

# SCOOPS OF STARLIGHT

BY THE UNIVERSITY OF IOWA CHAPTER FOR THE SOCIETY OF PHYSICS STUDENTS

**Funded by the Society of Physics Students  
through the Marsh White Award**

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“Now everyone, remember to get your show and tell projects! We’ll be showing them off after recess.”

Jocelyn and Edwin’s hearts sank as they remembered that show and tell will be taking place so soon. The friends glanced at each other, both asking the same question in unison.

“Did you remember to get something for show and tell?”

“OH NO!!” they both exclaimed.

DING DING DING!!! The bell rang, signaling recess. The doors opened, and kids scrambled outside toward the playground. Jocelyn and Edwin strolled across the woodchips toward the slide.

“I can’t believe we forgot that show and tell is today. If we don’t find something during recess, we’re going to be the only students who don’t have anything to share. That could be really awkward,” Jocelyn said to Edwin. “What on EARTH will we do?”

“No, Jocelyn,” Edwin said, grinning. “What in SPACE?!?” He whipped out an astronomy book he had borrowed from the library.

Jocelyn’s face fell.

“Who wants to see a book for show and tell? We need to WOW them,” she said while frowning and slumping back against the slide. “Huh?! There’s something under my shoulder!”

Behind Jocelyn rested a button that read, “PRESS FOR ROCKET SHIP.”

“It looks like this is our only option for finding something for show and tell!” Edwin exclaimed.

“You’d be nuts to think that I won’t press this button! I NEED to see what happens,” Jocelyn said.



“Jocelyn is named after the astronomer Jocelyn Bell Burnell, the astronomer who discovered the first radio pulsar. Edwin is named after Edwin Hubble, the astronomer who played a crucial role in the creation of extragalactic astronomy.”



The ground started to shake. Suddenly, the playground started transforming! In a state of confusion, Jocelyn and Edwin scrambled to the top of the slide as it started to morph into a robotic arm. Pedestals popped up from the floor with jars resting on top of them. The playground came alive like a sleeping beast and transformed into a rocket. Attached to the pedestals were signs that read, "INSERT STAR JARS HERE."

"WHOA! Let's get scoops of starlight for show and tell!" Jocelyn yelled with enthusiasm.

BLASTOFF! First stop, the Sun.

"It looks like these jars are meant to collect stars, so why are we heading toward the Sun?" Edwin said curiously.

Jocelyn opened up the astronomy book that sat next to her.

"According to this astronomy book, the Sun is a yellow dwarf star that is 4.6 billion years old. The surface is about 10 thousand degrees Fahrenheit. That's pretty toasty!" Jocelyn said.

"WOW! That is pretty warm. I read that most of the basic building blocks of stuff come from stars. Those basic building blocks are called elements. I think the first element is called hydrogen..." Edwin said. "... which was created from the Big Bang, the explosion that created our Universe around 13 billion years ago."

Edwin lifted one of the jars, examined it closely, and placed it on the pedestal.

"I read somewhere that the next element is helium, and after that is lithium, and there are many more," Edwin said. "The Sun crushes hydrogen atoms so hard that they combine into helium. This is called nuclear fusion. The Sun fuses 600 million tons of hydrogen into helium every second. We can see and feel this on Earth: it's called 'daytime'!"

The duo zoomed toward the Sun and entered orbit, steadily maintaining a safe distance from the star's intensely hot surface.

Jocelyn stuck the jar into a hole on the pedestal and it popped into the hand at the end of the robotic arm.

"Launch the arm!" Jocelyn said as the robotic arm stretched all the way to the Sun and scooped a heaping mound of the hot star stuff, called plasma.

"It takes a little over eight minutes for light to travel from the Sun to the Earth and a little over four years for light to travel from the nearest star. The speed of light is the fastest speed anything can go, which makes this journey impossible for Jocelyn and Edwin in our universe. However, the duo lives in a universe that was created for educational purposes."





As the arm pulled back into the ship, an intense rumbling began inside the rocket.

“What’s going on?” Jocelyn said.

Without warning, a giant blast of hot plasma ejected towards them!

“A SOLAR FLARE!” the duo screamed in unison.

The plasma hit the back of their rocket, sending them flying deep into space towards distant stars. Jocelyn and Edwin fell backward onto the ground of their rocket, zooming on the crest of the solar flare.

Surf’s up!

The planets whizzed past the windows of the ship quicker than Jocelyn could count to eight.

The Sun shrank into a tiny yellow dot in the distance, blending in with the sea of stars in their vision.

“That solar flare was GINORMOUS. It was like, nine times larger than the Earth! And did you see the Earth compared to the Sun?! It looked like a million Earths could fit inside it!” Jocelyn exclaimed.

“Yeah, we’re really tiny compared to everything, aren’t we?” Edwin muttered. Edwin peered back toward his distant home. “Do you think anyone has ever been this far out into space?”



“Solar flares are powerful events that affect our Earth and other planets. These occurrences aren’t powerful enough to launch normal rockets to the stars, but Jocelyn and Edwin travel in a fantasy rocket.”





The ship zoomed toward what first appeared to be a red dot in the distance. Slowly, the dot became larger.

And Larger.

And Larger!

The red dot became a giant red fireball, filling up Jocelyn and Edwin's view.

"That's huge!" Edwin said. "Jocelyn, you're holding the astronomy book, what is that huge fireball?"

"I'm so glad we brought the book," Jocelyn said. "Stars like these are called red giant or red supergiants. The book says that our Sun will turn into a red giant in around 5 billion years."

"If this is a star and our Sun is a star too, why does this one look so different?" Edwin said.

"Let's see...our Sun is mostly made up of hydrogen. We already learned that the Sun stays alive by crushing hydrogen together in a process called fusion; it says here that stars use fusion to create heavier elements. Fusion gives off a tremendous amount of heat and light," Jocelyn continued to read. "When a star runs out of hydrogen in its core, it will change size and grow larger. Now known as a red giant or a red supergiant, it will next start to fuse helium together and then move onto other elements."

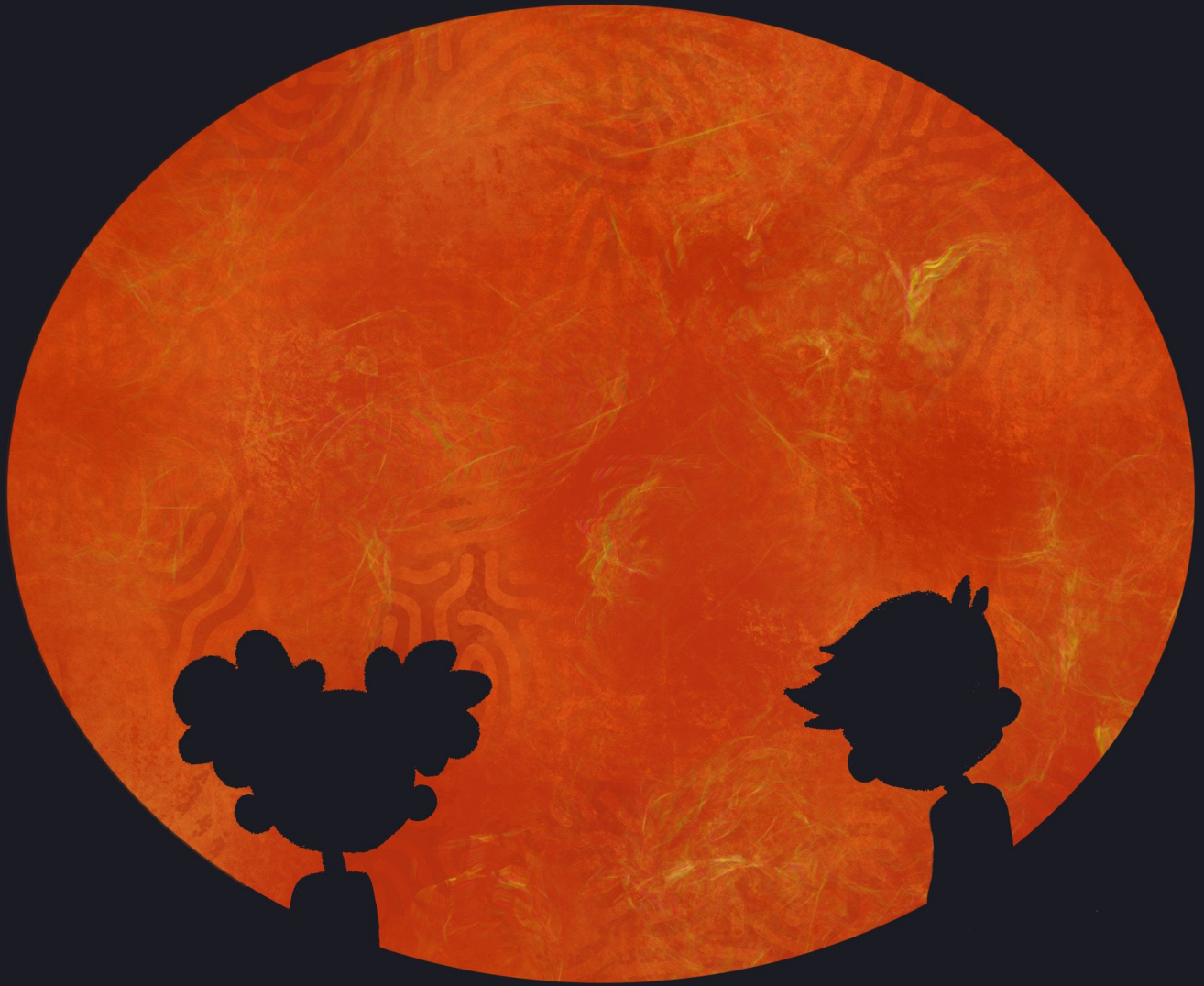
"Woah," Edwin said. "How big will our Sun get?"

"Apparently it will get so big it will consume the Earth and destroy everything!" Jocelyn said.

"I find that really scary. I want to enjoy our Sun as much as possible while it's the perfect size for life to exist on Earth," Edwin said.

"Don't worry, Edwin. 5 billion is such a big number that no person can count that high in their entire life," Jocelyn said. "For all we know, humans might leave Earth for another place in space!"

The two pressed their noses to the window to see the whole gargantuan star. They pulled their ship alongside the stellar behemoth and entered into orbit, basking in the glow of the huge star.



The robotic limb reached from the ship's side toward the star. In one quick motion, the ship scooped up a jarful of the red colossus. The glowing red jar popped up on the pedestal in the ship.

“Hey! This jar is dimmer than the jar that holds our Sun,” Edwin said. “The book says that a red giant or red supergiant's surface is red because its temperature is cooler compared to our Sun.”

Edwin picked up the shining red jar with ease in order to inspect it more closely. Attempting to pick up the Sun jar, Edwin let out a yelp.

“Yikes! Our Sun really is hotter than the red star. How cool! What did you learn from the book?” Edwin asked.

“A red giant or red supergiant's size is so much larger than our Sun that it appears a lot brighter overall. The reason the star's surface is cooler than our Sun's surface is that the heat is spread over a larger area,” Jocelyn said while reading from the book.

All of a sudden the ship shook violently and unexpectedly.

“OK! What's going on now?!” Jocelyn cried out.

“Orbiting this close to a star to collect plasma in a jar would melt most normal rockets and jars, but not Jocelyn and Edwin's.”





The ship was trembling under the mysterious force coming from the star. The star seemed to be pushing everything on its surface away. The duo was caught in a plume of gas that was shedding off the giant.

Edwin hastily opened the astronomy book.

“It says that when a red giant or supergiant stops fusing elements in its core, the star changes into something else,” Edwin said while struggling to keep his balance.

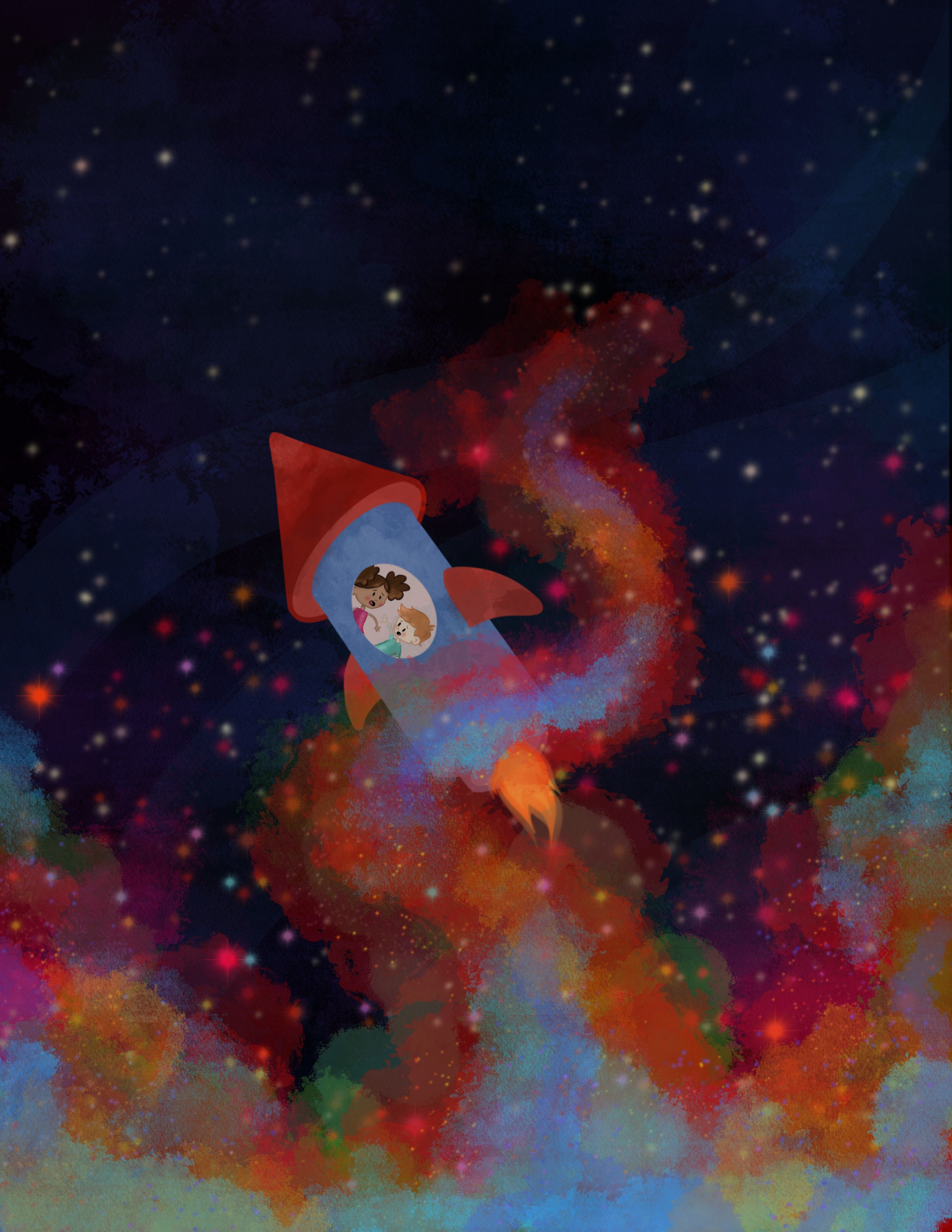
“What does that mean?! Like when a caterpillar changes into a butterfly?” Edwin studied the book some more, finding that the answer was not as simple as he had hoped.

“Well, it says here that the red giant or supergiant can change into many different things,” Edwin yelled over the racket. “If it’s a red giant, then it will turn into a white dwarf star with a cloud of gas called a nebula. If it’s a supergiant, it will explode and turn into a neutron star, a pulsar, or even a black hole.”

The rattling ship got louder and louder; they could barely hear each other over the noise.

“Wait, what?! A BLACK HOLE?! I don’t like the sound of that!” Jocelyn yelled. “Well, which one is it? Is this a supergiant or a red giant? How are we able to tell from here?!”

“IT DOESN’T SAY HOW TO TELL THE DIFFERENCE! This isn’t bird-watching!” Edwin yelled. In that instant, the ship’s movement became more violent. The ship started groaning under the strain. The two friends couldn’t hear each other over the noise. All they could do was scream and hope for the best.



As suddenly as the shaking started, the ship became still and sat quietly in outer space. All they heard was their breathing and the hum of the ship.

“What a relief,” Jocelyn said as she wiped a drop of sweat off her forehead.

Edwin stood at a circular window at the side of the ship, looking back toward where the red giant used to be.

“What is that?” Edwin said while pointing out the window. “It’s smaller than our Sun and the giant star. It almost looks like it’s the size of the Earth. I need to know what that is!”

“To the book!” Jocelyn shouted with excitement.

Outside the window, a white orb floated in the silent vacuum of space. The plumes of gas that had shed off the red giant dispersed into the cosmos.

Jocelyn and Edwin huddled around the astronomy textbook, flipping the pages to find anything that could help them.

“It looks like this is called a white dwarf star, which happens to be the final stage of our Sun!” Jocelyn exclaimed. “It looks like this star was a red giant and not a red supergiant! It shed off its layers and revealed its spent core. If it had been a supergiant, it might have turned into a black hole, and I sure would not have wanted to see what would have happened next!”

Ahead of them, the orb spun like a top. The rocket accelerated toward the white dwarf star.

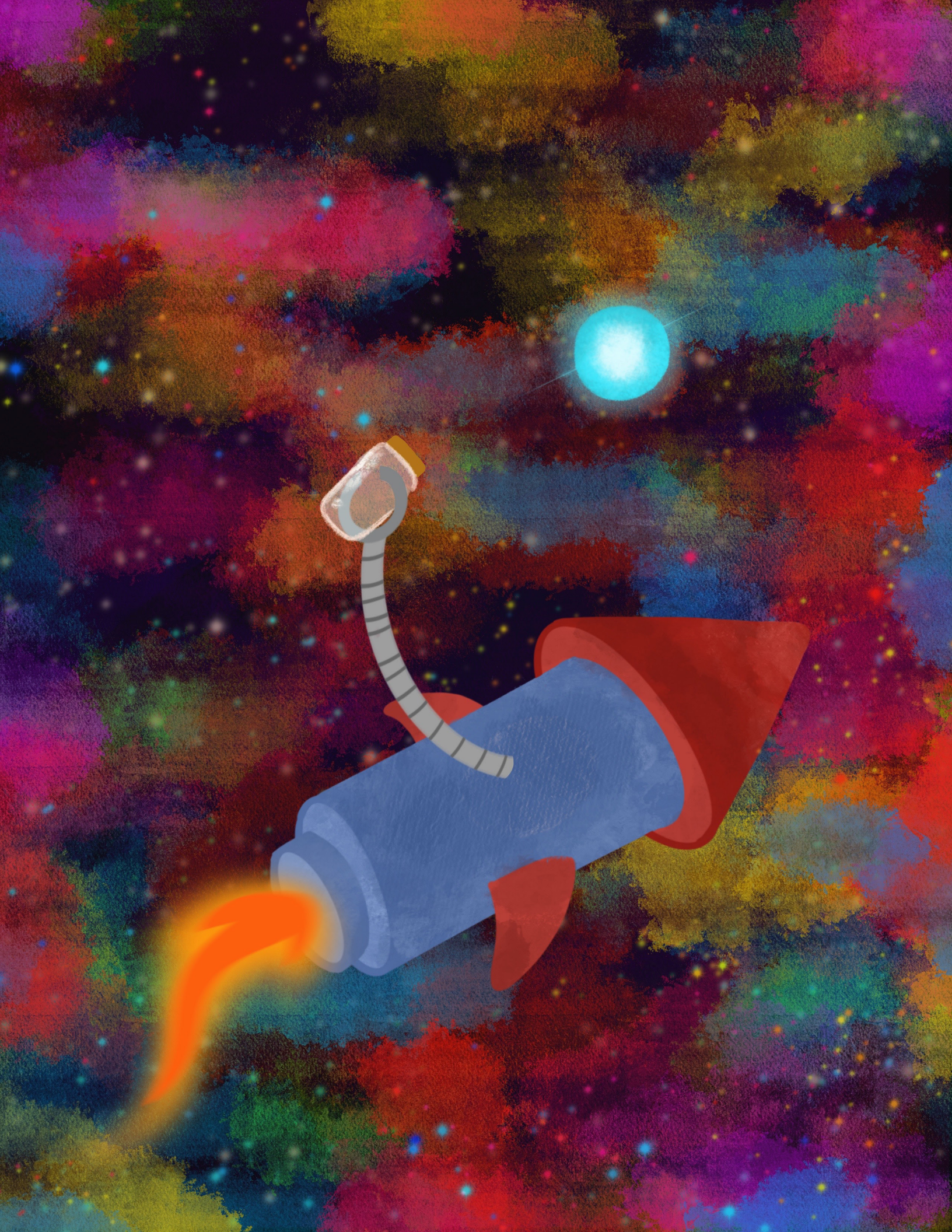
“It’s pulling us toward it with its powerful gravity,” Edwin said while using the rocket’s thrusters to slow them down.

White light blazed through the window.

“Ready the jar!”



The transformation from a red giant star to a white dwarf star usually takes around 75,000 years for a star with a similar amount of stuff as our Sun. For Jocelyn and Edwin, it was only a moment!





The robotic arm cranked into position.

“Ready to scoop!”

The arm dipped the jar into the star’s surface and began to struggle. The arm’s motors worked as hard as they could until they couldn’t move anymore.

“The jar is too heavy!” Edwin said with frustration.

“But isn’t this made of the same stuff as the other types of stars?” Jocelyn asked.

Jocelyn looked to the book for help. “Well, remember how the elements continue to fuse together in the core of a star until they make heavier elements? The white dwarf is made of the elements carbon and oxygen, but it’s so heavy because the star is tightly packed together! It still has the same amount of stuff as all the other stars, but now, it’s all packed into a small space only the size of the Earth.”

“Looks like I’ll have to pour some out to scoop it up!” Edwin said.

Edwin maneuvered the arm and poured out half of the jar. It was still too heavy to pick up. He poured out another half. Still too heavy. He poured out more and more until it looked like nothing was left. Finally, the arm pulled the jar back in.

The jar popped up on a pedestal in the ship. It weighed the same as the other jars.

“There’s nothing inside!” Edwin cried out as the two peered closer.

“Wait, look!”

Floating in the middle of the jar was the teeniest, tiniest, densest speck the two had ever seen. It was blazing hot and glowed brightly.

“Amazing! But, ummm, look at the time, we need to get back to Earth before we miss the show and tell!” Jocelyn said with concern.



Jocelyn turned the ship, turned the thrusters on to full power, and accelerated away from the white dwarf star.

“Would you look at that!” Jocelyn exclaimed and pointed out the window.

“The gas that shed off the red giant looks like it formed a cloud around the star!” Edwin noted.

They flipped open the astronomy book, hoping for a clue on what that meant.

“After a white dwarf star settles, a cloud of gas and dust is left around the cooling star,” Jocelyn read. “This cloud is called a nebula.”

“I know what a nebula is!” Edwin said excitedly. “Nebula are regions of gas and dust where new stars are born. It says so on the first page of the book. I think it’s amazing that when stars cool and their light begins to fade, they create gas and dust that can form new stars!”

They watched the white dwarf and nebula disappear as they got further and further away. The Earth came into view.

“Okay! We have one jar from our Sun, one from a red giant, and one from a white dwarf,” Jocelyn summarized. “This is the greatest show and tell in the history of show and tell!”

The ship landed softly on the empty playground.

“Look at the clock!” Jocelyn cried out. “Recess ended 30 seconds ago! RUN!”

The duo ran through the doors and burst into the classroom.

“We’re sorry we’re late,” Edwin and Jocelyn said in unison.

“There you are! We were so worried, we didn’t know where you two went off to,” the teacher said as the pair quickly scrambled toward the classroom.

“Knowing how adventurous and smart you two kids are, we are all at the edge of our seats and excited to see what you brought in for show and tell!”



“Oh? Trust us, this show and  
tell is out of this world.”

