

But Why: A Podcast for Curious Kids

Why Do We Sometimes See The Moon During The Day?

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[Jane Lindholm] This is *But Why: A Podcast for Curious Kids* produced at Vermont Public Radio. I'm Jane Lindholm. On this show we take questions from interesting kids like you and we dig up the answers. Today we're talking about something we all see at night, but only a very few very lucky people have ever been able to visit.

[Neil Armstrong] That's one small step for man; one giant leap for mankind.

[Jane] Today we're going to learn all about the moon. That recording was astronaut Neil Armstrong. You may have heard of him. On July 20th, 1969 he and fellow astronaut Buzz Aldrin were the first two people in the history of the world to walk on the moon...

[Jack King] ...twelve, eleven, ten, nine. Ignition sequence...

[Jane] ...Their mission was named Apollo Eleven...

[Jack]...four, three, two, one, zero. All engine running. Lift off! We have a lift off! 32 minutes past the hour, lift off on Apollo Eleven.

[Jane] The goal of the mission was to land a lunar module nicknamed "The Eagle" on the moon.

[Neil] Tranquility base here. The Eagle has landed.

[Charlie Duke]..Roger, Tranquility. We copy you on the ground. You got a bunch of guys about to turn blue. We're breathing again. Thanks alot.

[Jane] After their spaceship landed on the moon they put on their spacewalking suits and opened the door of their ship. And then they took those first very important steps. But, they weren't just going to the moon to see if they could or for the sheer adventure of it. The astronauts and NASA, the U.S. space program, were doing experiments and collecting samples of wind and lunar rocks. Lunar means "of the moon." It's from the Latin word that means moon. And if you speak French, or Spanish, or Italian you'll know that word loon or Luna. Anyway, the astronauts were also collecting information about the internal structure of the moon and measuring its exact distance from earth. This year, in just a couple of months, it will be the 50th anniversary of the Apollo 11 mission. Now, other moonwalks followed in missions that came later, and today, most missions to space don't include a trip to the moon. But, the moon is still fascinating to many of us here on Earth. Maybe that's because it's the biggest and brightest object in our night sky. It's easy to stare at the moon and imagine what it's like up there or wonder what it even is and how it moves through the sky. The moon is a satellite. A satellite is something that moves or rotates around a planet, the earth in this case. The moon is two-hundred thirty-nine thousand miles away. That's far, but it's way closer than any of the other stars or planets you can see in the night sky. That's why the moon looks so big compared to other celestial objects even though the stars are actually much bigger. We've gotten a lot of moon questions from you over the last couple of years. So, as we approach the

anniversary of that very first moon landing, we thought it might be neat to get some answers from one of our favorite *But Why* friends.

[John O'Meara] Hi, my name is John O'Meara and I am the chief scientist of the W.M. Keck Observatory on the summit of Mauna Kea on the Big Island of Hawaii.

[Jane] We've talked to John O'Meara before about all kinds of astronomical things. And he just took this job in Hawaii with the Keck Observatory, where astronomers and astrophysicists do research with two very large, very powerful telescopes. Our first question for John about the moon comes from Sagan.

[Sagan] I'm four and a half years old and my question is, why is there only one moon?

[John] This is a really cool question, Sagan. I wish I knew the answer to it, too. And I think it's probably because of how the solar system formed early on. Very early on in the history of the solar system, about four and a half billion years ago, all the stuff that was going to form into the planets started to collapse and form things like planets, but we called them protoplanets. They were smaller than the Earth is today. And those things, due to their gravitational pull on their surroundings, would start to get bigger as the smaller rocks would fall onto the bigger protoplanet. And eventually those things formed the rocky planets close to the sun. Farther out, it was too cold and so it was ices that would start to glom together, and then gas would fall onto them, and those would create the gas giants like Jupiter and Saturn, Uranus and Neptune. And those planets have lots and lots of moons. Some of them have over 60 moons. But back to your question, why does the earth have only one moon? Well, it turns out that the earth's moon is likely the result of something almost the size of Mars hitting the Earth many billions of years ago. And then those two pieces calmed down, cooled down and became the earth and the moon. And as a side effect, this is why we have the seasons. Because when this thing smacked into the earth many billion years ago, it knocked it slightly over from being straight up relative to where it's spinning and that's why we have seasons: because in some parts of the year we're tilted away from the sun and some parts of the year were tilted towards the sun.

[Anisa] Hi, my name is Anisa and I am eight years old and I live in Clarksburg, Maryland. And my question is, how much does the moon weigh?

[John] How much does the moon weigh? Well, it weighs a lot! In fact, it weighs one with twenty-three zeros after it pounds. And that's just such a big number that it really almost has no meaning to me. Instead, I like to think about how much does the moon weigh compared to something like the Earth? And, it turns out that the moon is about one percent the mass of the earth. And that is a lot!

[Jane] Here's a question about the way the moon looks.

[Mika] My name's Mika. I'm five and a half. I'm from Portland, Oregon. My question is, why does the moon have holes?

[John] Hi, Mika. Good question. The moon has craters all over it, craters of different sizes and shapes. Some craters are a little bit younger than others. Some craters are very, very old, billions of years old. And the reason why the moon has all these craters is that over billions of years, hundreds of thousands of objects have smacked into the moon, like asteroids, comets, smaller bodies, things like that. And they keep pummeling the moon and hitting it and creating these craters. And sometimes the craters are very, very big

because it's a very big object hitting it. And sometimes earlier on in the history of the moon, a big object would hit it and it would cause lava to flow out through the hole that it punctured in there. And that's why parts of the moon look darker than others. It's all because these things keep smacking into the moon now.

[Jane] Now, Argen wanted to know about the color of the moon.

[Argin] I'm 6 years old and I live in Canada. My question is, why is the moon white?

[John] So the moon appears to have lots of different colors. But when you get up really close to the surface of the moon, it's mostly sort of this dull grayish black. But that's not what we see from the earth. From the earth we often times see that parts of the moon are brighter than the others. And that's partly because the rocks are different colors in some of the regions where it's darker, that's because lava used to flow on top of there after a big impact. But most of the differences in colors are because of the way that the sunlight is bouncing off of the moon. And that makes some regions much brighter than others. In fact, that's what's responsible for the phases of the moon.

[Jane] When John O'Meara says the phases of the moon, he's talking about the shape of the moon and how it changes over the course of about 28 days, a full cycle. The moon is always a sphere, a ball, but it doesn't always look like that. Sometimes you look up at the moon and it looks like a banana or a crescent. Sometimes it looks like half a circle and sometimes it's a bright full circle, a full moon. But why?

[Satchel] Hi, my name is Satchel. I live in Mobile, Alabama. I'm five years. And my question is, why does the moon change its shape: circle, half, banana half?

[Sawyer] My name is Sawyer. I am eight years old. I live in Sherman, Texas. My question is, why does the moon change color and get smaller in the night sky?

[Lauren] Hi, my name is Lauren and I'm six years old and I live in Washington, New Hampshire and my question is why isn't the moon always round?

[John] Again, the reason for this is because we actually see the moon in reflected sunlight. Sunlight bounces off of the surface of the moon and into our eyes. The moon itself doesn't make its own light. And so depending on where we are on the earth and where the moon is in the sky, you'll see different amounts of light reflected off of it. Sometimes the moon is in between us and the sun, and so we don't see any sunlight reflected off of the surface. And that's what we call a new moon. On the other hand, if the moon is on the opposite side of the earth from the sun, then we see the entire surface that's facing us off of the moon in reflected sunlight. And that's what we call a full moon. So the moon itself isn't changing its shape. It's just reflecting different amounts of light into our eyes.

[Jane] Later in this episode...

Why does the moon always look like it's following us in the car always?

[Jane] And why can you sometimes see it during the day?

This is *But Why: A Podcast for Curious Kids*. I'm Jane Lindholm. Today, we're talking all about the moon with John O'Meara, chief scientist at the Keck Observatory. We've talked

a little bit about how the moon doesn't actually change shape, but often looks very different to us in the sky, depending on where it is in its phase: How much sunlight we can actually see shining onto the surface of the moon? When the earth is in between the sun and the moon only some of the surface of the moon gets that sunlight shining onto it, so parts of the moon appeared dark, and it makes the moon look like a banana or a crescent. That only happens because the earth and the moon are both moving all the time.

[Nina] Hi, my name is Nina. I am five years old. I live in Illinois. And my question is, how does the moon move?

[Rebecca] Hi, my name is Rebecca. I'm 4 years old. My question is, how does the moon stay in place?

[Jane] This is complicated and you'll probably learn a lot more about it when you get into high school physics. But let me give you a very brief overview. Remember how John O'Meara said that the best theory scientists have for how the moon was formed is that it came from a collision, a crash between the earth and an object about half its size, about the size of Mars. Well, when that crash happened, the material that was thrown away from the earth was traveling very fast. It all joined together to form the moon. And the force known as gravity kept it from just continuing out into space. The moon basically got trapped by the Earth's gravity. The force of gravity pulls the moon towards the earth, and then the moon moves around the earth. It can never get away from the earth because of gravity, and it doesn't become closer to the earth because it's still trying to move away. The moon, by the way, also exerts a force on the earth, and it takes the moon a little less than 28 days to go all the way around the earth and start again. That's one full cycle of the moon. Now, speaking of gravity...

[Claudia] Hello, my name is Claudia and I'm nine years old.

[Monica] Hello, my name is Monica and I'm six years old.

[Claudia] We're friends. We're in St. Cloud, Minnesota. And we want to know...

[Claudia and Monica] ...how does the moon control the waves and why?

[Jane] How does the moon control the waves and why?

[John] Hi, Claudia and Monica. Great question! The moon controls the waves for the same reason that if you drop a ball, it'll fall towards the earth. And that's the gravitational force. The earth and the moon are really big and have lots of mass. And so they exert a really, really strong force on each other. But, certain parts of the earth, like the oceans, are liquid and they can move more in response to that pull due to gravity. And so they're attracted a little bit closer to the moon than the rigid earth is because they're right on the surface and they're closer to the moon. And that gravitational force is a little bit stronger when you're a little bit closer to the moon than it is if you're right in the center of the earth. And so as the moon goes through the sky during the day because the earth is spinning around during the day, the parts of the earth that are just below the moon that are covered in water get pulled up a little bit more. And that's what we call tides. In fact, the moon isn't the only thing that can make the tides. The sun can make the tides, too. But the tides from the sun are much smaller than the tides from the moon, because the sun is really far away.

[Georgia] I'm Georgia and I'm six years old. I live in Fort Wayne, Indiana. I wanna know if the moon is actually the one that makes tsunamis with its magnetism?

[John] Hi, Georgia. Nope, you don't need to worry about the moon making tsunamis with its magnetism, because first of all, the moon doesn't really have a magnetic field. It doesn't have much magnetism at all. And secondly, tsunamis are caused by much more local events like big earthquakes can create tsunamis or if something really big were to strike the earth it might make a tsunami. But the moon really just raises the tides and it mostly raises the tides by 1 or 2 feet depending on where you are in the earth. In some places it's a little bit more. In some places it's a little bit less. But the moon itself is not going to make any tsunamis.

[Jane] We often think of the moon as coming out only at night. But as so many of you have observed, that's not really true.

Why can the moon be out during the day?

Why is the moon sometimes out at day, it usually rises at night?

Why is the moon up at day?

Why did I see the moon in the day?

Why can you see the moon during the day?

Why can you sometimes see the moon in the day?

Why can you sometimes see the moon in the day? And how old are you?

Three and a half.

[Georgianna] My name is Georgianna and I am from Gilroy, California. Yeah. And I'm five years old. And my question is, why is the moon out in the daytime?

Why is the moon up at the same time as the sun?

Where does the moon go in the day time?

[Isabelle] My name is Isabelle and I'm from Melbourne, Australia. My question is, where does this sun go when it's the moons time to come out?

[Jane] In addition to the names you heard that was Daisy, Elliott, two Emmas, Gabe, Sam, Rosa and Cal. Here's John O'Meara.

[John] We can see the moon during the day for the same reason that we see the moon at night. The surface is reflecting the light from the sun into our eyes. But you can ask a different question which gets at the heart of the question that you're asking, which is why don't we see the stars during the day? The answer is, is that the stars are nowhere near as bright as the blue sky during the day, but the moon is approximately as bright and reflected sunlight as the sky during the day. And that's why we can see the moon during the day, but not the stars during the day. Now we don't always see the moon during the day, and that's because of where the moon might be in the sky. Sometimes to see the moon, you

would have to look through the earth, and we can't do that. So when we see the moon during the day, that's because the moon is in the right spot on the sky and is reflecting enough sunlight to be as bright or brighter than the sky.

[Jane] Okay. One more question about the moon for this episode. Let's start with Anisa, who I think may have been riding in the car when this question was recorded.

[Anisa] I wanna know why it looks like the moon is following you when you drive?

[Elizabeth] My name is Elizabeth. I'm five years old. I live in Pennsylvania. Why does the moon look like it's following us in the car always?

[Phoebe] Hi, my name is Phoebe. Why does the moon follow you in the car right when it's night? Why?

[Jane] I love to look out the window at night when I'm riding in the car and watch the moon. It really does look like it's keeping right up with the speeding vehicle.

[John] I've always thought this when I'm driving along, "that moon is looking at me," "That moon is following me." Well, the reason for this is that it's a little bit of an optical illusion. The moon is very, very, very far away compared to any of the other things that you're seeing when you're driving. So if you're driving down the road and you see some telephone poles, you can see them fly past you as you drive past. Or you can see distant objects like buildings slowly get close to you. But the moon is so far away that its size and shape on the sky just doesn't change much at all because it's really, really, really far away. You driving one mile is insignificant in terms of how it makes the moon look on the sky. And because the earth is rotating around once every 24 hours, which is pretty slow, that means you just don't see the moon moving too much in the sky except for when it's really, really close to the horizon, and you can see the moon set and the sunset happen. But in terms of why you think the moon is following you, it's because it's just so far away and it really isn't changing its shape much on the sky while you're driving along.

[Jane] That's it for today. Did you learn anything new about the moon? Next time you look up and you see that banana shaped moon in the daytime sky, you'll know all kinds of things about it. Galactic thanks to our lunar guide, John O'Meara, chief scientist at the W M Keck Observatory in Hawaii. If you have a question for *But Why?* about anything have an adult record you asking it? It's easy to do on a smartphone using a free voice memo or voice recorder app. Then have your adult send your question to questions@butwhykids.org. We'll do our best to get an answer for you.

But Why? is produced by Melody Bodette and me, Jane Lindholm, at Vermont Public Radio. Our theme music is by Luke Reynolds. The sounds from the Apollo 11 mission in this episode come from NASA. We'll be back in two weeks with an all new episode. Until then, stay curious.