Astronomy Cast Questions Show:
Curtis High School

Fraser Cain: The first question comes from Outer Space:

Outer Space: Hi, I'm Outer Space. My question is, besides dark matter and dark energy, is there any possibility there's anything else in outer space?

Fraser: All right. We know there's regular matter, we know there's dark matter, and we know there's dark energy. Is there something else? We only learned about dark energy less than ten years ago. Little did we realise that 70% of the universe was even something.

Dr. Pamela Gay: The thing about dark energy is it had actually existed sort-of-kind-of in theories. There's a thing called vacuum energy or quiescence that kept popping up here and there. Most of all, dark energy and dark matter are catchall phrases for everything we don't know what is.

Anything that has mass, interacts with gravity, that's out there yanking on things gravitationally, we call dark matter. Dark matter is probably a bunch of different individual things. Some of it may be particles; some of it may be something we haven't even imagined yet. There's room within the idea of dark matter for there to be a lot of different things that we haven't even thought of yet. The same is true of dark energy.

Dark energy is probably one kind of thing, but we could be wrong. That's the cool thing about science.

Fraser: Could there be another thing that's completely different that we could call, I don't know, "dark vacuum"

[laughter]

Or something, I don't know! Just something we haven't even thought of yet, or discovered.

Pamela: That's the cool thing about astronomy. It keeps surprising us. We never know what new things our observations are going to lay in front of us. As we figure out new and better ways to explore earlier and earlier in our universe's past, there could still be things out there waiting to be discovered.

Fraser: So when people talk about, say, dark matter, they're really just collecting a whole pile of stuff into one pot and just saying, "this stuff we think is matter, it's pulling at regular matter with its gravity, we have no idea what it is, so that's dark matter."

Pamela: Yeah. One way to think of it is I can call everything in my silverware drawer a utensil. But not all utensils are spoons – some are forks, some are knives, some are funny little things designed to torture grapefruit. They're all utensils.

Dark matter could be a bunch of different things the way utensils are a bunch of different things. We're still waiting to discover just what those things are.

Fraser: I guess you'd almost be crazy not to say, "absolutely, there could very well be something out there that's very significant in the universe, that's completely undiscovered and we have no idea what it is."

Pamela: This is why I do astronomy.

Fraser: It's happened before, and it will happen again.

Pamela: Exactly.

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

Anonymous: Hello, this is Anonymous. I would like to know, since I heard about the new program for bringing life to Mars, I wonder if the big storm forming around Mars will have any conflict with the human development on Mars.

Fraser: Let's talk about those dust storms. What are the dust storms on Mars?

Pamela: Just like the planet Earth, Mars is tilted. It isn't straight up and down relative to the Sun. There are seasons – the North Pole has summer part of the year, the South Pole has summer part of the year. This sets up all sorts of neat weather storms. The same way we have hurricane seasons here, they have dust storm seasons on Mars.

During different parts of the Martian year, you can get these amazing storms that will encompass huge fractions of the planet. You look at Mars through a telescope and all you suddenly see is this bright orange smear with, hopefully, a frozen pole (if it's pointed in the correct direction). These dust clouds erase all the features you can normally see even with a backyard telescope.

Fraser: These dust storms can cover the whole planet.

Pamela: Yeah, and we have nothing like that to compare to here on our planet.

Fraser: we know that when these dust storms are at their height, they're severely limiting the amount of Sunlight that the Mars Rovers are getting on their solar panels.

Pamela: During the latest rounds of storms on Mars, we almost lost the little rovers. They have to get a certain amount of light every day in order for them to stay warm. It's so cold on Mars that it can actually freeze up the electronics, the wheels and pretty much everything on the rovers. They have heaters on them, but they almost lost so much electricity that they couldn't keep warm. If their batteries ever completely, completely discharge, no matter how much Sunlight hits them later on, they can never recharge again. The dust storms on Mars are quite frightening in their ability to cut off the electricity.

Fraser: All right. Let's talk about the time when humans will be exploring Mars. Are these dust storms going to be a big risk for them?

Pamela: Oh yeah. We have problems as human beings with the dust storms here on our own planet. People living in the Middle East, Africa and China now is starting to have massive dust storms as well. The dust gets into everything: electronics, mechanics, eyes, and throats. It clogs up wheels and makes all mechanical or electronic things extremely unhappy. It also coats solar cells.

When we take people to Mars, we won't have to worry about inhaling it because we can't breathe the atmosphere (so we'll always be inside a spacesuit). We'll have to worry about the dust working its way into the space suit and damaging it.

The sand can act like sandpaper, wearing out and rubbing down spacesuits and equipment. We're going to have to find ways to constantly blast everything clean. We also have to worry ourselves about the lack of electricity. Going to Mars, we're going to want to go as lightweight as possible. Solar electricity is one of the lowest weight ways to get electricity that we have right now.

Fraser: What would it feel like to be standing on the surface of Mars and be in one of those windstorms or dust storms?

Pamela: The atmosphere there is a lot thinner. When you get hit with the wind it's not as bad as getting hit with the wind here on the planet Earth, but sand hurts! There's no way around that. Imagine yourself just getting hit with high-power dust coming out the back end of a vacuum cleaner, but it's hitting all of you and its making it impossible for you to see, like the densest of fogs.

In different movies you see dust storms coming to attack the hero. This is the same thing, but in many cases, the dust is even finer. You're really getting attacked with the stuff that ends up in the grooves of your kitchen floor.

Fraser: This is going to be a huge problem that the explorers are going to have to deal with.

Pamela: A huge messy problem.

Fraser: All right, let's move on to the next question. This one comes from Rocks.

Rocks: Rocks here, what are the possibilities that white holes are really out there?

Fraser: All right. I've heard white holes theorized. Are they really out there?

Pamela: No. the problem with white holes is while they exist mathematically, the second even the smallest bit of matter falls into one, its toast. It can't exist with any matter.

Fraser: What is a white hole?

Pamela: Mathematically, it's the utter absence of matter. So you end up with this mathematical thing that looks a lot like a black hole, but instead of coming out of extremely high-mass situations, it comes out of an absolutely no mass situation. Then you touch that mathematical thing with a little bit of matter, even one electron or even one quark, and it collapses in on itself so you no longer have one.

There might have been white holes that existed when the universe was still forming. But because of the constant background flux of particles flying around – the cosmic rays, the gas and dust that permeate just about everything – these things can't actually exist in today's universe.

Fraser: Why do people find them so fascinating? It's almost like they think that white holes offer portals to other dimensions and methods of transportation across the universe.

Pamela: It's the sci-fi romanticism of it all. It's neat to imagine that there's this mysterious thing out there, this yin and yang to black holes. You have black holes and white holes. Somehow, travelling into these things that we have really no understanding of what's going on inside, will take you to this other place outside of our every day universe. Who hasn't wanted to escape our everyday universe now and then?

Fraser: All right, let's move on to the next one. This one comes from Santa's Little Helper – we've a Simpsons fan there.

Santa's Little Helper: Hi, this is Santa's Little Helper, I was wondering if we're at all close to finding intelligent life in outer space.

Fraser: So are we close to finding intelligent life in the universe – not withstanding our own planet of course.

Pamela: There are those who would say we haven't found intelligent life yet. No – we don't know. That's one of the things that are so cool about astronomy. Up to about ten, twelve years ago, we didn't really have any feel for how many other planets there were in the galaxy. Now we're finding planets everywhere. We don't know if there are any other planets with life.

Fraser: What methods are we using to search for intelligent life? You can't find it if you don't go looking. How are we looking right now?

Pamela: We're trying a couple of different ways. We're listening for it – this is the SETI program, the Search for Extra-Terrestrial Intelligence out in California. They're using radio telescopes – things like Arecibo and their own whole set of different telescopes – that they tune in to different nearby stars that look like they could have habitable worlds around them: they're the right type of star. We're listening for leaking radio information. We want to know what the top ten radio station around Alpha Centauri is (well, Alpha Centauri doesn't have one).

We're out there listening and looking for systematic signals coming from the vicinity of stars that could have habitable worlds. If it's something that we can't give a scientific origin to, perhaps we can give an extra-terrestrial intelligent origin to it. So far we haven't found any.

Fraser: In many cases, that stems from the fact that we just don't have a lot of telescopes pointing in a lot of locations. I know that the SETI institute is planning on boosting the number of telescopes and the width of the spectrum they're looking at – listening for AM, FM, television shows – and also increasing the range out to which they're listening.

I guess if you hit every star in every wavelength of radio out as far as we can possibly listen, and we don't hear anything, then that's an answer, right?

Pamela: All that actually says is no one else used radio communicate.

Fraser: Right, right.

Pamela: That doesn't tell us if there's no intelligent life out there.

The other thing we're doing is as we look for other planets, and as we find them, we're trying to sample their atmospheres through light. As a planet passes in front of a star, the light shining through that planet's atmosphere allows us to tell what atoms and molecules are in that atmosphere.

We can start to see that a planet might have an atmosphere that means life as we know it would be dead. We can then look at other atmospheres. We haven't found any yet, but we can start looking for the signatures of life. Trees give oxygen to our atmosphere. You're not going to get the same types of oxygen hanging out in the atmosphere without biologicals.

There are other sets of molecules that are also put forward as most often occurring through man-made processes. Perhaps, they can also be most often made through alien-made processes. As we're looking at atmospheres, we can start to say that world has life. As we start to see pollutants, we can say that world has industry.

Fraser: Right, so we could detect the smog of a distant planet and say there's some aliens polluting their environment.

Pamela: Exactly. So they may not be communicating in the radio. Maybe they just happen to have everything cabled. Imagine a super-secret society that is afraid to use wireless. We'd never be able to detect them from here on the planet Earth, except for how they pollute their atmosphere. So we're looking for pollution.

Fraser: In those two ways, both listening and just searching for them, the search is afoot. Whether or not we find it in the next couple of years, couple of decades, or the next few hundred years, we don't know. But you can't find them if you don't try.

Pamela: You never know when you're going to roll snake eyes.

Fraser: All right. Let's move on to the next question. This one comes from Star.

Star: Hi, this is Star. My question is, if a planet were located near a black hole, what would happen to it?

Fraser: So we've got a planet orbiting a black hole. How is our planet going to do?

Pamela: It kind of depends on how the black hole's behaving.

If you have a nice well-behaved black hole that is not in the process of eating anything (it's the eating ones you have to watch out for), it's going to hang out there going, "no light is getting away from me." As long as you're outside of the Schwarzschild radius from which you can never escape, you're just going to around and around, happily orbiting.

In fact, you could right now replace our Sun with an itty-bitty, little-tiny, not-naturally-forming black hole with the same mass as the Sun, and our planet would continue to orbit the exact same way.

Fraser: You couldn't tell, here on the planet, well I guess there'd be no light coming anymore.

Pamela: Yeah, that's the problem.

Fraser: Right, but from our motion in orbit around the Sun, whether we have the Sun or a black hole with the same mass, there's no difference whatsoever.

Pamela: The orbit is exactly the same. The orbit simply asks how much mass am I going around? Not how much mass is concentrated within a really tiny volume of space that I'm going around.

But there's that no light problem. If you're on a planet going around a black hole that isn't eating something, you're going to be really cold, really dark, and really wishing for a real star.

On the other side, if that black hole is in the process of consuming something, it's going to be blasting you with radiation. It's going to have an active, bright accretion disk. It could have jets. It's basically an extremely dangerous, extremely bright, extremely radiation-rich environment. Then you're going to be kind of unhappy because you're going to be kind of dead.

Fraser: But you're still not going to be sucked into the black hole.

Pamela: Not unless you get too close. The trick is keep a safe distance, stay out of the Schwarzschild radius, and you'll be just fine.

Fraser: But material falling into the black hole could bump into your planet or slow you down and your orbit could decay and you could end up spiralling into the black hole.

Pamela: That's a real problem. When you have these accretion disks, they're basically a whole bunch of different material that is jostling around each other in orbit. The jostling heats things up, makes it glow, and it also frictionally slows things down. Friction slowing you down changes your orbit. If your orbit changes too much, in you go! And you're dead.

Fraser: Right. So, let's hope our Sun doesn't get replaced with a black hole!

Pamela: There's no physical mechanism for that to happen.

Fraser: Good, good. If it does happen, we just won't get too close or we'll get bumped into the black hole.

Pamela: And we'll be frozen anyway.

Fraser: We'll be frozen anyway. Yeah. I'm going to go back to hoping we don't have our Sun replaced with a black hole.

Let's move on. The next question comes from Sleepy:

Sleepy: Hi this is Sleepy. Theoretically, if you have a white hole and a black hole next to each other, what would happen?

Fraser: So we've got a black hole, which we know exists, and one of these theoretical white holes, which as you said earlier are the absence of matter. If you had the two orbiting one another, what would happen?

Pamela: Einstein described it mathematically (and you can only describe it mathematically) as both of these objects as deformations in the shape of space. They basically formed hills, really, really steep ones. They could roll around one another.

So you could end up with a white hole and black hole rolling around each other, orbiting one another, until the day a particle fell into the white hole – in which case bad things would probably happen. I'm actually going to call a GLAST scientist and get them on this recording to tell us exactly what bad things would happen.

Dr. Charles Meegan: White holes are an interesting idea. They're the opposite of black holes, with matter flowing out instead of in. sadly, there's no evidence they really exist.

If they did, and one was close to a black hole, some of the material emitted by the white hole would be captured by a black hole. This situation would be very similar to one that certainly does exist. We've seen many examples of binary stars consisting of a normal star and a black hole, in which matter from the normal star spirals into the black hole.

The normal star could be shedding material because it's expanding and the outer layers come into the gravitational pull of the black hole. As this material approaches the black hole, it heats up to millions of degrees. At these high temperatures, the material emits x-rays, which can be detected by instruments such as NASA's Chandra Observatory.

Black holes seem to have an undeserved reputation as dangerous monsters devouring anything in their vicinity. It is true that if you get too close to a black hole, you would never be able to escape. This only happens very close to the black hole. If you were a million miles away, you could orbit a black hole in perfect comfort.

If you were a million miles away from a typical star like the Sun, you'd be vaporized. So if you're out tooling around the galaxy in your spaceship, don't be too worried about black holes. Watch out for those hot stars!

Fraser: All right. Let's move on to the next question. This comes from Leather Jacket:

Leather Jacket: Hi, this is Leather Jacket. What are the goals of the International Space Station?

Fraser: So, why do we have the International Space Station?

Pamela: This is actually a complicated question. The original reasons and the current reasons aren't entirely the same.

It was originally proposed to be built as a platform to be doing all sorts of materials research: go up and do chemistry in an environment without gravity, grow crystals without gravity, see if you can find the cure for cancer by mixing things in a way you can never do in a lab here on Earth because you have gravity separating the different components of the liquids or gasses you're mixing. It was a research place.

It was also a construction place, were the astronauts could haul things in, build them, and put them together. The plans have changed over the years. Roughly a third of the different things that were supposed to be part of the International Space Station are never going to get launched or built.

Today, the International Space Station serves primarily as a place of international meeting. It is a platform that is being built out of international treaties, where we have agreed we'll work with the Russians, the Italians, and the French pretty much with all of Europe, to build a place we can all go and join one another in space. We're completing it to complete our international treaty agreements.

Fraser: There will be some science done. There are several laboratories that will be installed, and there will be astronauts up there performing many, many experiments.

The controversy seems to come in with the question of if it's the best use of the money. That's not a question we can really answer.

Pamela: No. What's neat is one of the side uses for the International Space Station is actually space tourism. The Russians periodically, for large amounts of money, will take random rich people up to the space station for a few days. That's just kind of cool.

Fraser: That would be awesome.

Pamela: So, should any of you out there want to give us $60 million, we will gladly go up to the International Space Station and record for you.

Fraser: Right. Done!

All right. Let's move on. This is Major Tom from Ground Control:

Major Tom: This is Major Tom from Ground Control. I'm asking about the manned exploration to Mars. I want to know what you think about it, and I also want to know if you think we will benefit from it and how.

Fraser: This is kind of a tough one. How do we feel about the benefits of manned exploration of Mars? I'm going to tackle this one first.

I think that human exploration should be done just for the purpose of doing human exploration. There is a benefit to exploring your environment and learning how to live in space. We have all of our resources, all of humanity lives right hear on planet Earth.

It's inevitable that we would want to explore and get away from the planet and setup on the Moon, Mars and asteroids and all kinds of places, and start to use the resources of our entire solar system to be a true solar system civilization. The only way to do it is to do it – to learn what kinds of mistakes get made, what kinds of resources you need, and to finally learn what it actually takes to set up a self-sustaining civilization on another planet.

I know the problem is that right now, human exploration of the solar system is taking away from science. That's really unfortunate, because those two things shouldn't have to be fighting. Human exploration is one thing, science research is a completely different thing. I really wish those two didn't have to battle kind of like siblings.

Pamela: The thing is, if you look back over the history of the planet Earth, a lot of the exploration that took place on our planet was paid for by commercial endeavours. There was the West Indies Trading Company that basically owned the high seas.

One of the hopes I have is that as we start to develop more commercial space agencies – as Bigelo gets going with its space-based hotel, as Virgin Galactic starts taking its tourists up in orbit – that perhaps exploration of Mars and colonies being built on the Moon will start to be commercial endeavours.

Then, maybe NASA will be allowed to use the majority of its budget to do the things that are really only going to get paid for through tax dollars: basic research, going up and repairing scientific spacecraft like the Hubble Space Telescope.

Astronauts are some of the most amazing construction workers. We can't send robots up to the Hubble Space Telescope to renew its instruments, but we can send up astronauts. There's a place for taxpayer dollars to pay for space exploration. There's also a place for commercial space agencies to go and take over the exploration.

Fraser: So, what's the benefit? The benefit of human exploration is to learn how to do human exploration. I think with the Apollo missions and the exploration that's already happened, there's been any number of useful things that have come back into our culture: computers, plastics, airplane research, Velcro, tang! There's been all kinds of –

[laughter]

Pamela: I'm not sure Tang –

Fraser: You think it was a bad thing, okay. But everything else was pretty good, I think. We don't know what the benefits will be, but the one benefit is knowing how to do it so we can finally stop just living on Earth and live in the whole solar system.

Pamela: If you look far enough into the future, 50 million years, the Earth isn't forever. Someday humanity (should we survive our own problems and not find some way to kill ourselves off) is going to need a new home. Going to Mars is the first step in finding the new home for the human race.

Fraser: All right. We'll move on. This question comes from Doctor Love:

[laughter]

Doctor Love: Hello, this is Doctor Love. I want to know the difference between a red supergiant and a blue supergiant.

Fraser: All right. Red supergiant, blue supergiant, what's the difference?

Pamela: The blue supergiant is really, really hot. So hot most of the atoms have no electrons attached to them anymore. So hot it's burning through its fuel so quickly that it will only live for a few million years. The dinosaurs were around longer than some stars were around.

Red supergiants on the other hand are much colder. They have molecules in their atmospheres in some cases. While a red giant as a red giant only lasts a few million years, before becoming a red giant that star could've been just like our Sun.

Blue supergiant stars are very short lived, extremely high mass, they live, they burn brightly, they're the race cars of the stellar population. Then they go supernova and sometimes they leave behind nothing, sometimes they leave behind black holes or neutron stars. They're the showboats that everyone watches. You can see them from the greatest of distances.

The red supergiants are just sort of out there, hanging out, getting ready to die. These are the geriatric stars, the stars that are giving off the last puffs of their atmosphere before, in some cases, becoming very beautiful (but not extremely exciting as they get to that stage) planetary nebula.

Fraser: So the red giants are the end of life for stars, while the blue supergiants are very massive stars that have just started out. They live fast and die young and that's it for them. Our own Sun, for example, might eventually turn into a red supergiant.

Pamela: That's exactly what's going on. The biggest differences are blue supergiants are extremely hot and extremely massive.

Fraser: All right. Let's move on to the last question. This comes from Small Stick:

Small Stick: Hi, my name is Small Stick. I want to know what will happen to the Earth when the Sun becomes a red supergiant.

Fraser: In the previous question, we discussed that our Sun will eventually become a red giant. What will happen to our planet?

Pamela: People have been trying to figure this out pretty much as long as we've known what powered the Sun.

What we think will happen is in the process of becoming a red giant, the Sun will lose a lot of mass (shed pounds, you might say). In the process, it's going to blast the planet Earth. So, atmosphere? Gone. Surface of the planet? Toasted.

While the Sun is losing mass, our planet Earth is also going to be able to move a little bit further away from the Sun. This will allow it to at least still keep orbiting while it's toasted and atmosphere-less.

Fraser: Okay, so Mercury is just going to get gobbled up.

Pamela: Yeah. When it becomes a red supergiant –

Fraser: Venus will get gobbled up?

Pamela: Yeah, it expands and the Sun is just going to expand out to about where the Earth is right now. So yeah, Mercury: gone. Venus: gone. Hopefully we get to migrate.

Fraser: Right, well – you say hopefully, but we'll have had our atmosphere blasted off the planet and the whole planet will be scorched like a cinder.

Pamela: Even if our planet is complete toast, I can imagine, six billion years from now, humanity out having reached other planets, going "well, at least our planet's still there." It's kind of sad to think of our planet getting completely consumed.

Fraser: Right, but essentially its still a controversy. The Earth is right at the point where our Sun will probably expand. So the question all comes down to will the Earth spiral outward as the size of the Sun changes and as material is blasted away from the Earth.

Pamela: It's all about the weight loss.

Fraser: Right. If it does, the Earth will spiral outward as the Sun expands. If it doesn't, then as we enter the atmosphere of the Sun we'll spiral inward and die too.

Pamela: So, we'll know in 5.5 billion years or so.

Fraser: I'll wait!

[laughter]

Pamela: If only it were that easy!

Fraser: Yeah. Let's all wait and watch.

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