But Why: A Podcast for Curious Kids

But Why Live: Space Exploration

May 20, 2020

[Jane] This is “But Why: A Broadcast for Curious Kids,” I'm Jane Lindholm. For seven weeks this spring, we're bringing our podcast to the airwaves for live radio shows in collaboration with Vermont's Agency of Education to offer kids were out of school a chance for your own Call-In radio show. And if you live in Vermont and surrounding areas, no internet connection needed. Today we're going to talk about space exploration. Next week on May 27, two American astronauts are headed to the International Space Station. This is the first time in almost 10 years that American astronauts will head into space from an American launch site on an American rocket and spacecraft. They'll be traveling in a Space X rocket. Now, it takes less than 10 minutes for the astronauts to get into space, but much longer to get to the orbiting space station where they'll meet up with other American astronauts and Russian cosmonauts. So it seems like a great time for us to learn more about space exploration.

And if you have questions, which we know you do, because you've been sending us tons, now is the time to give us a call or you can send an e-mail to “questions at but why kids dot org.” And we have a very exciting guest with us today. Jim Green is the chief scientist at NASA. He also has his own podcast, by the way, called Gravity Assist. And he's going to see if he can answer all of your questions or at least most of them. Jim, thank you so much for joining us today.

[Jim] Well, Jane, thank you so very much for inviting me indeed. I'm very well connected with Vermont. You may not know this, but I was born and raised in Burlington.

[Jane] I did not know that. That's great.

[Jim] But not Burlington, Vermont.

[Jane] Oh, darn.

[Jim] Burlington, Iowa.

[Jane] There are Burlingtons all over this country.

[Jim] There are. And I think Burlington, Iowa, is actually named after Burlington, Vermont. So I'm well connected.

[Jane] Well, that's good to know. Jim we're going to dive in because, I mean, I think probably, you know, 4,000, 6,000, 20,000 questions are coming in from kids all over the country. But right before we get to the questions from kids, could you just tell us a little bit about this launch on May 27? It's pretty exciting.

[Jim] It is very exciting. This is the first launch that we've had since, with humans going up to the International Space Station, since our shuttle program ended several years ago. Now, how we've been going to space station is not from rockets leaving the United States, but with our partners, the Russians. And so it's great to get back into the space business

with our own rockets. Of course, we're building some really big ones that will take us, in a couple of years, to the moon and then on to Mars.

[Jane] We don't have to go into this too much. But when you say, you know, it's it's a U.S. rocket, but Space X is a private company. Right? So this is sort of a government and a private company working together to get Americans into space?

[Jim] Yeah. So about 2006, NASA decided, hey, if we're going to be able to bring what we know about space into our companies and using that new environment where you take gravity out of what we call “the equation” and new things can be made, we better start commercializing it.

That means we need to be able to get more companies involved in space. In the first place, of course, is low Earth orbit and a wonderful place to go, of course, is our national laboratory, the International Space Station. So, in 2006, we started that process of getting more and more commercial companies interested. And in this way, indeed, we now have several commercial rocket companies that are building the capability to take humans, along with a number of commercial experiments, up to space station.

And while they're doing that, we're going to move on to the moon and then on to Mars. So it's a wonderful partnership.

[Jane] So the astronauts that are going up next week are going to the International Space Station, which, as you said, is in low earth orbit. So this is not as far as the moon. It's not Mars. It's not they're not going way out. But they're going into space. And Donnelly, who's eleven and lives in St. Johnsbury, Vermont, has a question, because Donnelly saw the International Space Station last night and a lot of people have been able to see the ISS in the sky. It's a bright light, brighter than most stars. And Donnelly says, “last night I saw the International Space Station fly by overhead. In only half an hour, it had gone from the area of the earth where it is to the area where it is day to the area of earth, where it is night. What is that like for the people on board?”

[Jim] Well. They still have a regiment. They still work hard to use the life cycle of light and dark that we have here on Earth on space station. So indeed, they work on space station over a 12 hour period. Have a few hours of on their own to rest and relax and then eight hours sleep period, and then back to the grind, so to speak. So on station, they try to keep it as normal as possible. So, you know, when night comes, they turn off all the lights on space station, even though we orbit the Earth and we go from day to night in 90 minutes of full orbit occurs. And that turns out to be the best approach.

[Jane] So instead of just going to bed for half an hour and then for half an hour and then half an hour for half an hour, they try to keep a more normal schedule.

[Jim] Right. Right.

[Jane]All right. So here's a question from Nora, who's five.

[Nora] I live in Sharon, Vermont. And my question is, why do rockets have fire when they blastoff?”

[Jane] And five year old Jude from Kirkland, Washington, wants to know how fire makes rocket ships go into space? So, Jim, can you talk about fire and rocket ships?

[Jim] Sure. So what we want to do is we want to push off of the earth. You think if you're in you're in water in the pool and you want to go anywhere, you push off from the side. Well, we have we have to do that. And yet we have a lot of mass. And so we have fuel.

[Jane] And when you say a lot of mass, you mean we're heavy?

[Jim] Yeah, we're heavy. We're really heavy. So we got rocket fuel and we got people and we got experiments and we're gonna try to get them up into space. And so what we do is we burn that rocket fuel and that produces thrust, which means that allows us to do the push. And so the great thing about it is as we take our rocket fuel with us and burn it and produce the push, we get lighter. And so then it pushes and doesn't need to be as big as it is initially. And that eventually propels us forward until we get into space and beyond the bounds of our atmosphere.

[Jane] And once we're beyond the bounds of our atmosphere, we don't need the fire anymore?

[Jim] Correct. We're now in orbit. And now all we have to do is just puff a little jet of gas that will push us around. It's a completely different environment that we are so unfamiliar with. That's why space is so fascinating. And that's why we'd like to get, as we talked about earlier, more commercial companies thinking about things that they can make in space because there's no gravity in space station.

[Jane] Well, while we're talking about rocket ships steering in space, here's Wesley, who's calling or writing in and sent us something from St. Paul, Minnesota.

[Wesley] How do rocket ships' fins help them steer?"

[Jim] OK, good question. So as we move forward and through the atmosphere, of course, we've got to carve our way through. Now, many of our rockets that we launch don't really have fins. If you look at the shuttle and you look at the rocket that is going to go off next week, you don't really have fins. In fact, we don't want fins on these. We use fins on the shuttle, however, and the space shuttle, we needed those fins because we reentered the earth's atmosphere, but we acted like a glider. And because we came down in this big, huge vehicle we called the space shuttle, we needed those fins to be able to move in the atmosphere just like a plane needs wings. So it's a matter of going up: we don't need them, but coming down: we do.

[Jane] So while we're still talking about rockets, Wendell, who's five and lives in Pinehurst, North Carolina, wants to know where do rocket ships launch from?

[Jim] Well, there are a number of places that rocket ships launch from around the world. But the United States has two basic places we love to launch rockets from. One is in Florida at the Kennedy Space Center, OK? It's also called Cape Canaveral. This is a really great place to launch because when we launch, we always launch towards the east. Now, when you think about it, what's east of Florida is the ocean. So if there was any problem with the rocket that's launching towards the east, and we had to abort it, meaning it was going to malfunction and come down, then it would only come down in the ocean. So that's a perfect place. On the West Coast, we have another place. It's actually an Air Force base. It's called Vandenberg in Vandenberg is in California. And to the west of it is the Pacific Ocean. Now, in this case, when we launch, we don't launch straight west because we're

actually going in the opposite direction that we want to go. But from Vandenberg, we actually launch south. And this allows us to get spacecraft into orbit around the Earth, over the poles. And so that's a completely different orbit, a completely different view of the Earth as you go straight south. You actually have ocean from Vandenberg. You have.. Which sticks out is the furthest part of California that sticks out. And therefore, straight south of it is ocean. And so, once again, if the rocket malfunctioned and came down, it would come down in the Pacific Ocean. So we love those two spots.

[Jane] One time when I lived out in Los Angeles, the space shuttle landed and it was supposed to land in Florida, but it landed in California and we didn't know. And everybody was asleep because it happened in the middle of the night. But when it reentered the atmosphere, it made such a loud boom that it woke everybody up. But we had no idea what it was. It was kind of an amazing and scary thing at first, but then very cool to have experienced, once we knew what it was.

[Jim] Yeah. So now once it's there in California at Edwards Air Force Base, we now need to get it back to Florida. And so we worked a way where we actually mount the shuttle -this is what we used to do on a 747, really big plane that that was designed to have passengers and cargo. But in this case, the cargo is going to be the shuttle. And we put him on top of the 747 and then flew up, flew this jet with the shuttle on top of it, from California to Kennedy. And then we would add that once again back into the fleet of shuttles.

[Jane] That's pretty cool. Would be pretty awesome. Very cool. A plane carrying a rocket.

[Jim] Well, you could probably Google that. You know, we don't do that anymore. But you could probably Google, look at the images, and you could say you can see 747 carrying the shuttle. And in fact, there's quite a few quite a few pictures of from many different people and organizations that saw it.

[Jane] So Leo is 10 and Leo wants to know, does it make people sick to be in the International Space Station because it orbits so quickly?

[Jim] It turns out.

[Jane] And I think Leo means like carsick kind of.

[Jim] Yeah, right. It's moving at an enormous speed. Oh, my goodness. You just can't imagine how fast it's moving. I mean, you think about think about how long it takes for you to drive down town or to drive across your state. And yet in 90 minutes, you can go completely around the earth. And so it's moving at an enormous speed. But it turns out that's not what gets you sick. Now, many people never feel any sickness. Some of these astronauts are really great about being in space, enjoying it and being able to adapt. Others have other kinds of sickness. So we call that a little bit of a space sickness where internally, because they no longer are in a gravity field, things inside their body float. And so, you know, stomach acid will come up and you know, if you've if you've had heartburn, we call it, you may feel you may feel that in space. And some of them will take a few days to adjust. But I know of no astronaut that has been sick during their entire time in space. They usually can get over it.

[Jane] All right. So let's talk a little bit more about what it is like in space. And then we have a lot of callers who want to call in and ask questions about planets and stars and black

holes. So we're gonna get into that. But we're tackling space exploration here first at the beginning. So let's go to Lincoln. And Lincoln is four. Lincoln lives in Westport, New York.

[Lincoln] How do astronauts make food in their rocket ship?

[Jane] All right. So that was how do astronauts make food?

[Jim] Yeah. And I understood him completely. You bet. So it turns out the International Space Station is so close to the earth, even though it is know more than 100 miles up, that we have supply rockets. And so they will bring up supplies and those supplies will contain all sorts of things from new scientific experiments, to, but also of food and a variety of water and things that need to be replenished on space station. However, most recently, we began to grow food on the space station.

[Jane] Wow!

[Jim] Yeah. It's cool. We now have what we call “the veggie experiment.” And this particular experiment grows lettuce. And we've been doing this now for a couple of years and we've tasted we've tested the lettuce and in it, it's wonderful. It's and now we've eating. Now we're eating it. And it's nutritional. And it helps supplement the food that we take up to space station. So we're going to do more of that in the future.

[Jane] Wow, that is cool. And nobody can bring the lettuce back down. Right? So you haven't tasted it, Jim?

[Jim] I haven't tasted it. You know, if it if they brought it back, I would.

[Jane] I would too! I would love to taste space lettuce. And this is great because you're helping to answer a question from Flora in St. Paul, Minnesota, who also wanted to know how to space guys live in space. But in answer to Flora, it's not just space guys, right?

[Jim] Oh, wow. No kidding. We have a significant number of women. And in fact, we have many people from different countries. So it's a very international space station. This is why we call it the International Space Station, because it is a wonderful place where different cultures and different people with different backgrounds come together to be a team, to be able to live and work in space and overcome those differences or biases that we all seem to have. And, you know, for me, it deserves the peace prize. I mean, and I'm serious. I mean, we could we could we could have a lot of political differences with countries as we do today. But yet those astronauts from those countries are on space station. And we live and work together with them while we are, by the way. Yeah, humans.

[Jane] Well, that's true. We are. We're not space aliens, although I suppose we're aliens. Alien life forms once we're up in space because we're not quite where we belong. I can't find it right now. I can't remember who it was who actually asked this question. And I'm sorry to you if you're the one who asked it. Well, we did get a question from a young person who wants to know, are there time zones in space? So, you know, the Russian cosmonauts, if they're living on Russian time and the American astronauts, if they're in the space station living on, you know, either Florida Eastern Time Zone or or whatever time zone they're living on, are there actually time zones?

[Jim] Well, in a way, because we have to establish a working day, which is 24 hours long on space station. We do indeed pick a time zone. And in that time zone, it was like the

middle of the United States, our country. That's the same time zone as Houston Space Center, which is in Texas. It's the Johnson Space Center, which is in Houston, Texas. And so that works the best because the controllers are on that same time. Those people that talk to the astronauts were on that same time zone. And so if you were from Russia, you would you would have to adapt to that new time zone. It'd be like, you know, you live in Moscow and then coming to middle America. And you'd have to you'd have to make that transition anyway.

[Jane] That's so cool. That is just fun to think about. And then we got a note from Charlie, who's eight and lives in Zurich, Switzerland, and wants to know what would happen if you took off your space suit on another planet.

[Jane] Well, that's a good question. Right now, we know of no other place in our solar system that could support our life without a suit. So that's a problem. Some of these planets are incredibly hot, like Venus. Oh. I mean, it's hot. Hot enough to melt lead. And the atmosphere is toxic. You know, it's largely carbon dioxide, which is which is a gas that we don't use in our bodies. And so there's no oxygen for us to breathe. And then there are places like Mars where it's very cold. You know, the high for the day is just above freezing. And at night, it could be a hundred and fifty degrees below zero. And so these huge ranges of temperature occur on a daily basis. And even then, the atmosphere is largely carbon dioxide. And once again, toxic to us. So Earth is the perfect place where we don't need a spacesuit and every place else we do.

[Jane] Well, so let's talk more about this while we're while we're doing it.

And I'll just say that question about time zones came from six year old Nathan, who lives in Grantham, New Hampshire. Thank you for that question, Nathan. And let's go to Andrew, who's calling in from Alamo, California. Hi, Andrew. Hi, Andrew, do you hear us?

[Andrew] Hi.

[Jane] Go right ahead.

[Andrew] I want to know if there's any oxygen in outer space?

[Jane] Good question. Oxygen in outer space, Jim.

[Jim] Yeah. It turns out there's an enormous amount of oxygen in space. Stars actually make oxygen. You know, that's really bizarre when you think about it. You know, these hot things that that glow, and inside them, they're making all sorts of things and they're making oxygen and iron and carbon and all kinds of things. And then they explode and then throw that material all over the place. So, yes, there's all kinds of material that's made in stars that we do find in space. And so, many of our planets have an enormous amount of oxygen in them and in particular, the moons of Jupiter have, you know, oxygen and hydrogen. Connected together, creating water. But it's not, you know, and on the surface, it's frozen. And underneath that frozen crust is the liquid water. So we see a lot of oxygen in the solar system.

[Jane] We're talking about space exploration today with Jim Green, who's the chief scientist at the U.S. space agency, NASA. So many questions from you. We've been talking about just sort of general space exploration and how we get into space. And we're gonna move into other questions that you're asking us about planets and astronomy

coming right up. So if you have one, you can send an email to: questions@butwhykids.org or call. But you should know we only have six phone lines and they're all full a lot of the time. So if you can't get through. I hope you understand. That's why. But you can send us an e-mail: “questions at but why kids dot org.” I'm Jane Lindholm, and this is “But Why: A Broadcast for Curious Kids.” Today, we're talking about space and space exploration with Jim Green, who's chief scientist at NASA. And we're hearing from kids all around the country and beyond. So if you have a question, send an e-mail to: “questions at but why kids dot org.” Let's go to Anika, who's calling in from Toronto, Ontario.

Hi, Anika. Nice to talk with you.

[Anika] Hi.

[Jane]What's your question for Jim Green?

[Anika] Why are some planets tilted?

[Jane] Jim, did you hear that? Why are some planets tilted?

[Jim] Thank you so much for that question.

So we've been studying planets since we started looking at them and noticing how they spin. In fact, everything in the solar system seems to be spinning. Earth spins, our sun spins, our moons spins. And so that means your question is so perfect because the next thing is they're spinning around, on an axis. And so those directions, those axes, all have to explain how the object came together.

And some of them are in very different locations that then we would expect if material fell and created a body and that body then has angular momentum and is spinning around an axis.

That would be like parallel to the Earth's axis. When we study planets, we wanted to see the axis and then that axis tells us what's happened to the planets. So let's take a look at Venus. Give you one quick example. Venus spins, but it's spinning like taking your right hand and moving it where your thumb thumb is up. That's the way the earth spins.

But Venus is spinning as if the thumb is down in your hands or your fingers are moving in the opposite direction. That flip, we believe, was caused by another body moving by it that then interacted with a gravitationally. So that had to happen early on in its evolution. And so the spinning of axis tells us a lot about how these planets were put together and what happens to them.

[Jane] Wow, that's neat to know that just by the way the planet is spinning, you can start to learn something about the planet itself.

[Jim] Yes. Its history.

[Jane] Well, here's a question from Sawyer, who is seven and lives in Chicago.

[Sawyer] My question is, what are planets made out of?

[Jane] So you were talking a little bit about this, but what what exactly are planets made out of?

[Jim] Well, many planets are like the Earth. They have soils. They have rocks. They have all sorts of minerals that are made as the gravity of the planet crushes material into new forms. But further away from the sun, not like our terrestrial planets, which are Mercury, Venus, Earth and Mars. Those are all made our rocky material. Further away, we see that the large planets are largely gaseous planets. That have huge atmospheres. Here on Earth, we have what we think of is really a very thin blue line that goes around our planet of gas. But on those planets that are in the outer part of our solar system, they're mostly gas. It's flipped in terms of having huge balls of gas with only small amounts of rocky material on their interior. And that tells us a lot about how they're made. So planetary scientists really get into the atmospheres to try to understand how these planets are put together.

[Jane] Well, while we're talking about planets, let's go to Aurora, who's calling in from Wethersfield, Vermont.

[Jane] Hi, Aurora.

[Aurora] Hi.

[Jane] What's your question?

[Aurora] My question is, Where do Saturn's rings come from?

[Jane] Ooh, Aurora. You have a lot of company in this question because, Jim, we also got this question from Georgianna in Gilroy, California. Sophie in Burlington, Vermont. And Lewis in Wisconsin.

[Jim] OK, so what we have found out by our Cassini spacecraft is that the rings of Saturn may actually be pretty young. Now, that means that when the planet was formed, it then came together as a ball with no rings. But something happened along the way for which a body orbiting the planet broke apart. And in the fact, the gravity from the planet itself continually pushes and pulls any objects that orbit it very closely and grinds them up into smaller bits. And so, when we look at the composition of the rings, these are mostly icy material, you know. So that may mean perhaps Saturn captured a comet, perhaps Saturn captured an icy moon. And then over time, just pulled it apart to create the beautiful rings that we see today.

[Jane] We have a lot of planet questions. Can we tackle a few more of them, Jim?

[Jim] Oh, yeah, please. I'm a planetary scientist.

[Jane]Yes. I suppose you're not going to say no to that, are you?

[Jim] I won’t say no.

[Jane] Here is Nikki and Aria. They're calling in from Pasadena, California. Hey, guys. What's your question?

[Nikki and Aria] My question is, why are there a lot of stars in space?

[Jane] Why is there a lot of stars in space? And you have another question too?

[Nikki and Aria] I have two questions.

[Jane] Go for it.

[Nikki and Aria] Why is the stars so big compared to the sun. That's my first one and the second one is, why is Uranus colder than Neptune even though it's farther away from the sun?

[Jane] Ok, so why is Uranus colder than Neptune even though its farther away from the sun? Why are there so many stars and then the size of the sun versus other things. So lots to tackle there Jim.

[Jim] Lots to tackle. So let's start with temperature of planets. And I'd be willing to bet our caller has made and worked with mom on a cake in and put in ingredients and then stuck those in a pan and put it in an oven and then cooked it and then pulled it out. And guess what happens? That cake is still cooking. It's hot on the inside and it requires time to cool off. And what we find is all these big objects in the solar system are still hot from the time they were made and they're in the process of cooling off. And so even though Uranus may be further away, Neptune may be further away from Uranus, their temperatures are all about how they're cooling off and not their distance from the sun.

[Jane] I find that a disappointing answer, Jim, because I thought when you started talking about cake, you were going to tell us that really, you know, Uranus is made out of chocolate or something.

[Jim] I wish that was the case. We'd be there sooner than what we're planning right now.

[Jane] So while we're talking about planet temperature, though, now, Calvin who's five and lives in San Diego, California, wants to know how hot is Venus?

[Jim] Oh, Venus is incredibly hot. So the surface of Venus, even though the planet is still cooling, the real problem is the atmosphere. The atmosphere is very dense. In fact, it's 90 times the pressure of our own atmosphere. Now to see that you'd have to go into the ocean a couple thousand feet and that's crushing depths.

And so on the surface of Venus, you have this enormous atmosphere pushing down on you. And Venus has volcanoes and we think there's still active. So those volcanoes are spitting out more and more carbon dioxide, which loves to hold the heat from the sun. And so the temperature of the atmosphere skyrockets. And in fact, it's hot enough to melt led on the surface of Venus.

[Jane] Wow!

[Jim] Well, yes. So we know Venus is not going to be habitable on a surface until that changes.

[Jane] So Cordelia is four and lives in Burbank, California. That helps to answer why Venus has volcanoes on it, which is her question.

[Jim] Yes. So it's still an active planet. The Earth has volcanoes on it, you know. And so Venus is Earth sized. You know, we call each other a sister planet. But that's only with respect to our sizes. Everything else seems to be so different from that. It's the one thing that also we have is we have volcanoes and so does so does Venus. Now, Venus may have been much more active than it is today in its past, which is why it still has a lot of that carbon dioxide sitting on its surface.

[Jane] So could Lee in Kansas City, Missouri, wants to know, how did the planets get their names?

[Jim] Oh, really good question. So you have to look back into history when many civilizations, the Greeks noticed that, that every night they'd go out and they'd be certain objects that seemed to have moved in. And so some objects stay in relationship to one another. Those are the background objects. They turn out to be stars. They turn out to be huge objects like our sun and even bigger. But they're much further away. And things that are closer to us, actually, than move with respect to those far away background stars because they're orbiting the sun. So once these ancient civilizations, the Greeks and Romans and Egyptians and began to see and notice these planets moving around, they wanted to give them special names. And so as Mars, the Greek name for Mars is Aries. Okay. But the Roman name is Mars. And so we adopted that Roman name, but it could have been called Aries. You know, we adopt a lot of Greek language, and so each and every one of the planets has that kind of history associated with it, except for a couple that could not be observed from Earth with the human eye. It requires the invention of the telescope. And those planets are Uranus, Neptune and further out, even Pluto. We had to have a telescope to find it. Then we named them intentionally in the modern era.

[Jane] And we named them after Disney characters like Pluto.

[Jim] Well, there's quite a story behind Pluto's name, of course. You'll have to you'll have to check me on this. But there is a relationship between the name Pluto and the Disney characters. And I'd have to I'd have to look back in my history book to determine that. I just don't remember that at the moment.

[Jane] You can send us a note when you remember, and we'll put it up on our Web page for anybody who is curious about that. Becket's with us from Winter Haven, Florida. Beckett, thank you for waiting on the phone. What's your question for Jim Greene?

[Beckett] Why do stars exist and why do some galaxies have two suns?

[Jane] Why do stars exist? And why do some galaxies have two suns? Good questions.

[Jim] OK. So we believe and this is now a science called cosmology, that at the very beginning when the when the universe started, we only had hydrogen and helium. We had the gases, the very the very beginning gases. And we had so much of it that gravitationally came together and created a ball. And the more it did that, the more gas it accumulated until it got so huge, it started a reaction on the inside that creates new material and that new material creates heat. And that heat is a part of the burning of gases on the inside of Sun's creating new material. And so those stars had to start.

And then as you get more and more stars, they gravitationally interact and they and they begin to move around a central location, which is the center of what we then call that accumulation of stars a galaxy. So our galaxy is called the Milky Way and it has billions of

stars. It has several billion stars in our galaxy. And yet we're not what we would call a huge galaxy. So we see billions of galaxies in our universe every place we look. We're finding more and more galaxies.

So that's a huge estimate of the number of galaxies. And then knowing each of those galaxies has hundreds and hundreds of millions to billions of stars, then that really gives us the impression of how large this whole universe is.

[Jane] It's amazing to think about that. Just mind blowing. So we've got a little bit more left in the show. And kids, I know you have so many questions and we're not going to get to all of them, but we're going to try to get to as many more as we can. You're listening to “But Why?” on Vermont Public Radio.

This is “But Why: A Broadcast for Curious Kids.” I'm Jane Lindholm, I host the show. All spring, we're doing these live interactive shows for kids while you're out of school. These programs are in collaboration with the Vermont Agency of Education. And today we're talking about space and space exploration with Jim Green, chief scientist at NASA, the U.S. space agency. We have a couple of kids who've been waiting on the line for a very long time. So let's go to them. And then, Jim, I want to talk about the moon, because that's something that NASA's really focusing on as well right now.

[Jim] OK. Sure. Wonderful.

[Jane] OK. So here's Neve calling in from Los Angeles, California. Hi, Nev. You're on the radio.

[Neve] Hi.

[Jane] What's your question for Jim?

[Neve] I have two questions. My first question is, how do black holes change time? And my second question is, is how gravity made?

[Jane] OK. Did you get both of those? How do black holes change time and how is gravity made?

[Jim] OK. Yes, boy. Let me start with the second one first. How is gravity made? Well, the concept of gravity is all about understanding how matter attracts other matter. There is a force for which we call gravity as a planet or anybody accumulates matter and gets bigger and bigger. It has the ability to attract even more things. And that ability to attract more matter is a property that we call gravity. Now, what's really exciting is Einstein actually in 1911 or so, right around in the in that era, began to think about how this attraction of gravity to other mass, or matter, affects light. And in fact, we now know that as you bring together larger and larger masses, it warps the space around it, allowing light to be bent. And that is connected to time. So as light moves at one hundred and eighty six thousand miles per second and it moves through space, we can connect light in time through Einstein’s equations. And so that is a really profound question that we're still learning much more about. There's plenty of things to learn in this area.

And we call this relativity.

[Jane] I feel like my brain is exploding when you talk about the space time continuum and how light and time are connected to one another. Yeah, it's mind blowing.

[Jim] So it's really exciting, you know. And if we can go back to the Pluto question, let me just answer that. You know, in terms of jogging my memory, of course, Pluto was found in the 30s by Clyde Tombaugh. And he had a contest for which a young young lady in England decided to submit the name Pluto. Now, Pluto turns out to be a Roman god of the underworld. And so Disney liked the name so much that he used that one of these characters, of course.

[Jane] Right. So Disney came second. That planet came second.

[Jim] Yes. Right. It is a Roman God.

[Jane] Yes. Alessandra is with us from Fairfax, Virginia. Alessandra. Hi. You're on the air now. Go right ahead with your question for Jim.

I hear you, Alexandra, are you there?

[Alessandra] Yes. How many dwarf planets are there?

[Jane] Oh, I'm glad you asked that since we're talking about Pluto here. Dwarf planets, Jim.

[Jim] OK. So there are probably thousands of dwarf planets. And the reason why is these are smaller objects that have accumulated enough mass to become spherical and yet not as huge as are other planets. And so astronomers want us to call them “dwarf planets.” Now, many planetary scientists don't like that idea. If an object is able to create a spherical body, we ought to call it a planet. But we don't. Astronomers want to call it a dwarf planet. But, where are the where are these dwarf planets? Where do they live? Well, it turns out we have found a region beyond Neptune that has thousands and thousands of these objects.

And we call that area the Kuiper Belt, named after astronomer who in the 50s proposed that that belt should be there. And it turns out Pluto was the first Kuiper Belt object we found. But we now know that we've observed several thousand of them in our as our telescopes get better and better and we see more of them. And it takes big telescopes because they are smaller round objects, you know, about the size of Vermont or Texas or, you know, the sizes of our states. You know, they're still big enough to be round. And so consequently, we have, because they're so far away, big telescopes to find them. We found several thousand, but there's probably tens of thousands of them out there.

[Jane] Wow. Tens of thousands of dwarf planets. So I promised that we'd talk about the moon. And I know that the U.S. is on a mission to send astronauts back to the moon by 2024. So let's talk a little bit about the moon and traveling there. Here's five year old Evio from Chicago.

[Evie] I would like to know why people aren't on the moon.

[Jane] And then this is Leo from San Francisco.

[Leo] I’m four years old, and my question is, why did NASA decide to go to the moon?

[Jane] Yeah. So why did why have we decided to put people on the moon? We've already done it. And now we're going to try to do it again.

[Jim] Right. So let's talk about how far things are away. So when we get above the Earth's atmosphere and we want to go get someplace, the first place that we would go to turns out to be the moon. The moon is the closest object to the earth that we actually can orbit, land on, and work. Now, it turns out the moon doesn't have an atmosphere. And so it's a very harsh location. It's a harsh place to work on. And we know a lot about the moon because when we went to the moon in the 60s and into the 70s and I was watching the TV when they were walking around on the moon and got so excited about that. The astronauts brought back lunar material rocks that we then could look at and find out all kinds of unbelievable things about the moon, but also about the earth. We know the age of the Earth as a planet by actually going to the moon because we find older rocks on the moon than we see on the surface of the earth. And the reason that is, is because the earth's climate and weather and plate tectonics and oceans have actually buried and hidden and destroyed the older rocks. And so coming from the moon where those rocks haven't been destroyed, we now realize the earth and the moon are 4.5 billion years old. But most recently, and this is what's really got us excited about the moon, is we now have uncovered in areas in the North Pole and the South Pole of the moon, a significant amount of water ice. These are regions in the polar caps of the moon that are have accumulated this water ice over billions of years. Now, the reason why that's important is water is very important to us as humans. We drink it. But did you know we could actually split up the water? Which contains hydrogen and oxygen. And we can breathe the oxygen. The hydrogen and the water and the oxygen can also be used as rocket fuel. So by going to the pole of the moon and we're going to go to the South Pole in particular, we're gonna be able to use and leverage and work with that water for resources. Now, that's important because that's exactly one of the first things we do when we go to Mars. So going back to the moon is going to allow us to live and work on a planetary surface.

And then the next one will be Mars.

[Jane] We don't know how long it'll take people to get to Mars, when that happens, because it's not a mission that we have right now. But it could take a long time, right?

[Jim] Well, we know a lot about Mars because we have launched and landed a whole series of spacecraft. We've also lost a bunch of spacecraft. Turns out about half the ones that the world has sent to Mars has malfunctioned or crashed or missed it. But now we've gotten to the point where we know how to do this pretty well. And in fact, in July, we're launching a huge rover. It's called the Mars 2020 Rover. And it was recently named Perseverance. And Perseverance now is the new name of the rover. It will launch in July 17. And then it will land in February.

[Jane] No, people on it, though?

[Jim] No people on it. But we're going to keep exploring Mars to understand it before we send humans.

[Jane] So Jim, Dalilah, who's eight and lives in Oakland, California wants your advice for a kid who wants to become an astronaut when she grows up.

[Jim] OK, so people that become astronauts have a desire to learn. In fact, that desire is so strong that it enables them to learn mathematics and physics and a variety of other things. And sometimes they're good at these things. Sometimes they're not. But they have one thing in common. They are driven. They have a dream. And they're not going to give it up. And so that helps make them the astronaut we see today. The other part of that is they are team players. They can work together really well with other groups of people. And that's essential.

[Jane] So, Jim, you're not an astronaut, you're chief scientist. What does that actually mean?

[Jim] So as the top scientist in the agency, I indeed help all the other scientists at all our centers ensuring that they are having the facilities and capability to do their work. And I advise the administrator and the administration on important next science activities that we should be doing.

[Jane] That is so cool. And Jim, what a pleasure to talk with you. I wish we could have gotten to all of the questions. We had so many more. But it was so fun to talk with you about space and space exploration.

[Jim] Well, thanks so much, Jane.

[Jane] That's Jim Greene. Jim is chief scientist at NASA and he also has his own podcast. It's called Gravity Assist. And that's it for today's show. But we want to make sure that you join us again back here next Friday. We'll be talking about words and language with linguist John McWhorter. Adults and older kids might know his podcast, which is called Lexicon Valley. He was also in one of our very early episodes about words and language and who invented words. You can send questions about words and language to "questions@butwhykids.org," or call us next week when the program is on the air.

Our show is directed by Jake Rusnock and produced by Melody Bodette. We had production assistance from Lydia Brown and our theme music is by Luke Reynolds. We have four more of these live episodes before the end of the school year. Thank you so much for making them so successful. And thanks to the Vermont Agency of Education for collaborating with us. You can go to our Web site, "But why kids dot org" for supplemental materials to go with each and every episode we make on the radio.

And we love all the calls and e-mails we're getting from so many of you. I'm Jane Lindholm. We'll be back next week. Until then, stay curious.