But Why: A Podcast for Curious Kids

How do they control the Mars Rover from down here on earth?

March 3, 2017

[Jane] This is *But Why: A Podcast for Curious Kids* from Vermont Public Radio. I'm Jane Lindholm. Every episode we take questions you have sent us and we find cool people to offer answers.

If you have a question, have an adult record you asking it. They can use their phones memo function and then send the file to questions@butwhykids.org.

Did you hear the big news that just came out from NASA, the U.S. space program? NASA just announced that seven new planets have been discovered. They're called exoplanets because they're not in our solar system. That means they do not revolve around the sun that we are all familiar with. This discovery is really exciting and interesting because some of these planets could have life on them.

These planets orbit a star that's much cooler than our sun. The type of star that they orbit is called an ultra-cool dwarf. I love that name. Yo, I'm an ultra-cool dwarf man. What that really means is that even though those planets are closer to their sun then we on earth are to our sun. It's not too hot for them and these planets could have liquid water which is a prerequisite for life. Prerequisite means something that must exist before something else can happen. So water must exist before life, at least life as we know, it can emerge. So these planets are rocky. They might have water and they're not too hot or too cold. At least some of them could potentially have things living on them. That is very exciting.

The other reason this is an exciting discovery is because these planets are only 40 light years, or 235 trillion miles away. That doesn't sound very close does it? But it is by astronomical standards. That's important to scientists because these planets are close enough that maybe someday we'll be able to build telescopes and tools that can explore these planets more closely and we can actually find out if there's anything alive on them. Whenever I hear about cool things in space there's a guy I know who I always want to talk to.

[John] I'm John O'Meara. I'm associate professor of physics at St. Michael's College. My specialty is trying to figure out how galaxies take the gas inside of them and form them into stars.

[Jane] John is very excited about the discovery of these new planets. He says this discovery proves that this kind of planet, that might also contain life, is more common than we thought. In fact John says there are maybe billions of planets in the habitable

zone in our galaxy alone. The habitable zone is a place where life might exist. That's pretty amazing: billions of planets. The trick is how do we find out about them? We have to build the tools that will allow us to explore these planets. We've already built tools to explore some of the planets in our solar system. Here's a question we got about one of them that we asked John O'Meara to help us answer.

[Sadie] My name is Sadie. I'm 7 years old and I live in Blacksburg, VA. My question is how do they control the rover on Mars back here on earth?

[John] Wow, Sadie, that is a really good question it's a really fun question for a lot of reasons. So there are two Mars Rovers that we have that are driving around on the surface of Mars. One is called Opportunity, which was part of a set of two rovers that landed over 12 years ago, Spirit and Opportunity. And Opportunity is still driving around. And the larger Mars rover is called Curiosity and it's about the size of a small car. And these Mars rovers are driving around trying to figure out whether or not there was water on Mars, on the surface of Mars back in Mars's past, because we really want to know if there was life on Mars. And to be able to do that we first need to be able to find water.

If we want to be able to send people to Mars we want to know what kind of place we're sending them to and so the rovers are driving around drilling into rocks, looking for water, looking for other things, trying to understand what Mars was like a long time ago and what it's like today. The rovers are really neat, that has cameras that look at the rocks and so they send the pictures back. It's got a laser that can shoot at the rocks and then they look at the smoke that's given off whenever it does that and some very sensitive instruments can figure out what atoms are in the smoke to figure out what the rock was made of. It also has a drill that can drill into the rock and then they take a scoop of the dirt from the drill material and they dump it into an oven in the backside of the rover, cook that and then try to figure out what atoms are in that from that way. So the Mars rover can do all of those things. The one thing it can't do yet is bring stuff back.

[Jane] Because it's never coming back.

[John] It's never coming back. Not this one.

[Jane] Eventually the Mars rover will stop working and then it's just stuck on Mars. Which is kind of a problem because it essentially becomes space garbage on another planet. But let's get back to Sadie's question about how the Mars Rover is controlled. Have you ever played with a remote controlled car? You press buttons or move knobs on the little gizmo in your hands and a signal goes to the car and tells it what to do. And then the car moves around. It's kind of the same idea for how the Mars Rover moves around, way, way, way, way, way out on the surface of Mars.

[John] Every single day some people at the Jet Propulsion Laboratory out in Pasadena, California, the people that helped build the Mars Rovers for NASA, they upload a set of commands to the rover and they say ‘OK Rover, I want you to go over to that rock and drill it or look over at that piece of gravel or dirt out there and we want to see something interesting about it.’ And so they will tell the rover to go over to that spot and they will tell the rover to go over that spot in one of two ways: either they just say ‘Go over there and you figure it out.’ The rover has these hazard cameras called has cams on it that are kind of like our eyes. And so they can see in 3-D and figure out where rocks are, how big they are, whether or not they're dangerous. And the rover can figure its way out over there all by itself. It's got that good software inside of it. Or if it's a particularly dangerous way for the rover to go they will upload commands to say OK go, go a few feet and then stop and take a picture and send us the picture and then go a few feet more and send us a picture and they keep going stop and start and stop and start like that. Because it's, they've only got one big Rover like that on Mars and they want to make sure that it's safe.

[Jane] When you say they tell it or they give it commands, they're not you know speaking into the Rover’s ear it's all a computer thing so they're typing out a command in code.

[John] Yeah that's right. There's no like joystick or anything like that. Yes they type the commands into a computer, that computer then talks to a satellite and that satellite is part of what we call the deep space network. The deep space network sends things off to another satellite that's orbiting around Mars and then that satellite relays the information down to the rover. And this is all really difficult because it takes like 15 minutes for the light to get from the Earth to Mars. And so whenever they tell the rover to move they have to wait a really long time to see whether or not it did.

[Jane] When you say a really long time, how long?

[John] Well, sometimes if you tell it move over to that rock over there, it'll take the rover only a minute to move over to the rock but it'll take a half hour to know that it got there.

[Jane] So it takes you know 15 minutes for that command to get to the rover and then the rover does the thing and then 15 minutes for it to get back to the scientists who are driving the rover to see what happened. So you can't say to the Rover ‘look out there's a rock’ and actually have it stop right then?

[John] That's right. That's why we have all these hazard cameras on there and all this software inside of the rover and they had to build similar software into the rover system when it came into Mars because it only takes about seven minutes to go from outside of Mars’s atmosphere to landing on the surface of Mars. And it takes a much longer time

for the signal to get to us. So the Mars Rover had to land itself. It had to be smart enough to land itself safely and it was really awesome to watch it pull that off.

[Jane] When you talk about the people who are making these commands and driving the Rover, who are they? How do you get the job of driving the Mars Rover?

[John] Well that's a great question. A lot of these people are astrophysicists. Some of them are planetary scientists, some of them are engineers and some of them are people who just really wanted to work for NASA, and so and they started working for NASA just outside of college and stayed there and got to build on the Mars Rover. And it's men and women from all over the country and all over the world who come together to work for NASA at one of the main NASA centers to help make these rovers work, because pieces of the Rovers were built all over the country and then assembled and then launched from Florida, and so it's all over the country that's working on this thing.

[Jane] So you haven't driven the Mars Rover, right?

[John] I have not driven the Mars Rover.

[Jane] But you've driven some other pretty cool astronomical instruments. Can you talk about them?

[John] Yeah I think my favorite thing that I ever get to drive is, I get to tell the Hubble Space Telescope where to point. The Hubble Space Telescope is one of the greatest telescopes ever built and it takes such wonderful, wonderful images of things way out in the universe. And it's really fun to be able to tell it where to point.

[Jane] If somebody is picturing a telescope maybe they've seen a telescope in their home or you've been to an observatory near your home and there's a big dome and a telescope that points up out at the sky. That's not what the Hubble is.

[John] No. The Hubble Space Telescope is orbiting around the earth so we can't go out there and push it with our hands to aim it where we want to. It's kind of like the Mars Rover. Every day they upload a series of commands and they are talking to the computer that then talks to the Hubble and then the Hubble points. And you can just, you can actually watch on Twitter now where it's pointing it will say every time it points to something new it will say where it's pointing, it's kind of fun.

[Jane] When we talk to Professor O’Meara about this he was just about to change the direction of the Hubble Space Telescope a couple of days later. I wondered where he was going to tell it to point.

[John] I'm going to tell the Hubble Space Telescope to point at a very, very, very distant galaxy, a galaxy that's over 12 billion light years away. And I'm trying to figure out what

the gas that surrounds that galaxy is made out of and how big that galaxy is. And we need to have something with eyes as good as the Hubble to be able to do that.

[Jane] The Hubble Space Telescope, as John said, is a telescope that's up in space orbiting the Earth. Since it's in space already, it's able to see things farther away than we could see them from a telescope that's anchored to the ground here on Earth. The Hubble is a lot like the telescope that was used to find those new planets I talked about at the beginning of this episode. The telescope that astronomers use to find these seven planets is one called the Spitzer Telescope. It looks at a different kind of light called infrared. But the Hubble Space Telescope is now being used along with another orbiting telescope called the James Webb telescope to learn more about these new planets. So maybe in your lifetime we'll know whether or not these planets have living things on them. Now that would be an amazing discovery.

Of course, don't you actually want to visit these planets? I do too. But don't get too excited yet. John O'Meara says visiting will be very, very hard. It would take many millions of years if we were to fly there in a regular plane. But he says maybe someday we'll build spaceships that hold generations of people so people would be born on the space ship live their whole lives and their kids would live their whole lives on the spaceship and then eventually their great great great great great great great great great great great great great grandkids would reach that faraway planet.

I want to leave this part of the show with one other cool thing from our friend John O'Meara. When I was setting up his microphone I asked him to tell me about his favorite space fact and this is what he said.

[John] My favorite space fact is that half of the air you're breathing right now came from stars within our galaxy and half the air you're breathing right now came from outside of the galaxy. How do we know that? Well, we look at the details of oxygen absorption both inside galaxies and stars and then now in the regions surrounding galaxies called the circumgalactic medium. In 2011 I was on a paper that figured out there was a lot more oxygen surrounding galaxies than we thought.

[Jane] So when you say that it makes me feel like the oxygen I'm breathing is really old stale air.

[John] The air isn't stale but the oxygen is older than the Earth because that oxygen was put in place, that oxygen is the result of stars going through their entire life cycle more than five billion years ago.

[Jane] Whoa. You're breathing oxygen that's more than five billion years old. That is a really a wild thing to think about isn't it?

I want to pause for just a minute before we get back to the questions. For the month of March, podcasts of all kinds are getting together to spread the word about how cool podcasts are. So here's what we want you to do. Right now, think of a friend, could be your mom, your teacher, a friend at school. Can you think of a podcast, you think that person would really love? We want you to tell your friends about it and maybe help get them started. You can find an adult to help you with that part. And then have your adult tell us what you recommended using the hashtag #trypod. T-r-y-pod. And thanks for spreading the word.

That's the sound of ice skating. If you live in a part of the world where there is winter or if there's a rink nearby, it may be something that's a pretty familiar sound to you and maybe like skating too.

In Ottawa, the capital of Canada, about 20,000 people every day head onto the ice on the Rideau Canal. A canal is like a river but it's not natural. It was built to connect two waterways. The Rideau Canal becomes the world's largest skating rink when it freezes over in winter. On a busy day, you'll see families skating people walking or pushing kids, some adults in sleighs on the ice. Some people may even commute to work or school along the canal on ice skates, and machines go by with big brushes to keep the ice clean. It's like a carnival. There are even places you can play games and listen to music and eat pastries called Beaver Tails. We found someone on the Rideau Canal who could help us answer a few questions you sent us about ice.

[Bruce] Bruce Devine, senior manager for the Rideau Canal Skateway working for the National Capital Commission. Well the Rideau Canal, for the wintertime the National Capital Commission has the mandate to manage the ice rink. It is the largest skating rink in their world on natural ice, floating ice surface, there's water moving underneath. It's UNESCO historic site since 2007. It started, this is our 47th year. It started around the 70s where he actually had his crew to shovel five kilometers. And it was so much of a success, so it started to build up and build up and now we're 7.8 kilometers long. We average We average about 20,000 visit a day, so a regular season of 50, 52 days, it's about 1.2 million visits that we have during the season.

[Benjamin] I'm Benjamin. I'm five and a half. I live in Philadelphia. My question is why does ice float?

[Bruce] The water is made of many molecules like you imagine small, small bingo balls all tied up together, so it very tight. It has something of a weight. But when it freezes those bingo balls separate. So they separate as much that becomes less dense so it's lighter. And now it begins to float.

[Jane] I like that picture, lots of Bingo balls, or say tennis balls, all hugging tightly together when the water is liquid. And then those balls, or molecules spread out when they get older and turn into ice. That makes the ice less dense, it makes it lighter because it’s not so many balls packed into that same space. There are fewer of those balls in that same square, so it’s lighter, that makes the ice lighter than the water, and the lighter ice floats on top of the heavier water. Here’s a question we got about the clarity and color of ice.

[Caleb] Hi my name is Caleb, and I live in Amherst, Massachusetts and I’m seven years old. And my question is why is some ice clear and some is not.

[Bruce] We've seen in pictures or some have seen it in life, the icebergs are blue, sort of. So those are old, old ice blocks. The sunshine goes through and it absorbs every color of the sun except the blue and it reflects it. So that's why we sort of see it like kind of blue.

Whereas here we have two types of colors because it's not an old ice. It just forms quickly and then it disappears when it gets warmer. So you've got clear ice. So this is the natural water underneath that has no snow on it. There's no dirt on it, it's very clear. We can see it through. Since we are processing now, when it snows before we open the season, to accelerate the thickness of it, the 12 inches for instance, we water all the snow on it. So it becomes, it acts like a sponge, and absorbs all the water and becomes very, very, very tight. And like this one in my hand we called it the white ice. You see all the bubbles in there. So those are air bubbles. But you and see how tight they are, so it's all squished together. So this becomes very, very solid, as normal ice. So the tighter this ice, less bubbles there is the safer it is to be. Like, if you see some gray ice, this is a mixture of the ice, it gets warm and then it gets cold so there's a little bit of water that gets trapped into it. It doesn't freeze very well. So we call it a grey ice that is not a safe ice to be on.

[Jane] Did you catch all that? An oversimplified answer is that clear ice is usually ice that froze slowly enough for bubbles and impurities to have a chance to rise to the surface and escape before they were frozen in. Bruce mentioned blue icebergs where made from old ice. Basically because those icebergs were formed so long ago, they have been compressed over time. The ice has been squeezed more and more tightly together and all of the oxygen in the ice has been squeezed out of it. When light hits this iceberg the light is absorbed instead of reflected because there’s not as much oxygen in there, so we see the iceberg as blue and not white.

Bruce also mentioned that the ice on the Rideau Canal is 12 inches thick. That's pretty solid. Still there are people who monitor the ice to make sure it's safe for people to skate

on. But how do you know if natural ice that you find near your house is thick enough to skate on?

[Bruce] You want to make sure that you've got at least if you're just skating, six inches, five inches of ice, especially if it's a river. Well you should wait…well you'd shouldn't venture on the river. If there's a large current because the water underneath eats the ice from underneath and becomes weaker. So but the lake, four inches here should be fine if it's all tight.

[Jane] It's always best to check with an adult before you go out on any ice. All right let's get back to skating and see if we can find some more music.

By the way if you ever skate indoors on a hockey rink, that ice is layered onto a hard surface and it's painted. One of the layers of ice is painted usually white, or pale blue. And then there are lines painted on top of that, center ice or around the net, if you think about a hockey game. And then there's more ice layered on top of that. And one of my favorite things is called the Zamboni. That's a machine that puts a very thin layer of water on top of the ice after it's been scratched up by skaters that water freezes on top of the ice creating a nice, clean, smooth surface. And remember how we said the ice on the Rideau Canal is usually about 12 inches thick? Well, the ice in a hockey rink is usually just an inch and a half thick.

That's it for this episode. Don't forget to tell a friend about a podcast you really like this month and if you really like this podcast you can follow us on Facebook or write a review of the program in iTunes.

By the way we're working on an episode about race and racism based on a few questions we've gotten from you in the last few months. So if you have a question on that topic that you're wondering about, we'd love to hear what you're thinking. Have an adult record your question or your comments on a smartphone. And send the file to questions@butwhykids.org. Don't forget to tell us your first name, how old you are and where you live.

But Why is produced by Melody Bodette, and me, Jane Lindholm, for Vermont Public Radio. Our theme music is by Luke Reynolds. We had additional music this week from Ryan Cullinane.

We'll be back in two weeks with an all new episode. Until then, stay curious!