



Delight in Creation

Scientists Share Their Work with the Church

Edited by Deborah Haarsma & Scott Hoezee

12 Recent Discoveries in Astronomy

by Deborah Haarsma

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A passenger settles in beside me on the airplane. We chat a bit about our destinations, and then comes the inevitable question: “So, what do you do for a living?” I pause a moment before answering. If I answer “astronomy,” I know my fellow passenger will perk up, comment that he has always loved stars, and ask a question about a comet or planet that’s been in the news. If I answer “physics,” he will shrink back, comment that he didn’t do well in physics in high school, and the conversation will quickly come to an end. My professional colleagues have noticed the same thing. We joke that if you want to sleep on the plane, just answer, “Physics!”

It’s true that physics sounds scary to many people, and it can indeed be a difficult topic to learn. Yet I’ve always loved physics (my degrees are in physics rather than astronomy), because of the way that mathematical equations can describe and predict so much of what we see in the world around us. One reason I got into astrophysics is because the universe contains so many bizarre situations that we can’t reproduce on earth, like ultracold, or extremely high density, or extremely high magnetic fields. It’s a fun challenge to figure out which physical process will be the most important when the situation is so dissimilar to everyday experience. But if the word “physics” makes you shrink in distaste or fear, don’t worry. For the rest of this article, we’ll focus on a more friendly topic: astronomy.

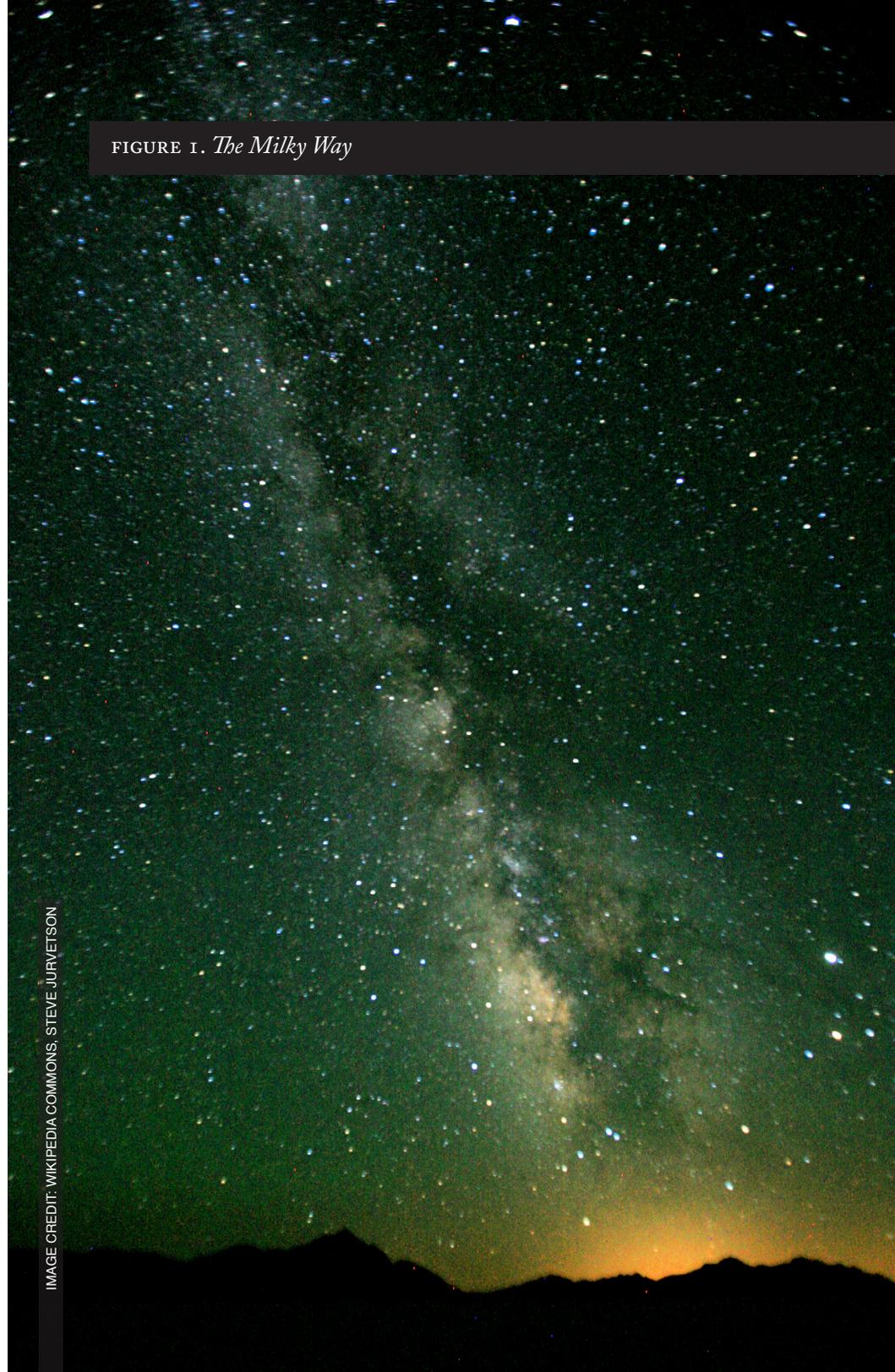
In the last decade or two, our knowledge of the universe has grown dramatically as many new telescopes and spacecraft have come online. In this essay, I’ve selected some of my favorite recent astronomy photographs to share with you. As a professional astronomer and a Christian, I feel God has called me to share these wonders with the Church. Many times, these new discoveries are presented without any mention of God, and sometimes in a context of overt atheism. I want to share these things with you in a Christian context, with God as their creator.

The Milky Way

Have you ever seen the Milky Way? If you live in a rural area, you may have seen it many times. If not, it may have been a dramatic surprise when you first saw it while camping or traveling. On a clear night out in the country, the sky is strewn with brilliant stars—many more stars than you

FIGURE 1. *The Milky Way*

IMAGE CREDIT: WIKIPEDIA COMMONS, STEVE JURVETSON



can see under city lights. The faintest stars form a creamy, smoky band from horizon to horizon. Our galaxy contains billions of stars, and thousands of those stars are visible to the naked eye. The stars appear in a band across the sky because we are viewing on galaxy edge-on, like looking at the edge of a dinner plate.

When David looked up at the night sky over Israel thousands of years ago, he may have seen the Milky Way, or a comet, or simply the brilliance of the full moon. Whatever the sky looked like that night, it inspired him to sing:

The heavens declare the glory of God;
 the skies proclaim the work of his hands.
 Day after day they pour forth speech;
 night after night they reveal knowledge.
 They have no speech, they use no words;
 no sound is heard from them.
 Yet their voice goes out into all the earth,
 their words to the ends of the world. (Ps. 19:1-4a)

The heavens are displaying the glory of God for all people to hear, proclaiming their message to people of every language, tribe, and nation. Just about anyone who looks up at the night sky feels a sense of wonder. Yet as Christians, we feel more than a vague sense of awe; we know the Creator of the heavens personally, as our own loving Father.

The heavens declare more than God's glory. The universe is God's revelation of himself to us, and teaches us about his character. As the Belgic Confession says about "The Means by Which We Know God,"

We know him by two means:

First, by the creation, preservation, and government of the universe, since that universe is before our eyes like a beautiful book in which all creatures, great and small, are as letters to make us ponder the invisible things of God: his eternal power and his divinity, as the apostle Paul says in Romans 1:20.

Second, he makes himself known to us more openly by his holy and divine Word, as much as we need in this life, for his glory and for the salvation of his own. (Article 2)

The natural world teaches us about God's glory, power, divinity, faithfulness, extravagance, immensity, love, and other attributes. God's special revelation in scripture is our primary place to learn of God's character (Ps. 19 goes on to talk about special revelation in vs. 7), but the natural world can bring the message to our senses in a powerful way beyond mere words on a page. The Holy Spirit can use the natural world to get the message past our hardened or weary hearts. Nature illustrates these attributes in ways that enlarge our imaginations to appreciate afresh the glory of God.

The Sun

The Solar Dynamics Observatory was launched into space in 2010, the latest of several spacecraft to photograph the sun in detail. In Figure 2, the upper photo shows the face of the sun with a sprinkling of sunspots. The sun is powered by nuclear fusion reactions deep in its core which heat the hydrogen and helium gas till it glows. A sunspot is a place on the sun's surface where the gasses are a bit cooler than the surrounding area, so that it glows less brightly and appears dark.

The lower photo in Figure 2 was taken the same day, but in X-ray light. X-rays are invisible to our eyes, but you have experienced them at the dentist's office. There, the X-rays are produced by a machine, travel through the mouth, and are detected by film to reveal an image of your teeth. In this image, X-rays are produced by the sun, travel to the Solar Dynamics Observatory, and are detected by a camera to show an image of the sun. In X-rays, the sunspots are the *brightest* part of the image, not the faintest. If you look at the sunspot on the left edge, you can see bands of particles rising out of the sunspot in a looping path above the sun's surface and falling back down on it. As the particles follow lines of magnetic field, they emit X-rays. The loops you see are not small—they are about the size of planet Earth!

Because of modern spacecraft, telescopes, and cameras, we can see so much more in the heavens than what is visible to the naked eye. Thus, we are seeing more of what the heavens have to declare about God. In Psalm 19, David goes on to describe the sun:

In the heavens God has pitched a tent for the sun.
It is like a bridegroom coming out of his chamber,
like a champion rejoicing to run his course.
It rises at one end of the heavens
and makes its circuit to the other;
nothing is deprived of its warmth. (vs. 4b-6)

If David had lived today, maybe he would have written about other properties of the sun, like the power of God as seen in nuclear reactions and looping magnetic fields. As it is, he makes two important points. One is the universal warmth of the sun, by which God provides for all life on earth. The other is the faithful path of the sun, day after day, unchanging year after year. In the book of Jeremiah, God promises his people that he will not break his covenant with them, any more than he would break his covenant with day and night and the fixed laws of heaven and earth (33:19-26). The sun is a persistent reminder, woven into our lives, of God's faithfulness to his promises.

Asteroids

In July 2011, the spacecraft Dawn arrived at the asteroid Vesta and took the photograph shown in Figure 3. Vesta is about 530 kilometers across, or about the size of Wyoming. This beautiful image shows the varied texture on Vesta's surface. Vesta has craters like the moon, but also ridged bands along the upper left. In fact, there are craters on top of the ridged bands! Just from looking at the surface, it is clear that Vesta has a history, in which the bands formed first, and after that small asteroids hit Vesta to make the craters on top of the bands.



SDO/AIA-4500 20110922_230008

FIGURE 2. *The Sun on September 22, 2011, in visible light and X-ray light as seen by the Solar Dynamics Observatory.*

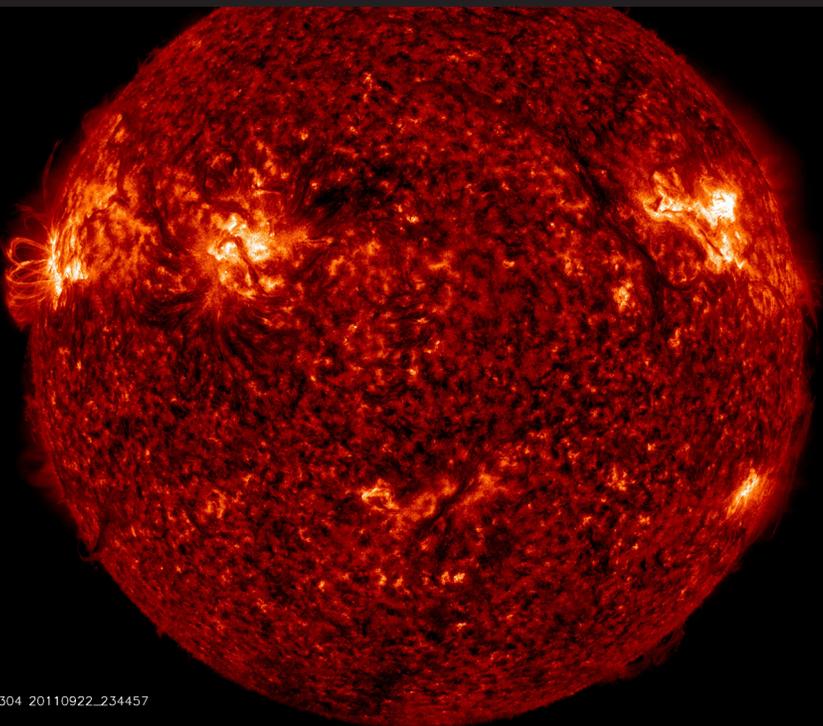


IMAGE CREDIT: NASA, SOLAR DYNAMICS OBSERVATORY

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Astronomers now know the orbits of nearly half a million individual asteroids in the asteroid belt. The asteroids are grouped into families that have similar chemical composition and similar orbits. College students with whom I work have programmed computers to run the orbits back in time under the laws of gravity. The students find the same thing that professionals do: asteroids in the same family have orbits that converge at a certain time in the past, millions of years ago. This was the time when two asteroids collided, breaking off many smaller asteroids. The new smaller asteroids are seen as a family today.

Charting the origins of asteroids is an excellent example of historical science: by using the evidence we see today, we can deduce what must have happened in the past. Very few assumptions go into the orbit calculation, just Newton's laws of mechanics and gravity. Even though no one was there to see the collision, the orbits today show that a collision occurred millions of years ago. God gives us a glimpse of how he created the asteroid belt.

The idea that something happened millions of years ago may seem startling to you. Christians disagree about the age of the earth, solar system, and universe. Some Christians believe the solar system is only 10,000 years old, in agreement with the genealogies recorded in the Bible. Other Christians believe the solar system is 4.6 billion years old, in agreement with many lines of evidence from astronomy and geology, including asteroid collisions.

Since God has revealed himself in both scripture and nature, we need to take both revelations seriously. Both revelations require human interpretation: scientists interpret the evidence in the natural world, and Christians interpret the Bible every time they read it. Many biblical scholars say that the best interpretation of Genesis indicates that it was never intended to teach scientific information about the age of the universe, but it was intended to teach truths about God's sovereignty and the goodness of creation. A full discussion of age is beyond the scope of this essay, but resources on this topic are listed at the end under Further Reading.

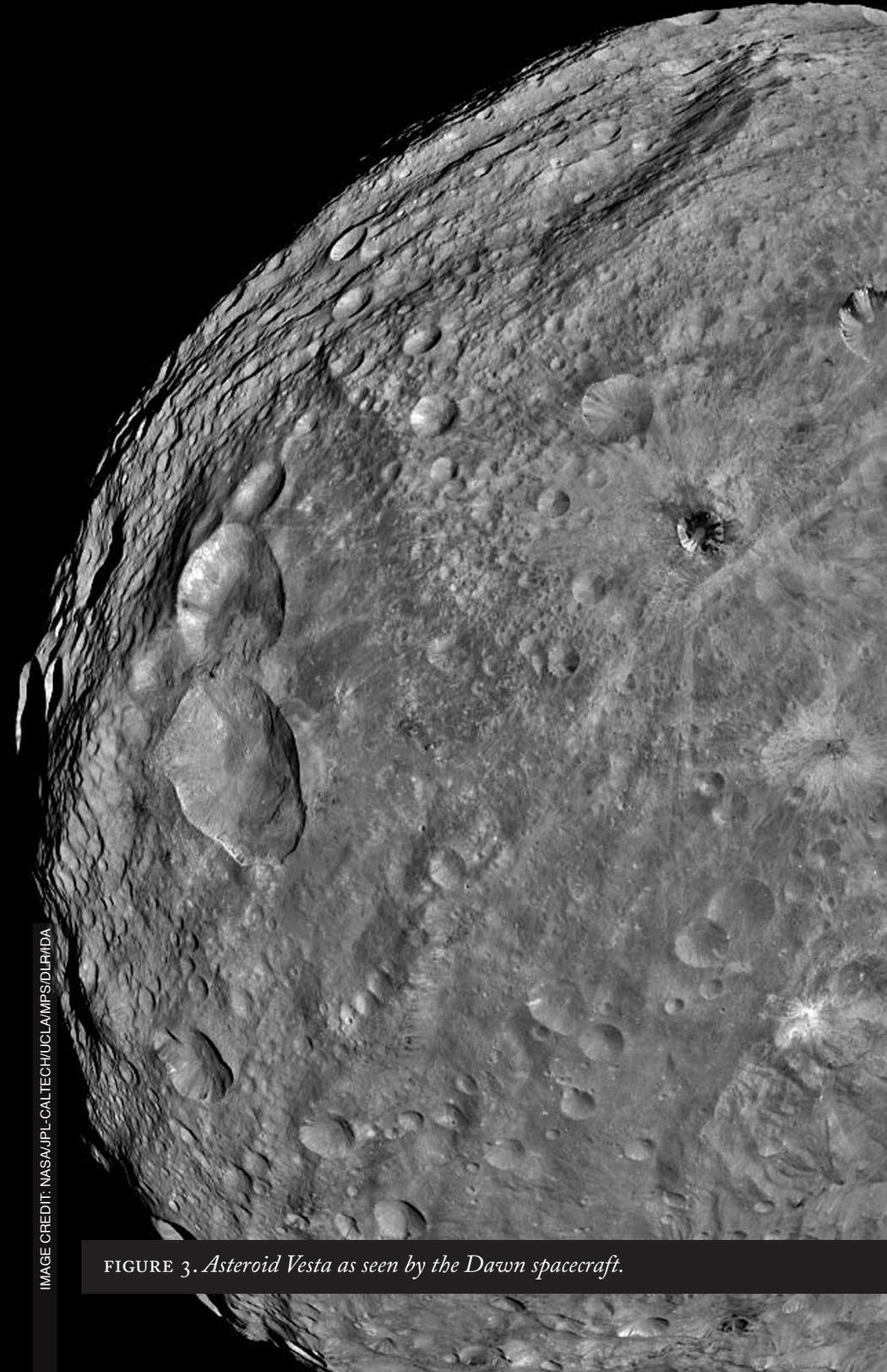


IMAGE CREDIT: NASA/JPL-CALTECH/UCLA/MPS/DLR/IDA

FIGURE 3. *Asteroid Vesta as seen by the Dawn spacecraft.*



FIGURE 4. *Carina Nebula as seen by the Hubble Space Telescope.*

IMAGE CREDIT: NASA, ESA, N. SMITH (UNIVERSITY OF CALIFORNIA, BERKELEY), AND THE HUBBLE HERITAGE TEAM (STSCI/AURA)

Nebulae

When you look at the night sky, the space between the stars looks black. Figure 4, however, shows that the space between the stars is actually filled with rich complexes of dust and gas. The Carina Nebula is located 7,500 light-years away. A light-year is the distance that light travels in one year, so that means the light we see left the nebula 7,500 years ago. This image is about thirty light years across. The beautiful colors represent different types of gas: blue for nitrogen, green for hydrogen, and red for sulfur. The dark clumps and filaments are regions where dust clouds absorb the light.

The resulting picture is as elegant as an abstract painting, truly a display

of God's artistic creativity. This nebula was around long before human history, but only in the last decade or two have we had telescopes and cameras to make images like this. We've found nebulae throughout our own galaxy and in other galaxies; God appears to have filled the universe with an extravagance of beauty, even where no human is there to see it.

This nebula displays God's creative nature in another way: in this region God is creating new stars. It is an active "stellar nursery." The smallest dark globules in the lower center of the picture are similar in size to our own solar system. Each globule will likely become a star with planets of its own. Our own solar system probably had its origin in a nebula like this. God brought together the dust and gasses in a swirling cloud to make the sun,

earth, and planets. The very nitrogen in our bodies was once glowing in a beautiful nebula. God made us from stardust.

This nebula illustrates an important truth: *a scientific explanation does not replace God*. Some atheists say, “Scientists can explain this, so there’s no need for God.” And some Christians say, “Scientists can’t explain this, so God must have made it.” Both statements make the error of assuming that a scientific explanation is somehow a substitute for God. Yet in other areas—gravity or photosynthesis or chemical reactions—we view God as upholding the laws of nature. We don’t say that natural laws indicate God’s absence. For a Christian, a scientific explanation doesn’t diminish God’s role; it gives additional insight into God’s action and increases our praise of him.

Galaxy Clusters

Since the Chandra X-ray Observatory was launched into orbit in July 1999, it has been sending back amazing pictures of the universe in X-rays. As with the sun, this galaxy cluster looks very different in visible light and X-ray light. On the top in Figure 5 is a visible light image from the Hubble Space Telescope of galaxy cluster Abell 1689, located 2.3 billion light years away. You can see hundreds of yellow galaxies, each containing billions of stars. Many of these galaxies are larger than our own Milky Way galaxy.

Before X-ray telescopes, astronomers had no idea that there was more to a galaxy cluster—we thought the space between the galaxies was basically empty. On the bottom in Figure 5 is an image from the Chandra X-ray Observatory of the same region of space. Instead of individual galaxies, the image shows X-rays coming mostly from a huge cloud of hot gas filling the space between the galaxies. In fact, there is much more mass in the gas than in the galaxies!

Yet even this isn’t the whole story. Astronomers have found that most of the cluster mass is not in galaxies, and not in gas, but actually in a mysterious substance called dark matter. Dark matter is stuff that has mass but doesn’t emit light. Astronomers are not sure what dark matter really is, but the best guess is that it’s some bizarre elementary particle that doesn’t exist on earth except in particle accelerator experiments. Only 2% of the

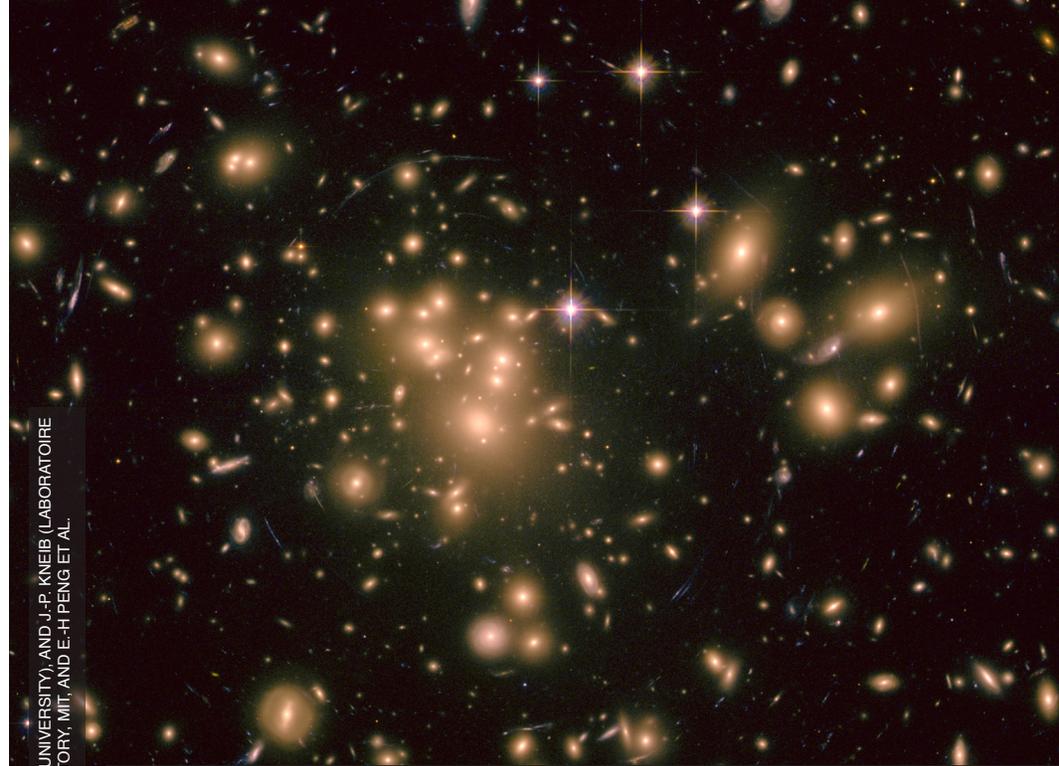


FIGURE 5. *Galaxy Cluster Abell 1689, in visible light from the Hubble Space Telescope and in X-ray light from the Chandra X-ray Observatory.*

IMAGE CREDIT: TOP: NASA, ESA, E. JULLO (JET PROPULSION LABORATORY), P. NATARAJAN (YALE UNIVERSITY), AND J.-P. KNEIB (LABORATOIRE D'ASTROPHYSIQUE DE MARSEILLE, CNRS, FRANCE); BOTTOM: NASA, CHANDRA X-RAY OBSERVATORY, MIT, AND E.-H. PENG ET AL.

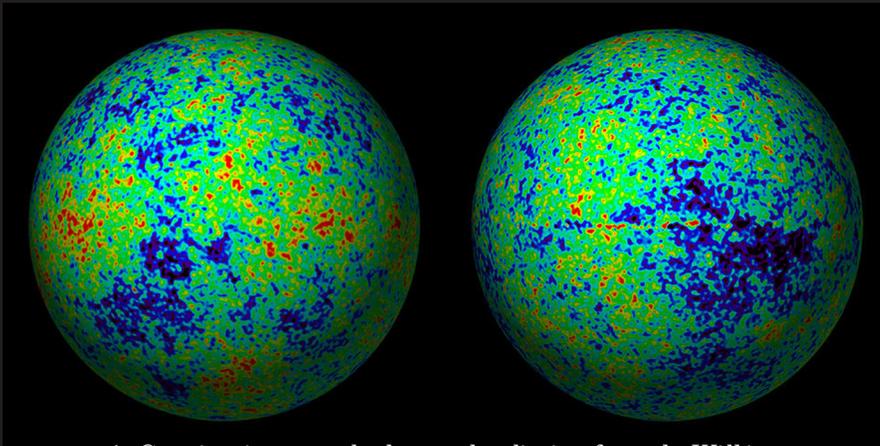


IMAGE CREDIT: WMAP SCIENCE TEAM, NASA

FIGURE 6. *Cosmic microwave background radiation from the Wilkinson Microwave Anisotropy Probe.*

cluster mass is actually in the galaxies! I love how modern telescopes show a reality beyond what our eyes can see. Without optical telescopes, we couldn't see the galaxy cluster at all. Without X-ray telescopes, we wouldn't know about the hot gas. And without particle accelerators, we would be even more confused than we are about what dark matter is.

I study galaxy clusters like Abell 1689 in my own research program. My students and I are investigating how the hot gas interacts with the galaxies, specifically how the central bright core of the gas interacts with the big galaxy at the center of the cluster. My students and I share the joys of discovering new things about the universe, and suffer the daily frustrations of calibrating data and computer analysis. We contribute a small piece of the puzzle within a community of hundreds of astronomers around the world who study galaxy clusters.

The Universe

Figure 6 looks like a child's marble or a funny planet, but it is actually an image of the whole sky. Imagine yourself standing at the center of the sphere and looking out at the universe all around you. You'll also need to imagine that your eyes can detect microwaves, because this image was taken by the Wilkinson Microwave Anisotropy Probe (WMAP), launched in 2001. Throughout this decade, WMAP has sent back increasingly precise pictures of microwave radiation from all over the sky.

This image shows the heat radiation left over from the beginning of the universe. When these photons first started traveling, the universe was as hot as iron in a blacksmith forge, but the expansion has cooled the universe way down to -454.49 degrees Fahrenheit. In the early 1900s, the prevailing view was that the universe was infinitely old and unchanging. By the mid-1950s, astronomers were considering a new model: the Big Bang. The Big Bang model predicted that faint heat radiation would be detected from all over the sky. When this was detected in 1965, most astronomers accepted the Big Bang model. In this model, the universe has a beginning in time, which is closer to the biblical picture. Unfortunately, some scientists have told the story differently, claiming that the Big Bang model means that God is unnecessary. But as with the Carina Nebula, *a scientific explanation does not eliminate God*. I see the Big Bang model as a scientific description of how God brought about the universe.

The exciting news in the last decade is about the bumps and smudges on the globe. These are regions slightly warmer and cooler than the average, and their shape and distribution (combined with some other data) leads to some amazing conclusions. The WMAP team has precisely measured the ingredient list for the universe and only 4.5% of the universe is the atoms we are familiar with from the periodic table, while the rest is exotic stuff we don't understand yet: 22% dark matter and 73.5% dark energy. When I was a young graduate student in the early 1990s, astronomers thought there was no dark energy and had major debates over the amount of dark matter; I'm thrilled that we can now measure these values with 1% precision! I hope to live to see the day when we actually understand what the dark stuff *is*. The thrill of discovery is one of the joys of studying God's creation. Even though I didn't personally contribute to this discovery, I can learn about it and share the excitement, and so can you and your congregation.

Billions of Galaxies

All photographers know that if you want to take a picture in dim light, you need a long exposure. When astronomers take a long exposure photograph with a powerful telescope, they call it *deep*. The photo in Figure 7, from the Hubble Space Telescope, is the deepest ever taken in optical light, with an

exposure time of eleven *days* (divided into many shorter exposures). In a short exposure photo, this part of the sky looks black with just a few stars. The deep exposure reveals *thousands* of galaxies. This photograph is the one of the most sensitive images of the sky ever made and was taken of a small patch of sky that didn't include any bright stars, nebulae, or galaxy clusters. And this part of the sky isn't special; a deep image anywhere in the sky would show the same "wallpaper." There are probably ten billion galaxies in our universe!

Look at the thousands of galaxies strewn about. You can see white spiral galaxies, orange elliptical galaxies, and small blue blobs that are baby galaxies, just in the process of forming. (God is making whole new galaxies!) This picture reminds us of one of the ways God sees the universe—all of the galaxies dancing and spinning through space, governed by him and following his grand design.

This picture can also make us feel really small. After all, we live on one little planet, orbiting one star in a galaxy of billions of stars, and our galaxy is just one of billions of galaxies in God's creation. Some people react to this fact by feeling profoundly insignificant: they think maybe God is just some idea we puny humans thought up to make us feel better, or an idea that can't possibly be relevant. They think that if God does exist, he couldn't possibly care about us while he is governing this whole huge universe.

My Christian faith teaches me to react to this picture in a different way. This picture of the huge universe reminds me how big God is. The Christian faith has never said God was restricted to our planet; we have always claimed God is outside of his creation and is thus, in a sense, bigger than all of his creation.

But if God is so huge, how can he care about our little planet? How can he care about my little life on this planet? This question isn't new. David writes in the Psalms:

When I consider your heavens,
 the work of your fingers,
 the moon and the stars,
 which you have set in place,



IMAGE CREDIT: NASA, ESA, S. BECKWITH (STSC) AND THE HUDF TEAM

FIGURE 7. *The Hubble Ultra Deep Field.*

what are mere mortals that you are mindful of them,
human beings that you care for them? (8:3-4, TNIV)

The question of human significance in the face of the cosmos has been with us for thousands of years. David answered it by remembering that

You have made them a little lower than the angels
and crowned them with glory and honor.
You made them rulers over the works of your hands;
you put everything under their feet... (8:5-6)

One reason we are significant is that God gave us a special role in creation, to study it and care for it. He has asked us to be partners with him in governing his creation. We are not insignificant. In fact, our responsibility to care for this earth is a much more important issue for Christians to be concerned about than arguments over the age of the universe.

Since David's time, we have learned so much more about God through his revelation to us. God himself chose to become human, like one of us. He sacrificed all of his glory, held back all of his power, and died to show us how much we matter to him. The same God who governs the galaxies all across the universe also loves each one of us enough to die for us. As Psalm 103 says,

For as high as the heavens are above the earth,
so great is his love for those who fear him;
as far as the east is from the west,
so far has he removed our transgressions from us. (vs. 10-11)

The night sky isn't meant to remind us of how small we are; it is meant to remind us of how vast God's love is.

Further Reading

To read more on astronomy and faith, the age of the earth, or interpretations of Genesis, visit The Ministry Theorem web site (<http://ministrytheorem.calvinseminary.edu>) and browse resources listed by topic. Here are a few highlights:

- Brouwer, S. *Who Made the Moon? A Father Explores How Faith and Science Agree*. Nashville: Thomas Nelson, 2008.
- Giglio, Louie. "Indescribable." Six Step Records, 2009. A video sermon on the glory of God seen in astronomy.
- Gingerich, Owen. *God's Universe*. Cambridge, MA: Harvard University Press, 2006.
- Haarsma, Deborah and Loren Haarsma. *Origins: Christian Perspectives on Creation, Evolution, and Intelligent Design*. Grand Rapids, MI: Faith Alive Christian Resources, 2011. Includes chapters on age, Biblical interpretation, and astronomy.
- Walton, John. *The Lost World of Genesis One*. Downers Grove, IL: InterVarsity Press, 2009.
- Zeilstra, Bill. *Today: A Majestic Creation*. Palos Heights, IL: Back to God Hour, 2001. A month of devotions on astronomy.