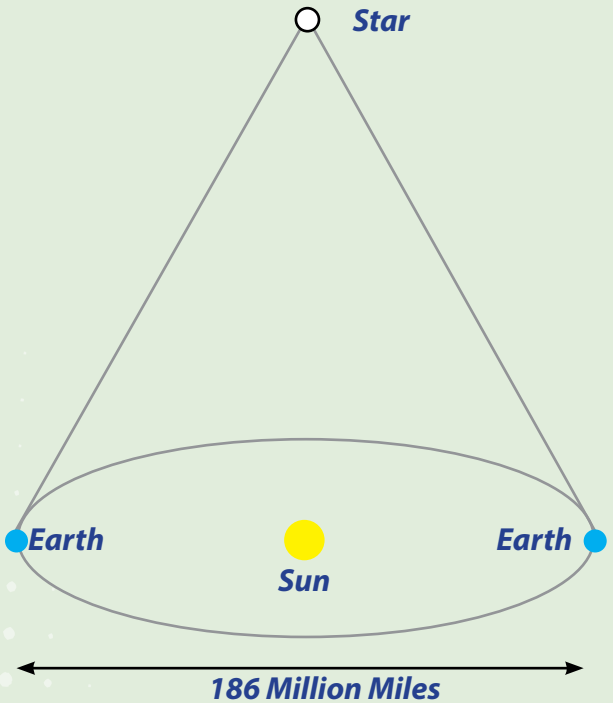
The word *universe* is a term that includes all the galaxies in space. There seems to be from 100 to 200 billion other galaxies in the universe, but the number keeps changing as telescopes and technology make it possible to detect more stars and galaxies. Some of the points of light we can see in the night sky are really far away galaxies made up of billions of individual stars. The universe is so big that it is impossible for us to even imagine its size.

It is easy to be confused about all of this information, so let's review the main points. Starting with our solar system, you should understand that there are 8 planets (9 if you count Pluto) that travel around the sun. Most of the planets have their own moons. The planets, their moons, comets, asteroids, TNOs, dust, and everything else that is captured by the sun's gravitational force are part of our solar system.

Our solar system is part of the Milky Way Galaxy, which is part of a cluster of galaxies known as the Local Group. Our Milky Way Galaxy is only one of the hundreds of billions of galaxies in the whole universe.

Making Connections

Astronomers have calculated that there are about 6,000 stars that can be seen under the best night time conditions, but the actual number is much greater than that. Scientists have always been fascinated with the number of stars in the universe, and there have been many attempts to count them by astronomers. The number is unbelievably huge. For example in our Milky Way Galaxy, it is believed that there may be 200 billion stars.



One method for calculating the distance to a star involves using the diameter of the earth's orbit around the sun as the base line of a triangle. One angle from the earth to a nearby star is measured and then 6 months later another angle is taken with this same star. This gives enough information to use geometry and calculate the distance from the earth to a specific star.

Although astronomers feel confident that this kind of method gives accurate distances of our nearest star neighbors, it is not used with confidence for very far away stars and galaxies.

Comparing the parallax of different stars or galaxies is another method for calculating the distance to a star. This is similar to the situation where someone is looking out the window of a moving car looking at mountains that are far away. The objects close to the car appear to be moving fast while the mountains don't seem to move at all. Astronomers on earth can see nearby stars that appear to be moving while distant stars do not seem to move at all. Nearby stars have a high parallax, and more distant stars have a low parallax.

What Did You Learn?

1. Why do scientists sometimes use models to explain things in nature?
2. What is one problem with using the penny model to help explain the solar system?
3. What kinds of things are found in our solar system?
4. Name the four rocky planets in order.
5. Name the four outer gas planets in order.
6. Explain what is meant by an AU.
7. Where are the solar system's asteroid belt and the TNO region?
8. What is a light-year? Why are AUs not used to measure some distances between objects in the universe?
9. Briefly explain each of the following: solar system, galaxy, cluster of galaxies, and universe.
10. "Milky Way" and "Local Group" are the names of two things found in space that contain the earth. What is each?
11. What is the nearest star to our sun? Is it in our solar system? Is it in our galaxy?
12. Briefly describe one method scientists use to estimate the distance between objects in space.

Discussion:

1. What are some of the things the sun, the moon, and the stars reveal to us about God?
2. The human body is made up of trillions of cells. Do you think a trillion stars in space are more awesome than the trillion cells that work together in your body in perfect harmony?
3. Read Isaiah 40:26 again. Do you find it amazing that God knows the name of every star?

Dig Deeper

Do some additional research on TNOs. What do scientists know about them and how far out into space do they seem to go before the sun's gravitational pull no longer keeps them in orbit?

Spreading Out the Heavens

Think about This

Julie and Justin were laughing hysterically as their father showed an old video of them playing on a slide. He showed the clip in forward motion and then showed it in reverse. "Do it again," they said in unison. Their big sister Anita laughed along with them. Then she thought how neat it would be if a video of their lives for the past year could be shown in reverse to show how much everyone had grown and changed over the year.

Her father said, "Let's take this idea a little further. What if there was a video of the entire universe that could be shown in reverse right back to the beginning of everything? What do you think we'd see at the very beginning?"

Anita remembered seeing a TV program once about the big-bang theory. It showed the beginning of the universe as a small dense ball. Then, about 15 billion years ago, the ball exploded and everything began to move out in all directions forming stars, planets, moons, and all the other objects in the universe. Do you think, if it were possible to see a movie of the universe in reverse, it would begin as a small dense "ball" 15 billion years ago?

The Investigative Problems

Is the universe expanding? What are some possible explanations for an expanding universe?

Gather These Things:

- ✔ Large round rubber balloon
- ✔ Colored marker
- ✔ Bag of large marshmallows

Procedure & Observations

Part A

Partially blow up a large balloon and put colored dots all over the outside. Space the dots somewhat evenly apart from each other. Continue to blow into the balloon so that is gets larger. Notice that the dots get farther and farther apart as the balloon gets bigger. Now gradually let the air out of the balloon and notice that the balloon gets smaller and the dots get closer together. Blow up the balloon again and observe. Write about what you observe.

Part B

You will need a partner to do this.

A will toss a marshmallow to **B** every second. **A** should slowly count "one thousand one," "one thousand two," etc., to estimate the time. How many marshmallows did **B** catch in 10 seconds?

Now **A** will toss a marshmallow to **B** every second while **A** walks slowly toward **B**. How many marshmallows did **B** catch in 10 seconds?

This time **A** will toss a marshmallow to **B** every second while **A** walks slowly away from **B**. How many marshmallows did **B** catch this time?

The Science Stuff

There has been an assortment of ideas through the ages about how to explain the universe, but there are still more questions than answers. Some of the first real clues about how the solar system works came from scientists like Copernicus (1473–1543), Galileo (1564–1642), and Kepler (1571–1630). At the time when Copernicus cautiously proposed that the planets moved around the sun, he did not have the benefit of telescopes. Both Galileo and Kepler were able to study the planets with telescopes. The explanation for movements of planets and stars caused people to eventually shift from believing in an earth-centered universe to accepting a sun-centered solar system. The change to a sun-centered solar system took a long time, but by the time of Isaac Newton (1642–1727), the evidence had persuaded most scientists it was true.

Another major shift in viewing the universe came as Edwin Hubble (1889–1953) made use of more powerful telescopes and other kinds of technology during the early 1900s. At first Hubble agreed with other astronomers of his day that the solar system, the stars, comets, asteroids, and nebulae were all part of the same galaxy. At this time, it was thought that there was nothing outside of our galaxy.

But in 1923, as Hubble began studying a fuzzy patch of sky called the Andromeda Nebula, he found that it contained individual stars. After making many observations and then doing some mathematical calculations, he finally concluded that he was viewing a set of stars that made up another galaxy completely separate from the one the earth was in. In the next few years, Hubble was able to identify several other galaxies. By 1929, most astronomers had come to believe that our Milky Way Galaxy was only one of millions of galaxies in the universe.

Hubble discovered that not all galaxies are alike. He found elliptical galaxies, spiral galaxies, and barred spiral galaxies. We know today that there are even more different kinds of galaxies than Hubble imagined.

Eventually, Hubble collected spectra of light from 46 galaxies. He noted that there was always a red shift in the colors of the visible spectrum that came from these galaxies.

Since red is the longest visible wavelength, a red shift in the spectrum would indicate that the light from these galaxies was being stretched out as it reached the earth. This information led scientists to believe that all of the galaxies were moving away from the earth and getting farther apart over time. If the spectrum colors had always shifted toward blue/violet, the shortest wavelengths, this would have been a clue that the galaxies were moving toward the earth and getting closer together. If the light the galaxies emit was stretched out by the time it reached the earth, the light spectrum would show a red shift. This is a clue that the universe is expanding.

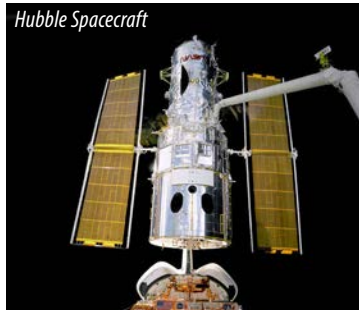
The activity with the marshmallows should help you understand this concept. The light (or sound) waves are squeezed together as one object approaches another. The light (or sound) waves are spread out as one object moves away from another one. The marshmallows were easier to catch as the pitcher moved away from the catcher, representing how the waves were stretched out a little.

Not long after the red shift discovery, the "big-bang" theory was introduced. Many astronomers reasoned that if galaxies in the universe are now expanding, there must have been a time in the past when they were closer together. They kept trying to rewind time and concluded that the galaxies must have started out from the same place. They reasoned that their expanding motion must have started from an explosion. Hence, the name the "big bang."

Soon, another theory known as the nebula theory was made based on the big-bang theory. According to this theory, after the big bang occurred, large clouds of dust particles were thrown into space and began to spin. Within these spinning clouds, other whirlpools formed. Then the particles in these whirlpools condensed to form galaxies, stars, planets, and other objects in space.

There are problems with the big-bang theory, the nebula hypothesis, and billions of years to create everything. However, all three principles continue to be accepted by mainstream scientists.

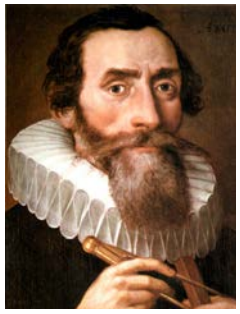
An alternative explanation that is consistent with Scripture is being studied by some astronomers. They are looking at the possibility that the originally created universe was much smaller than it is today. And, at some point after creation, it expanded to the present size, causing light rays to also be "stretched" in the process. Some creation scientists believe this process might be something like how you observed the spots on the balloon expand, as the balloon got bigger.


Hubble Spacecraft


Elliptical galaxies

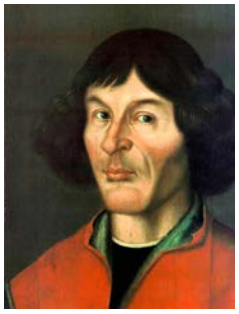

Spiral galaxies


Barred spiral galaxies



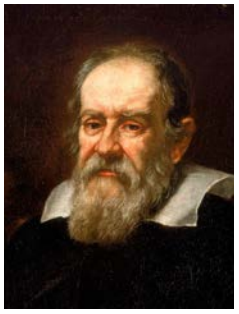
Johannes Kepler

1571-1630



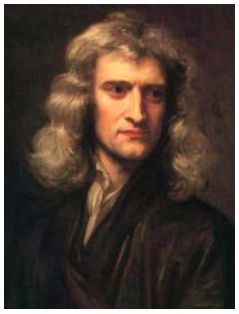
Nicolaus Copernicus

1473-1543



Galileo Galilei

1564-1642



Sir Isaac Newton

1642-1747

Edwin Hubble

1889–1953

Making Connections

Recall that *parallax* is a method for estimating extremely distant objects in space and that such objects may appear not to be moving. When objects are trillions of miles away, they appear to be staying still even though they are probably moving.

The idea that the universe was stretched out is found in several places in the Bible. Isaiah wrote that God stretched out the heavens like a curtain. Notice that this idea is like the big bang in suggesting that there was once an expanding of the sky.

The appearance of a red shift in the light reaching the earth from distant galaxies is based on an assumption that light from these galaxies is moving away from the earth. This should work in the same way that radar uses the Doppler effect to give readings about the speed and direction of moving clouds. Waves from the clouds are compressed as they move toward the radar and are stretched out as they move away from the radar.

Dig Deeper

What are the differences between astronomers and astrologers? Try to find the names of early civilizations that studied the heavenly bodies. (Keep in mind that some of the early survivors of the Flood were expert astronomers.)

Find out how a Doppler radar works and how weather forecasters use them in predicting weather. Compare Doppler weather radar with instruments that astronomers use to measure shifts in light spectra.

Position yourself on a sidewalk. Have a parent drive a car down the road next to the sidewalk while continuously blowing the car horn. Describe how the pitch of the car horn changes as the car approaches and then moves away. The change in pitch is known as the Doppler effect.

Draw shapes of different kinds of galaxies.

What Did You Learn?

1. What scientist discovered that there were other galaxies in the universe in addition to the galaxy our earth is in?
2. What evidence did Edwin Hubble discover that caused him to conclude that galaxies are moving and getting farther away from the earth?
3. Before the time of Hubble, did scientists believe all the stars in the universe were in the same galaxy?
4. Which color in the visible spectrum has the longest wavelength?
5. Is the bluish/violet end of the visible spectrum made up of shorter waves or longer waves?
6. What major shift in thinking about the solar system came from scientists like Copernicus, Galileo, and Kepler?
7. The "big-bang" theory is based on what main piece of evidence? Does this prove that the big bang actually happened?
8. Briefly tell about the "nebula theory." Does it attempt to explain the origin of all the stars, planets, moons, comets, rocks, and dust in the universe?
9. What instrument was available for Galileo, Kepler, and Hubble to use that Copernicus did not have?
10. Give the shape of two different kinds of galaxies.
11. All galaxies appear to be moving. Why are we unable to look at them and tell that they are moving?

Pause and Think

There are numerous references in Job, Isaiah, Jeremiah, and Zechariah that refer to a mighty act of God in which He spread out the stars in the sky.

Isaiah 48:13	Isaiah 51:13	Isaiah 40:22	Job 26:7
Isaiah 42:5	Isaiah 44:24	Isaiah 45:12	Job 37:18
Jeremiah 10:12	Zechariah 12:1		