Astronomy Cast Questions Show:
Farmersburg School

Fraser Cain: Now as you all know, you recently recorded a bunch of questions about space and astronomy, and we're here to answer them. Let's get started. First we have Sierra.

Sierra: We learned in class that stars emit radio waves. My question is, what do radio waves given off by stars sound like?

Fraser: I guess the question then, is what's different between a great big radio telescope and me taking the radio from my car and pointing it at a star or the Sun?

Dr. Pamela Gay: The biggest difference is just sensitivity. When you tune your radio to some place that's between a couple of different stations, you'll hear a lot of hissing and crackling and white noise. Some of that white noise you're hearing is actually radio signals from stars and nearby planets. We can't make it out really clearly with our car radio, because it can't be pointed at "Jupiter". If you had the right radio – and some people actually build these for science fair projects – you can actually listen to the noise made by Jupiter.

In general, stars don't sound like much. You tune your radio to them and in general it's hissing and crackling and kind of boring. Some of them, like pulsars, make periodic beeps. It's like listening to some sub-sonar noise like from a TV show were it's just "beep, beep, beep" over and over extremely regularly. More regularly than any clock we can build here on Earth.

Other objects appear to squeak and squelch and sound to me a little bit like recordings of whale songs. The universe is this crazy cacophony of different noises coming out from different objects, but they're not just sending us light, they're sending us radio light. It's the radio we use that has equipment in it that instead of turning the light into pictures, we turn it into sound.

Fraser: I guess it's important to put it that way. The radio waves coming off a star are very similar to the visible light waves that we can see with our eyeballs. It's just a difference of how far apart the waves are. With light, the waves are a fraction of a millimetre apart, but with the waves that are coming off of stars in the radio, they can be meters apart.

Pamela: Kilometres!

Fraser: Kilometres apart, yeah. I you take the radio waves that are coming off a star and mash them together, then they would be visible light. There's no real difference in how far apart the waves are when they're bonking into your eyes or in this case bonking into the radio.

Pamela: In fact, astronomers who use radio telescopes to look at stars, planets and galaxies, we are able to take those pictures that we take in radio waves, and get these really neat, pretty pictures of our universe that are taken in the exact same colours of light that you might listen to with your radio. This is a problem for astronomers.

As we go out and look around the universe, occasionally we can't look at things in radio colours because we're getting blasted by the local radio station or cell phone signals. Astronomers are slowly losing their ability to see different parts of what we call the electromagnetic spectrum, different colours of light, because those colours are getting completely washed out by man-made light, just like you can't see the stars during the day because of the Sun, and you can't see the stars when you're in the middle of a football arena lit up at night because those big lights in the stadium drown out all the starlight. Your cell phone is also drowning out starlight, just of a different colour.

Fraser: To sort of bring it all around, if you were able to hook up your car stereo and listen to radio waves you would hear pops, crackles, beeps, chirps and just very bizarre sounds. Nothing you could really dance to.

Let's move on then. The next question comes from Alex.

Alex: We learned that black holes absorb everything. My question is, what happens to the energy that goes into a black hole?

Fraser: So we know that the mass – planets and moons and stars and galaxies that get gobbled up by a black hole, just go to increase its mass. If you shine a flashlight at a black hole, that light's just going to go down the black hole just like matter. What happens to that energy?

Pamela: Here's the neat thing. Since mass is just frozen energy, basically shining lots of light into a black hole also makes the black hole get bigger. The mass of a black hole consists of all the normal stuff it eats: all the rocks, planets and anything that gets too close so it can suck in and consume it. It also consists of all of the light the black hole has absorbed, all of the energy. All that goes in to increase the mass too. It's kind of hard and weird to think about, but light, mass… one is just the frozen form of the other.

Fraser: So does it just turn into the same stuff? Let's say you could take a black hole apart and take a look at it. Would you be able to tell the difference between the stuff that was once planet and the stuff that was once light?

Pamela: Once it falls into a black hole, not really. The thing that's so weird about black holes is they basically don't let information escape. So once something goes into a black hole, it's there and we can no longer get it back out. We don't know what it becomes once it falls into a black hole. It could be that all of the matter gets compressed so much that it can no longer exist as matter, and becomes pure energy. It could be that the matter gets squished together so much that it becomes some sort of particle we can't even imagine yet.

The insides of black holes are one of those places that physicists are still trying to figure out how to understand. Since we can't go and visit one without dying, it means we have to do all of our work inside computers. We're still looking to try and find the physics, but it's quite possible that if you could take apart a black hole, everything would just be pure energy.

Fraser: So I guess we know that matter and energy are interchangeable (thanks Einstein) so, we can be pretty sure that everything that goes into the black hole turns into the same thing since they're interchangeable, we just have no idea what that thing is. Perfect.

At least it all gets treated the same – matter, energy, it all gets mashed into the black hole and what it gets turned into is a great big mystery. But it's the same mystery.

Pamela: Someday, maybe one of you will help figure out what that mystery is.

Fraser: All right. Let us know.

Okay. Next question comes from Lacy.

Lacy: If the ozone layer protects us from the Sun, why can't we look at the Sun?

Fraser: All right. I think I can back up this question. If I look at the Sun, it really hurts! Clearly, the light is not being blocked from the Sun. what's going on?

Pamela: The Sunlight comes in a lot of different colours – colours seem to be the theme of the day. Some of these colours can't quite make it through the atmosphere. For instance, the GLAST satellite is going to get launched to look at gamma rays, because gamma ray light is really, really blue light – so blue you could never see it with your eyes, so blue and high energy that if you got shot with a gamma ray it would damage your cells and cause them to break apart.

Fraser: So if I look at a rainbow out on the horizon, it's blue on the inside and then goes green and then yellow and then red is the top of the rainbow on the one that's the largest part of the arc. Could we continue that rainbow in both directions?

Pamela: We can keep going in both directions. If you take off on the red side it goes from red to infrared, then it goes to microwave like the colour you use to cook your food. Beyond microwave we start to get to radio – the different colours of light we use for our cell phones, wireless internet connections, Bluetooth headsets. It keeps getting into longer and longer wavelengths – television and radio wavelengths. They're all just different colours of light.

If you go out the other direction, from blue, it goes to ultraviolet – the colours that cause you to get Sunburned in the summer. If you keep going beyond the ultraviolet you start getting dangerous colours. X rays – they're a specific colour of light, and a colour that can pass through your skin and organs but can't pass through your bones. If you get too many x-rays, it'll start damaging your cells.

Out beyond even x-rays is where we start getting to gamma rays. When they strike your cells, it totally blasts them apart. It's really bad for you. Our atmosphere keeps us safe.

Fraser: So when I'm staring at the Sun, that's the visible light, right? The stuff that's too bright. But I'm also being pelted with ultraviolet, right?

Pamela: Some of the ultraviolet light from the Sun does get through the atmosphere. Our ozone layer blocks a lot of it, which is why not everyone gets skin cancer and Sunburns are something to be concerned about. If you have dark hair/eyes/skin, you can probably go outside for half an hour and not get too burned.

The Sun also gives off other colours of light that don't make it at all through our atmosphere, because it blocks them completely. So it's out there blocking some colours of light and letting some colours through.

Now, the reason our atmosphere keeps us safe is it blocks most of the dangerous rays. What it doesn't do is dim the Sun. if you look straight at the Sun, it's like getting a 100W light bulb a millimetre from the surface of your eye. It hurts! It's so bright, there are so many particles of light – photons – hitting the back of your eye that your eye can't handle it. The little cells in your eye can't react fast enough to deal with it. That's why looking at the Sun is dangerous – the brightness, not just the colours.

Fraser: So our atmosphere and the ozone layer is stopping certain kinds of light and letting other kinds of light through. So it's the kind of light that it's blocking that's the dangerouos stuff. The kind of light it's letting through is stuff we need to see. So we're actually quite fortunate when you think about it. All the really dangerous stuff gets blocked by the atmosphere.

We get x-rays that would give us all cancer, the gamma rays that would turn us into the Incredible Hulk – well, maybe not, I guess they all just give us cancer. The ultraviolet light gives us skin burns and… well, skin cancer eventually. But the stuff we need, visible light and radio waves, is all let through.

Okay. Let's move on. The next one comes from Jake and he wants to know:

Jake: Are all wavelengths of the electromagnetic spectrum absorbed by a black hole?

Fraser: I think we're going to have fun with this question, because I think I know the answer but let's find out. Can black holes absorb all the electromagnetic radiation?

Pamela: Black holes can eat anything they feel like.

Fraser: Anything! So, like visible light?

Pamela: Gone!

Fraser: X-rays?

Pamela: Gone!

Fraser: Radio waves?

Pamela: Oh, totally eaten!

Fraser: Okay, so no matter what you shine at a black hole, it'll bend it towards it and suck it in.

Pamela: What's neat though, is not all of the light's going to go straight in. some light is going to hit it at an angle and it's sort of like when you throw a basketball up at a basketball hoop. If you don't get it straight in, it bounces back out at you.

With black holes, if the light is shining toward the black hole but it's shining at it at just the right angle, the light will go all the way around the rim of the black hole at the edge of the Schwarzschild radius and come back out at you.

Fraser: So you could shine a laser at a black hole at just the right place and be shooting yourself in the eye with the laser?

Pamela: Oh yeah, isn't that cool?

Fraser: But if you aim it right at a black hole, then goodbye laser.

Pamela: Yeah, well – yeah. Laser beam.

Fraser: Okay so we know what light is going to do. Let's just throw anything at it. Is there any kind of matter? Anything? Come on!

Pamela: No. What can happen though is as stuff is falling into the black hole, there's this amazing magnetic fields that wrap around the black hole as well. So you have this disk of material streaming around the black hole waiting to get eaten and there's this magnetic field there as well.

If you've ever played with magnets you know you can pick things up and move them around using magnets. This magnetic field can do the same thing and will occasionally grab a chunk of stuff and fling it out the pole of the magnetic field.

So you have this disk of material where most of the material is on its way to being consumed. Some of that stuff gets launched out the ends of the magnetic field and forms these amazing jets. These jets can span bigger than the size of the galaxy.

If you look at a picture, you'll see this little tiny galaxy in the centre, and these huge jets that go tens of times the length of the galaxy at both ends. The jets are just coming from an angry black hole inside the galaxy that's mostly eating its food, but not consuming all of it. Instead it's spewing some stuff out its two poles.

Fraser: That's funny. The light is doomed, but some of the matter has a chance of just getting ejected out and not even making it into the black hole.

Pamela: It's all because it can get caught up in this magnetic field on the way to the Schwarzschild radius.

Fraser: I think of it like a drain choking up. You're trying to put so much material down your tub – it's why your tub doesn't empty out in a heartbeat. It takes time for all that water to get down the drain, which is why you get the whirlpool forming. All this material is backing up, waiting for its turn to go down the drain.

It's the same thing with a black hole: it's too much for it to eat too quickly. With black holes, they create these giant magnetic fields and fire this stuff off in magnetic jets. It must be quite amazing to see.

Pamela: It's a violent universe out there.

Fraser: All right. Let's move on. The next question comes from Alexis.

Alexis: Since the Sun gives off harmful rays, could it help if we figured out how to block all the rays that are harmful and trigger cancer?

Fraser: So can we figure out how to block those rays from the Sun? Isn't that just what Suntan lotion is?

Pamela: The problem with Suntan lotion is it's not a permanent thing. You have to keep putting it on every 20 minutes or so, depending on what colour skin you have and what type of Sunblock you're using.

It would be so cool if we could change our atmosphere to make the ultraviolet light not get through our atmosphere so easily. If you think about it, 30 years ago people were going outside, lying outside, covering themselves in baby oil instead of Suntan lotion. They were getting burned some, but they didn't worry about cancer. Nowadays, no one goes outside without Suntan lotion – don't do it!

What's happened is we've actually damaged our atmosphere. We've caused a hole in the ozone layer that causes more ultraviolet light to get through our atmosphere than used to get through. We discovered this big hole back in the '80s, and the entire world did this simultaneous "oh no, we're in trouble."

The governments of the world got together and passed legislation to ban the chemicals that were causing the hole in the atmosphere. The hole was caused by the type of stuff that's in air conditioners (or at least, it was), Freon. When that Freon escaped into the atmosphere, it destroyed the ozone. They were caused by the chemicals in aerosol hairspray. Those chemicals got out and destroyed the ozone.

We've had to go through and change a lot of the products we use every day so they're friendlier for the atmosphere. Because people have been doing this, that hole is now healing itself, getting smaller and smaller (most years – it occasionally gets a little bit bigger again). We seem to be, in this one case, repairing our planet.

Fraser: Now, that's fine. We're not doing the thing that's damaging the atmosphere as much anymore. That's a positive. Could we take this to the next level? Could we do something to the atmosphere? Instead of having to put on Suntan lotion everyday, could we do something so that we actually pump out ozone into the atmosphere and have that beef it up?

Pamela: A lot of scientists have come up with a lot of economically-not-so-friendly ideas because these things cost so much money. There are ideas that we could put a bunch of tiny satellites that would orbit the planet and block light from the Sun, reducing heat from the Sun and therefore global warming.

There have been suggestions to go up and add ozone to the correct layer of the atmosphere, but then you're flying planes which are harmful to the atmosphere to get the ozone up there.

There's no easy solution, and there's no inexpensive solution other than to ban the chemicals that did the damage originally, and hope it heals. It may be that someday we have to start doing the harder things, and have to start figuring out how to go out and manually fix our atmosphere. Right now, it's doing a reasonable job at repairing itself.

Fraser: I think it's one of those things where it's all about a sense of scale. It didn't take a lot of chemicals to cause the damage, but it will take a lot of stuff to try and repair the damage. If you try and do some kind of gigantic engineering project where you fly balloons filled with ozone and release them to try to repair the ozone layer… the cure might be worse than the disease in the first place. There might be all kinds of unexpected repercussions. It seems like in these situations the best thing to do is stop wrecking it and from that point on really take advantage of the natural processes that happen on the Earth, designed to try and create balance in the atmosphere and temperature and all those kinds of things.

I've heard some research fairly recently that really talks about a lot of these super-engineering projects, and that in many cases they may seem good on paper, like launching a million satellites to block global warming, or carrying tankers of iron out to see and dumping it to try and make algae bloom and cool down the oceans, but there's so many repercussions that can happen that you don't know about. In many cases you just have to stop wrecking it and then give nature a chance to try and repair the damage.

Pamela: It's the good old "when in doubt, do no harm".

Fraser: Yeah.

Okay, let's move on. Here's Carol-Beth's question:

Carol-Beth: How hot is the hottest star, and how do we know?

Fraser: All right, hottest star. Name it!

Pamela: Well, I would… except the scientists keep changing their mind as we explore more and more of the universe. The sky is a huge place. To quote Carl Sagan, there's billions and billions of stars out there.

It seems like every four or five months, someone else comes out with another "I've discovered the biggest star". It's sort of like on our planet, the person who's the oldest person keeps changing. The person who's the tallest or the shortest… these things keep changing.

In general, the biggest stars are pretty big and they're really hot. The hottest stars are 40,000 degrees Celsius.

Fraser: So the hottest stars are the biggest stars and the biggest stars are the hottest stars. Those two go hand in hand.

Pamela: Yes.

Fraser: Well, I think we just answered some future question there. What are the biggest stars? The hottest stars. What are the hottest stars? They're the biggest stars.

Pamela: So we have these amazingly hot stars. Americans don't think in Celsius that much, but Fraser, you're Canadian.

Fraser: I encourage you to think in Celsius!

Pamela: How hot is the hottest summer day? In Celsius.

Fraser: In the 30's. 30 is uncomfortable, 35 would make me want to stay inside all day long.

Pamela: So 35 degrees Celsius is so hot you just want to stay inside where it's air conditioned all day. These stars are more than 1000 times hotter than that. So we have stars 1000 times hotter than the hottest day you ever want to experience.

Fraser: How does that compare to our Sun? What's the temperature of our Sun?

Pamela: Our Sun's only a few thousand degrees – about 6 thousand.

Fraser: So eight times hotter than the Sun.

Pamela: We're talking white-hot.

Fraser: Yeah.

Pamela: We're talking so hot that you look at them and you don't actually want to look at them (if you really want to understand them) with a normal backyard telescope. You want to look at them in other colours (this seems to be the theme for this show). You want to start looking at them in the ultraviolet.

When things get this hot, they start giving off light in weird colours like ultraviolet more than they give off light in colours like red. These stars give off huge amounts of ultraviolet light, and they live a very short life. Sometimes only a few million years, compared to our Sun which will live tens of billions of years.

Fraser: These super-hot stars will burn up their fuel in just a few million years, and then kaboom.

Pamela: And then we may get a black hole.

Fraser: Right. This is really wrapping up. All these questions link together. The biggest hottest star is going to blaze in the high end of the spectrum, the ultraviolet and x-rays, and will in just a few short million years, explode as a supernova and turn into a black hole.

Pamela: Then it will eat things.

[laughter]

Fraser: Then it will eat things, including all that light and matter, and do things that we just don't know what it did to it.

All right, let's move on. The next question comes from Haley:

Haley: Why can't we see the rays like microwaves, infrared or radio waves, but we can see other light rays?

Fraser: It seems kind of sad that there are all these different kinds of radiation or light coming from everything, and yet we can only see just a fraction. We can see the colours, but we can't see the radio, microwaves, gamma rays, x-rays… how come?

Pamela: This actually starts to be a biology problem. If any of you have a pet snake, some snakes don't see in the same colours of light that we do. They instead, see in the infrared. Then they can go hunting at night and see a mouse as this bright infrared object, this bright object giving off light because it's warm, against a cold bunch of leaves, even though to our eyes, the leaves and mouse are the exact colour.

Snakes, some of them, see in different colours than human beings do. We're geared to be able to find a red apple in a green tree, and to notice that a tiger is about to eat us out in the bushes. We're developed to wander around in the middle of the day, feed ourselves, and not get eaten by other animals.

Since we don't get gamma rays or x-rays coming through our atmosphere, our eyes don't need to be able to see those colours. So they don't. it's probably pretty good, because if we were able to see everything in every different colour, it would probably be really confusing.

Imagine you're sitting in your room and all of a sudden you see this beam of cell phone radio light in front of you. You couldn't see your wall or your computer screen because you're blinded by the radio light.

Only being able to see in the visual light spectrum frees up all those other colours to get used for communications or to cook your dinner. We don't have to worry about all those extra colours getting in the way of our ability to not fall down the stairs.

Fraser: I guess with the radio waves and microwaves, although they're out there in space (I know there are radio waves from the Sun and microwaves coming from various objects in space like Jupiter), they didn't really play any role in our evolution, so they weren't really necessary in the same way.

If they were evolutionary advantageous to us, someone could very well have an organ that sees in one of those spectra, right? Aren't there birds that can sense magnetic fields? Could you, theoretically, have a creature that for some good reason needed to spot radio waves because maybe it's food gave off radio waves? Could you have an animal that could've evolved like that?

Pamela: Anything should be possible. You start getting into trouble with x-rays and gamma rays. These are dangerous colours of light, and there you'd have to do something radically different than anything we know of to be able to safely see those without getting cancer or something.

Life is highly adaptable, and we find life capable of doing all sorts of crazy things. There's no reason to say there isn't somewhere in our vast universe, some microbe that swims along radio waves looking for specific types of food.

Fraser: I think it's important to know that when astronomers are looking at visible light, they use a telescope with a mirror that reflects the light. The same thing goes for infrared, except they have to use helium to cool down their telescope. Ultraviolet as well, they use a mirror.

With radio waves, your car antenna will pick up radio waves and that is a very different looking thing. For the high end of the spectrum, telescopes don't work anymore, right?

Pamela: No, we end up using completely different technologies. The Chandra X-Ray Observatory, the upcoming GLAST mission… their technologies are completely different.

We say these are missions instead of telescopes because the Chandra X-Ray Observatory and the future GLAST mission are satellites that are put up above our atmosphere so astronomers can see things we can't see here on Earth.

GLAST is going to go out and look for the excited matter getting shredded around black holes. It will be out there looking for bursts of energy coming out of supernovas from when that hottest star collapses and becomes a supernova.

These missions are going to be out there looking for the things that we can't see from here on the planet Earth. They're going to be out there looking for things we can't see with our eyes.

Fraser: Okay. Let's pretend that you could. You could put on a different pair of glasses and see the sky in different ways. Right now you look up and see the stars with your eyes in visible light. Let's say you put on infrared eyes. What would you see?

Pamela: In the infrared you start to see all these gassy clouds of material waiting to collapse down into stars. You see Jupiter as one of the brightest objects in the solar system because it's giving off vast amounts of infrared light. You see galaxies that are out there forming stars that are rich in gas. Gas forming stars and infrared light just go hand in hand throughout the entire universe.

Fraser: All right, so let's say we swap in our ultraviolet glasses.

Pamela: When you start looking in the ultraviolet, now you're looking at the hot, young stars that are just basically angry toddlers throwing energetic temper tantrums as they work to form and blow off energy. These are the hottest stars. These are the brightest stars. They often are found in what we call stellar nurseries.

They're found in collections of young, angry stars that are all in the process of forming together. By the time they're adults, these systems have often spread apart so that you can no longer see what nursery the adult stars originally formed in.

Fraser: All right. Take the ultraviolet on and put on the x-ray glasses on.

Pamela: X-rays are cool. They're actually really hot. We see x-rays when we look at families of galaxies called galaxy clusters. Galaxies, like people, don't like to be all by themselves. We generally find galaxies in pairs and groups. Sometimes in neighbourhoods of thousands of galaxies all collected together.

In the middle of all of these galaxies is usually a pool of hot gas. This is gas that has gotten pulled out of each of the individual galaxies and collected in the space in between them.

If you have dogs, you know they'll run around and leave fur everywhere. If they romp and play, it removes more fur as the dogs are scratching on each other. You end up with a pile of dog fur wherever your dogs got into a particularly interesting play match.

As galaxies interact with each other, they gravitationally play and gravitationally pull gas out of each other. Just like the dog fur falls to the floor, the gas in the galaxies falls into the space between the galaxies. That gas heats up and gives off x-ray light.

Fraser: Don't forget about black holes.

Pamela: You get x-ray light from families of galaxies, but you also get it where you have black holes that are heating up the material around them, causing it to get extremely hot and crackle with x-rays.

Fraser: The last glasses are the gamma ray glasses.

Pamela: These are some of the coolest glasses of all. If you look around the sky in gamma ray bursts, you see these bright explosions popping in random explosions around the sky. These pops of gamma ray light mark the spots where the most massive stars in the universe are in the process of dying – or sometimes merging, to form even bigger objects.

We have what are called gamma ray bursts. We think we know what causes these. We think they come from certain special types of supernova, that we call hypernova. Or maybe they come when you get two black holes merging together. When you get two other really high mass, dead stars, called neutron stars merging together.

When you have these different explosions taking place, you get blasts of gamma ray bursts, and they go off like fireworks all over the universe. These are the most energetic things we know of anywhere.

You also see gamma rays associated with some of the hottest stars, with material falling into black holes. It's a violent, exciting and beautiful universe out there, when you start looking at it with high-energy x-ray and gamma ray glasses.

Fraser: I want some of those!

[laughter]

Let's move on. Here's Jake's question:

Jake: Are there any known waves that travel faster than light, and if so, how do we detect them?

Fraser: So does anything travel faster than the speed of light?

Pamela: As far as we know, the answer is no. It's kind of a sad answer, you want to go faster than light because that means you could do what they do in Star Trek and explore the entire galaxy. But as far as we know, there's nothing that travels faster than light. The rules of physics actually say you can't go faster than light.

So we're kind of stuck. Light is the fastest thing we know of. Mass just can't go anywhere near that fast. It's kind of sad, but light seems to be the fastest thing and its speed limit is the speed limit of the universe.

Fraser: Now, you can move up to the speed of light and get close. Theoretically. Right?

Pamela: Theoretically. It takes a lot of energy. You'd have to pretty much use up all the energy of a planet to accelerate you or me to close to the speed of light.

Fraser: Aren't there particles being blast at us from supernova explosions that are going that fast, almost the speed of light?

Pamela: There are individual particles that you run across that are going 60 or 70% the speed of light.

Fraser: We don't want to go too deep into Einstein's calculations, but I know he said that the faster you go, the more energy it takes to keep going faster. As you get closer to the speed of light, you just have to pour in more and more rocket fuel. Before you could reach the speed of light, you would've consumed all of the energy in the universe and you still wouldn't be quite at the speed of light.

Pamela: It's a problem. There's limited resources everywhere, and going really fast takes a lot of energy. Imagine that you're trying to accelerate your car, and when you start off, your car weighs 1000 lbs. you get to going 10mph and suddenly your car weighs 1100 lbs. You get to going 20mph and your car suddenly weighs 1500lbs.

The faster you go, the more your car weighs. It's going to be harder and harder to accelerate your car as it seems to weigh more and more.

One of the weird things about physics is, the faster you go, the more massive you get and the harder it is to move you. These things all tie together and it's really weird and complicated. It keeps us down on Earth going at slow speeds.

Fraser: In fact, if you could go fast enough, you'd just turn into a black hole, wouldn't you?

Pamela: Pretty much. You'd eventually become really massive, and that's a bad thing.

Fraser: Yeah. So, unfortunately there's just no way to go faster than the speed of light. No one's ever found it. But boy, if we could, that would be the greatest thing.

All right, let's move on to our last question, this is from Cody:

Cody: How do you tell the difference between a black hole and nothing in space?

Fraser: So if I'm looking into space and there's a black hole there, how do I know it's a black hole there and not just nothing? It's black. We already talked about how anything we throw at it just gets sucked in.

Pamela: The weird thing about black holes is if they're not eating anything, they're just hanging out being black. By this, I mean an utter lack of light. No light whatsoever.

Fraser: You would have no way of visually spotting one. You'd just be like, "I've got nothing."

Pamela: Absolutely nothing.

Fraser: Right.

Pamela: They're not that big, in general. If you took the Sun and were able to compress the Sun so it behaved like a black hole, it would only be about three kilometres across.

Fraser: So, with the great big universe, how would you spot something that's three kilometres across?

Pamela: You won't.

Fraser: Right.

Pamela: The way we find black holes is, well, our universe has a lot of stuff in it. While it's mostly empty space, there is dust around, there are asteroids around. Just like when you're bike riding down the street and occasionally get a bug flying in your face, as a black hole slowly rotates around the galaxy it's in, it will occasionally get an asteroid in its face. It can eat it.

When it eats it, it's going to give off a burst of light, it's going to give off a burst of gamma rays or x-rays, all depending on how much it eats and what it eats. We can see that burst of energy that comes from something getting destroyed as its about to fall past the black hole's Schwarzschild radius.

Fraser: Right. It's not the black hole pumping out this radiation. The very moment the asteroid is being shredded apart right at the edge of the event horizon, parts of it are being converted to energy. Some of that energy is being sucked into the black hole and some is being emitted out into space. That's what we get to see.

Pamela: It's like the asteroid or gas or whatever it is the black hole is eating, is screaming with light.

Fraser: Right. Screaming is the right word – that's how we can see it. Even a little asteroid will die so hard that we see the light.

Pamela: This is why we need the telescopes like GLAST and SWIFT (another one that's out there that can detect these high energy bits of light), and why we need all these orbiting space telescopes: to help us see these flashes of material falling into black holes and screaming with light.

Fraser: I like that, "screaming with light".

All right. I think that wraps up our questions from Farmersburg School. Thanks to everyone who participated and sent in questions. I hope this helps you with your answers, and I hope that you find astronomy and space as fascinating as we do.

This transcript is not an exact match to the audio file. It has been edited for clarity.