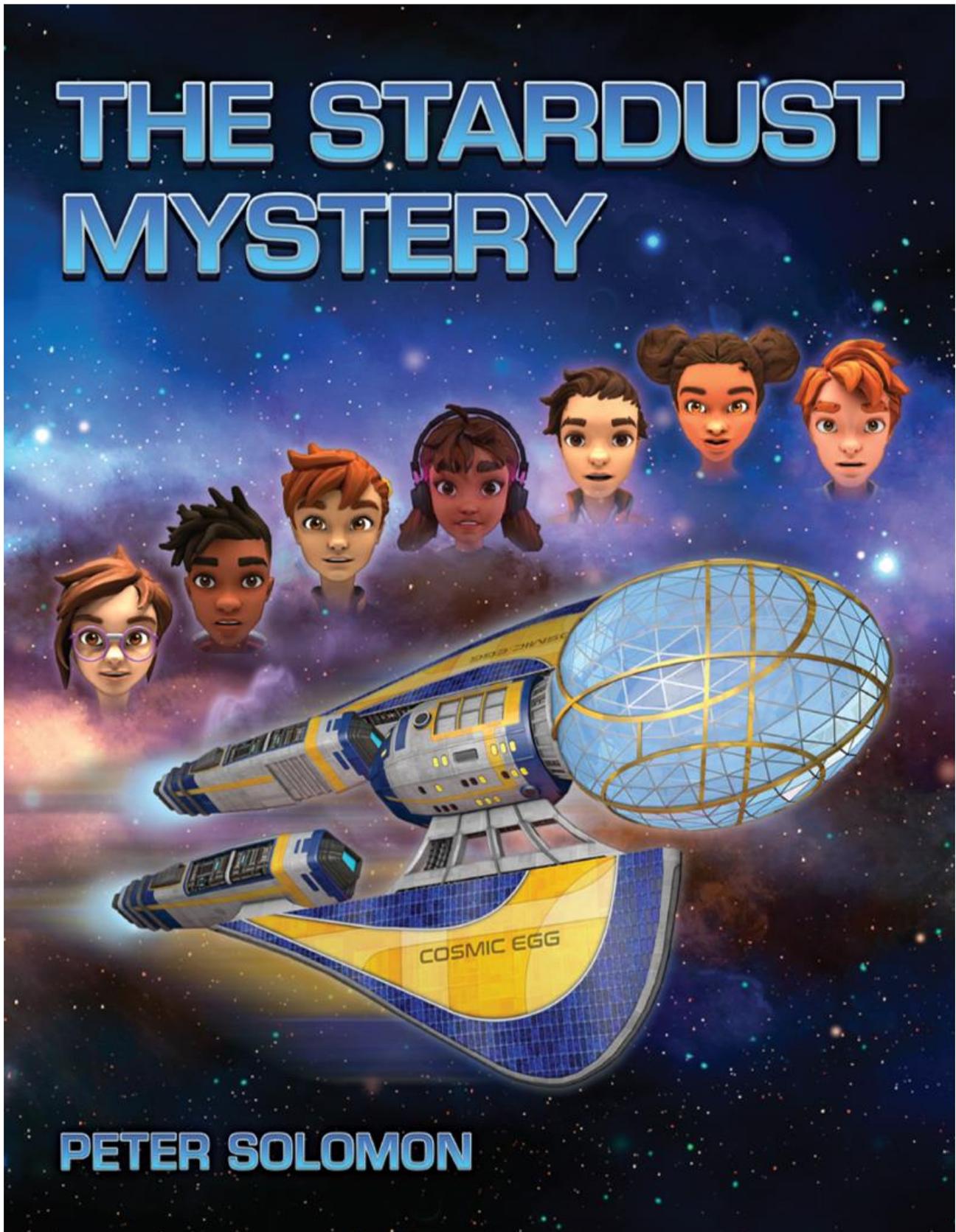


WHERE DO WE LIVE?

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LIZZY'S STORIES

WHERE DO WE LIVE?

(AS TOLD BY LIZZY)



"You sneaky little creep," I shouted. "Take it off right now. I swear, if you keep stealing my clothes, I'm going to strangle you."

I'm so sick of Neddy always stealing my best stuff. This time I caught her wearing my favorite shorts, which she tried to cover up with a long top. This wasn't a good way to start our working together. "You'd better quit it, or else."

I don't actually care if Neddy borrows my clothes, but I wanted her to ask me first. Last time I cut up her favorite tank top in retaliation for her evil thieving and klutziness that ended up with chocolate on my favorite top. But then she got me back by having a guy call and say he was this dumb kid from the boys' basketball team that I don't even like. I was so embarrassed when I called him back, and he was totally clueless about why I was calling. I can't prove she did it, but I know my little sister very well. After last week's prank phone call, I can't loan her anything on principle, probably for the rest of our lives, even if she does ask first.

Neddy glared at me as she took off the shorts and I saw she was wearing my polka-dot underwear.

"I'm so going to kill you," I screamed. She scampered away to our room and I heard her lock the door. I think she has more than her fair share of atoms from criminals.

While she sulked, I logged on to the TSI website to check the leaderboard. She snuck up behind me and started reading over my shoulder.

"OK, this is good," she said. "The Russians are not in first this time. We're closing in on the contest leaders. We only have to move up a few percent to make the cut."

"Look what Grandpa got in the mail from TSI!" I said, jumping up and pointing at the telescope that he brought over last night, which I assembled this morning. "So, what we're studying is right on target. Let's get started."

"I already did a bunch of the work on where we live in the universe," Neddy said. "First, I took a picture of our house, printed it, and drew an arrow on the picture to show where my room is. Then, for the next part of the report, I went to the computer and typed our house address into Google Maps. I zoomed in on our house and printed the satellite

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image. Then I drew an arrow to show where our house was on the street. Here's our house at 33 East Hill Drive."

"And where's East Hill Drive?" I asked without prompting, knowing where this was going.

"That's so easy," answered Neddy as she showed me the next picture in her report. "We live in West Hartford."

"Where's West Hartford?"

Neddy was ready with a map that showed that West Hartford was in Connecticut, and Connecticut was in the United States of America.

"OK, your report is pretty complete so far, but what's the biggest place that you can think of to describe where we live?" I asked.



"Now you're getting to the stuff that I so love the most!" exclaimed Neddy the Space Case. "Here's a night photograph of the Earth from space. It shows the United States with the lights on, and you can even pick out where Connecticut is. And you know what?" she went on annoyingly. "The size of the Earth is almost a million times larger than the size of our house!"

But I'm glad she said it because I suddenly got a really cool idea.

"Neddy, remember from Mission KT how the *Beamer* could make us bigger?" She nodded enthusiastically.

"Let's expand so we can look at where we live as we get bigger and bigger!"

"I so love it," agreed Neddy with a high five.

We rode our bikes to the grandparents' house to use our special computer and projection system. We barely said hello to them sitting at the kitchen table—Grandpa reading *Wired* magazine and Grandma reading a food magazine called *Gourmet*.

We logged on to the [Virtual World](#), and the image of the Mystery Museum lit up the walls, making us feel almost like we were actually inside. Since we were going to travel in

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space, we chose flight suits for our avatars. We teleported up to the *Beamer* and went to a special room off of the flight deck where I sat in a chair and started typing instructions for increasing our size.

The motherboard started to smoke; then actual lightning bolts started coming out from various points on the control panel.

"Uh-oh," I said as I flew out of the chair.

"Wow," exclaimed Neddy, "that's fantastic!"

"Let's get out of here," I objected. "I think we could get microwaved!"

"Stop being such a chicken, Miss black-belt-in-martial-arts," Neddy replied. She sat down in the chair. I continued to stand by the door, ready to bolt if necessary. If Neddy lost one life for our team, we'd still be OK since she had scored lots of extra points in Mission KT. Neddy continued typing in the instructions I had started.

"Set the size scale for a 1 million times expansion!" I called from the door. "That way we would be the same size as Earth."

Neddy clicked go and grabbed my hand as she dragged me to the flight deck for a better view. My heart was racing. Now we were both going to die. Loud humming and shrieking sounds filled the space, while outside the windows the view became filled with bright streaks of colored lights. After about thirty seconds, the noise and lights stopped, and we could see the Earth, now really small, right outside the window.

You can see Africa, and Europe," I exclaimed. "This is really cool."

"Yeah," agreed Neddy.

Earth slowly revolved in front of our eyes. Neither of us spoke while we watched the breathtakingly slow movement of our home planet. After a few minutes we could see the beginning of Iceland coming into view. If we stood here for another few hours, North and South America would eventually be visible. But right then, that didn't matter. We had to see where Earth was in relation to . . . well . . . everything!

"OK, I said to Neddy. "You know what to do next."

We both said together, "Where's the Earth?"

Neddy went to the controls and expanded us even more. She didn't tell me, but she also called in Lizzy the as the *Beamer Guide* to explain what we were seeing. She looked just like me.

"The Planet Earth is racing around the sun in the solar system. It is the third planet from the sun," She . . . er . . . I said. Lizzy the Guide pointed out the window toward the Earth. "The size of our solar system is almost a million times larger than the size of Earth."

"And where's the solar system?" I asked.

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This time the Space Nerd knew the answer. She held up her hand toward Lizzy the Guide to cut her off. Then she expanded us some more so we could see the Milky Way which was kinda flat like a pancake made out of stars and planets. Lizzy the Guide pointed out where our solar system would be.

Neddy explained, "Our solar system is revolving around the center of the pancake like the Earth revolves around the sun. But it takes one Galactic year—250 million times our solar year!—to complete one revolution!"



"And I read something really interesting in a book called [*Dark Matter and the Dinosaurs*](#)." Said Neddy. "About every 30 million years, the solar system moves through the [dark matter](#) in the galaxy."

"What's dark matter?" I asked.

"Scientists aren't even sure," Nerdy said. "It's this strange stuff that doesn't seem to give off any light or energy at all but still has a gravitational field!" So, after that nonexplanation, she went on. "Anyway, according to the theory in the book, when our solar

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system moved through the high gravity of the dark matter, an asteroid got knocked out of its orbit and slammed into Earth—maybe it was even the one that killed all the dinosaurs!”

“The KT extinction!” I said.

“Interesting, huh?” said Neddy.

We asked Lizzy the Guide about our present location and she replied, “Our solar system is an estimated 28,000 [light years](#) from the center of the Milky Way galaxy.” She made us feel very small when she added, “We’re just one tiny star system in the galaxy, and our sun is just one of roughly hundreds of billions of stars in the entire Milky Way.”

“Now what about light years? Do you know what those are?” I asked. Neddy pointed to Lizzy the Guide, who answered, “A light year measures distances in space.” She told us that a light year is the distance that light travels in one year which is 5,879 billion miles, because light travels at 671 million miles per hour.”

“Inventing a new term for a big number is sorta like what I did when I created the LIZZY for counting atoms in our bodies,” I said.

“And 28,000 light years to the center of our galaxy means 160 million billion miles away,” Neddy added.

“Think of this,” I said, suddenly really fascinated by everything we were learning, “the starlight that we see from the center of the Milky Way started out toward us 28,000 years ago.”

“OMG!” exclaimed Neddy, “how many times would we ask, ‘are we there yet?’ if we were going there by spaceship?”

We both laughed.

“The size of the Milky Way is more than 100 million times larger than the size of our solar system,” Lizzy the Guide added.

“OK,” said Neddy, “let’s do another expansion by 1 million and see what comes next.”

Outside the window, we saw lots of galaxies swirling in what looked like tiny whirlpools of stars.

“I bet there are a million of them,” I whispered as the darkness consumed the *Beamer*. All the pricks of light were stunning.

“No, even more!” Neddy said. “According to NASA, there are 100 to 200 billion galaxies like our Milky Way surrounding us in the universe.”

“Wow,” I added. “If each galaxy has 100 billion stars, and there are 100 billion galaxies, there would be 10 trillion billion stars in the universe.”

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"That would be 25,000 LIZZY stars," observed Neddy. I was impressed the kid could do the math that fast. But her next thought impressed me even more. "There's many fewer stars in the universe," she said, "than the number of atoms in our bodies."

Neither of us said anything after that because, wow!

I typed in the coordinates for one more expansion of our size by 1 million and the view out the window became totally blank.

"Can we see the Milky Way from the Earth?" I asked as we stood in almost complete darkness except for the blinking lights of the *Beamer* panels.

"Yes!" Neddy answered. "Actually, that would be a totally cool thing for us to do."

Lizzy the Guide added, "Most of the time, when we look at the sky, we don't see the Milky Way. That's because there's too much light around us from the city lights, so our eyes can't see the fainter stars."

"Hey!" I said, suddenly having a brilliant brainstorm. "Let's get Grandpa to take us out into the country tonight where there are fewer city lights and see if we can see the Milky Way!"

"Great idea!" Neddy answered. We logged off.

I was feeling great about my idea. Then suddenly I got nervous. Grandpa might still hate me. "You ask him," I tacked on. A few minutes later Neddy was asking Grandpa, and he was saying yes. In fact, he thought we should just make it a camping trip. We called the other kids to tell them to get ready to go camping. Grandma started packing the cooler with hot dogs, buns, carrots, and pickles. Then she said, "Just in case," and winked at me as she added marshmallows, graham crackers, and chocolate.

Then Neddy and I rode home. We had to organize everything we'd learn to share with the team. Neddy wrote a poem while I wrote up our actual findings. Two hours later, Grandpa was honking. Dumb Milo was riding shotgun but that's only because Grandpa passes his house first. We picked up VC last. Luckily, Grandpa had a minivan so we could all fit and so could our stuff.

We stopped for some junk food snacks because we knew we didn't want to start a fire until after we tried to see the Milky Way. We didn't want the firelight to get in the way of our view. Everyone ate while Grandpa drove. We got to our campsite just as the sun was setting behind some green hills. We set up our tents. After that, the sun was down completely, and the first stars were coming out.

"Get your sleeping bags!" Grandpa called. We all gathered our sleeping bags and unzipped them. We piled them on top of each other laying them flat out. Then we all laid

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down, side by side, so that we all could get a little space on the sleeping bag mattress. I was lying next to Grandpa. He took my hand and kissed it. I was glad.

We all laid there looking up at the sky. It was a velvety black with pricks of shining light filling up every inch. I don't think I'd ever seen so many stars before.

Then I could see it. The Milky Way.

"There it is!" I cried. "It was there all the time, and I had never seen it." The Milky Way looked like a stripe of stars across the sky. So many tiny stars all together actually did make it look milky against the extreme blackness of the night sky.



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"Welp!" said Neddy, breaking the magic of the moment as she stood up, "this is a perfect view to explain what Lizzy and I found out about where we live!"

I pushed myself up too.

"What you are seeing is called the Milky Way," Neddy began.

She explained that if you were looking at the Milky Way from outside of the Milky Way, it would look a lot like a flat pancake of stars.

"From here we were looking across the plane or flat part of the pancake from near an edge," I added. Neddy and I told the team all we learned about the distances and number of stars and where our Earth was.

Neddy and I had brought the telescope. We pushed it toward our cousins. "Let's see if we can see anything cool," Neddy said. We pointed the telescope at the brightest star that we could see. But Grandpa told us it wasn't a star at all, it was the planet Saturn. We looked again and sure enough it was a big shiny ball like the moon, but striped, and around it were the rings like in the NASA pictures.

"Wow, it's beautiful!" cried VC.

"I can even see one of its moons!" said Neddy.

We pointed at another bright area of the sky and we saw thousands of stars in a cluster. "That's the center of the Milky Way," Grandpa told us.

After an hour of stargazing, we finished with a view of our next nearest neighbor, a giant spiral galaxy called Andromeda.

"It looks like pictures of the Milky Way," observed Neddy. "You know, like a twin."

"And speaking of our Andromeda twin," Grandpa told us, "NASA predicts that the Andromeda galaxy is gonna smash into the Milky Way." It was dark, but I'm pretty sure Milo turned a little pale.

"Wait, what?" he said. "When?"

"In about 4 billion years," I announced laughing. I knew because Grandpa had told Neddy and I that story last year.

Grandpa gave me a high five, which made me feel good.

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"You know," observed Neddy, "this whole thing kinda reminds me of the Russian nesting dolls. The biggest doll is the universe, and inside that is the galaxy cluster, and then the Milky Way, and then the solar system, and then the Earth, all the way down to our state, Connecticut."



To finish off our presentation, Neddy read the poem she had written. "It's called 'Where We Live.'"

*We live in a house with a dog that's brown.
On a lot, on a street, in a nice part of town.
And the town's in a state in the US of A.
And it is all just perfect for school and for play.
All of it sits on our pretty blue planet,
that is made out of water, and air, and granite.
Earth circles our sun that's really a star,
if you were to see it from super-way far.
And our star is one speck in a galaxy,
that has hundreds of billions of stars to see.
The Milky Way galaxy is our home.
One end to the other is too far to roam.*

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*One hundred thousand years for a one-way trip,
on a super-duper speed-of-light ship.
One galaxy of billions is our Milky Way.
Is that the whole universe? Is there more to say?
Another universe could still be out there,
we can't see it, so we don't know where.*

Everyone liked our presentation, but Milo wanted to get to the hotdogs and make s'mores. While everyone else built the fire, Grandpa asked me to go with him for a little walk. He wore a flashlight lamp on his forehead that lit the way on a path through the trees. We didn't walk very far—maybe ten minutes away—but we came out of the trees at the top of a hill that overlooked a valley. The sky here was enormous. Even before Grandpa turned off his headlamp, the Milky Way was visible. It was truly something else.

"You know, kiddo," Grandpa said as we stood looking at the miraculous sky, "I'm very proud of you."

I felt tears leap into my eyes almost as soon as he said it. I had to be so still so I wouldn't start crying like a baby.

"Lizzy," Grandpa went on, "I feel like ever since the watermelon experiment, there's been something between us . . ."

"I'm so sorry, Grandpa!" I exclaimed as the tears started pouring out of my eyes freely. "I got you fired, and I'm so sorry."

"Lizzy!" Grandpa's voice sounded stern, but he put his arm around my shoulders. "What happened was an accident. I made a mistake asking you to throw a giant melon from a window. Do you understand?"

I didn't answer and kept crying, so Grandpa took my cheeks in his hands, so I had to look at his face. It made me stop crying because he looked kind of silly with the headlamp on his forehead.

I nodded and smiled. "I understand. But I'm still sorry."

Grandpa kissed my forehead. He put his arm around my shoulders and began to walk me back to camp. "I'm proud of all of you kids," he began. "You're all doing so well with this contest. Tonight's presentation was just fantastic! And so was your idea about the LIZZY as a unit of measurement of huge numbers of things."

Grandpa continued to say nice things to me all the way back to camp. By the time we got back, I felt like things might go back to normal with Grandpa, and it made me so happy. The fire was going strong and of course Milo was on his third hotdog. Neddy was on

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her third s'more. VC just kept setting marshmallows on fire and pulling off and throwing away the charred part to eat the gooey middle.

Grandpa and I joined them. We stayed up until we were all exhausted, full, and a little bit sticky. We slept well. The next day Grandpa drove us home. He hugged everyone goodbye, but I gave him an extra squeeze and he whispered in my ear, "I love you, kiddo."

Later that day we filed our contest report for the week about where we live in the universe.

GRANDPA'S GLOSSARY

Virtual World: Virtual worlds, also known as virtual environments, use computer technology to create a simulated world that a user can explore and interact with, while creating a feeling as if he or she were in that world. The representation of the user in that world is called an avatar. The user can even wear goggles to make it appear that he or she is surrounded by the 3-D virtual world. That is called virtual reality.

Dark Matter and the Dinosaurs: In her book *Dark Matter and the Dinosaurs*, particle physicist Professor Lisa Randall of Harvard makes a case that dark matter had something to do with killing off the dinosaurs. Her proposal goes like this: When geologists and paleontologists look at the fossil records, there appears to be evidence that a major species extinction occurs every 30 to 33 million years. "So," she asks, "is there a physical reason to explain that?" There is a physical event that has such a period. It is the oscillations of our solar system up and down through the plane of the Milky Way disk as it makes its way around the galaxy during its 225-million-year orbit. Each such orbit makes a galactic year. The idea is that the passage through the plane with its higher gravitational field might knock comets and asteroids out of their normal orbits around the sun, and some of these unhinged bodies might hit our planet. But calculations of this effect suggest gravity from normal matter is not sufficient to dislodge these objects from their orbit. Hence, she proposes that there is some extra gravity exerted by a disk of dark matter that lies within the disk of the visible Milky Way. The combined gravity from the normal matter disk and the dark matter disk might be enough to do the job.

Dark Matter: Dark matter is one of the big puzzles in physics today. Dark matter is what we scientists call a fudge factor. We put it into our theories when the physics we know doesn't work. So why do we need dark matter? Where does our physics not work? The answer is the structure of the universe. Normal physics says it shouldn't look like it does. Take a galaxy like our Milky Way. It is rotating like pizza dough when the pizza guy throws it in the air. It gets bigger because of centrifugal force, which wants to push the dough away from the center. You feel that force when you stand at the edge of a merry-go-round. If you don't hold on, you fall off. Gravity is holding on to the stars at the edge of the Milky Way disk as it rotates, but gravity from the visible matter isn't enough to do the job. Our Milky Way would fly apart if the only gravity were from visible matter— hence, the fudge factor. Let's assume there is enough extra matter to do the job of keeping the stars from flying off the galaxy, but we can't see it—thus, the name dark matter. Calculations show that dark matter makes up more than 85 percent of the total matter in the universe.

Light Years: The distances to other places in space are huge. For example, the distance from the Earth to the sun is 93 million miles; the distance to the closest star, Proxima Centauri, is 24 trillion miles; and the distance to the nearest galaxy, Andromeda, is 14 million trillion miles

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(14,000,000,000,000,000 miles). Astronomers decided that giving distances in such large numbers of miles or kilometers was not very easy for comparing different distances. So, they decided to invent a new unit of distance called the light year. The light-year is the distance that light travels in one year. Since the speed of light is 186,282 miles per second, it travels 5.79 trillion miles per year. Proxima Centauri is 4.22 light years away, and Andromeda is 2.5 million light years away.

When looking at an object in a telescope, the light year tells us something interesting besides distance. It is the time it took for the light we are now seeing to get here. So, we are really seeing how the object looked at some time in the past. When we see Andromeda in a telescope, we see how it looked 2.5 million years ago. When the Hubble telescope takes pictures of the furthest objects away from us, it is actually seeing what they looked like 13 billion years ago, not that long after the Big Bang. So, looking at objects that are further and further away lets us look at earlier and earlier times in the history of the universe.

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