Astronomy Cast Episode 8:
Meteor Showers. Yes, the Sky is Falling.

Fraser: Most people, I think, totally overestimate what they're seeing when they're watching a meteor shower. I think they're imagining some kind of rain of giant space rocks crashing through the atmosphere, but that's not really what's going on, is it Pamela?

Pamela: No. We're actually basically getting handfuls of dirt thrown at us by comets. As comets go through the inner parts of the solar system, the Sun heats them up and they melt. As they melt, they don't go into a liquid form, they actually go straight from solid to gas, and the gas carries with it bits of dirt and dust that the comet has picked up as it's gone through the solar system. If the Earth crosses the path of one of these comets, we intercept this dust and dirt. When it hits our atmosphere, it lights up and burns up.

So each of those little shooting stars is a grain of stand or a dust mote.

Fraser: Like how big, just to be…

Pamela: Occasionally we'll get a quarter-sized thing

Fraser: Yeah, so just to be precise… if I go down to the beach and pick up some sand, that's the exact size we could be looking at, or smaller?

Pamela: A lot of times it could be smaller than that, even.

Fraser: So why does something that small cause something we can see? I mean, it must be crashing into the atmosphere hundreds of kilometres up – how come we can see it so brightly?

Pamela: Well, you're converting matter into energy, and anytime you do that you get a lot of light. It's possible to provide electricity for a city with a potato, if you're able to convert the potato's mass into energy. When we burn up that dust in the atmosphere, we're converting the mass into energy: it's heating up, burning away and we're getting light as a result. There's a lot of light trapped in a dust mote if you heat it up hot enough.

Fraser: So how much energy do these grains have? How are they getting so much energy in them?

Pamela: Well, these dust motes are, in some cases, hitting the atmosphere at 71 km/s. that speed is causing them to hit gas molecules and get them excited and that emits light, and they're burning up and emitting light.

So for a moment, we're getting as much light from a dust mote in the atmosphere as we're getting from a distant star.

Fraser: Right, okay. So the comet is moving very quickly and shedding off this material. The Earth is moving at a certain speed in its orbit, and you kind of add the two velocities together (like a car crash) – the dust hitting our atmosphere, the Earth moving, and you get this bright flash.

Pamela: Exactly.

Fraser: So what happens if something a little larger hits?

Pamela: Well, a little bit larger initially just gets you a bigger flash. Occasionally you'll see a small rock hit the atmosphere, and that small, fist-sized rock looks like a small explosion in the sky. Suddenly instead of having something as bright as a distant star, we have something as bright as airplane lights.

As things get bigger and bigger, you get streaks that last longer because it takes more time for the dust mote (or in this case, the rock) to burn up in the atmosphere.

Fraser: I've seen a couple of those. You just see a streak that goes across the sky. It can go quite a distance, and just kind of stays there in the sky like a line. It can last for seconds, tens of seconds, sometimes almost a minute. It's quite amazing.

Pamela: You're seeing two different effects. The rock getting destroyed as it burns through the atmosphere, and you're seeing the heated up gas left behind from its passage. So, the fact that the streak moves across the sky and appears to stay there for more than an instant, that's the hot gas taking time to cool back off.

So, lots of different things are going on. There's complicated physics involved in what's going on with our atmosphere to allow us to see such a fabulous fireworks show.

Fraser: Let's go bigger!

Pamela: So, you get bigger than a rock, and you start getting noises. You can actually hear the crackling as it goes through the atmosphere in some cases. You get bigger glows that you can see across larger parts of the sky. You start getting people reporting UFOs.

Once you get to something a few meters in size, you get spectacular explosions. Once you get up to 50m in size, objects can make it all the way through the atmosphere.

They start burning up, get smaller and smaller and smaller… but something makes it through and hits your house/Antarctica/the ocean… these things are raining down all over the world.

Fraser: We talked about how amateurs can get involved in astronomy last week. One of the things is if you happen to spot a large object or trail, is there anything you can do, as an amateur, to help out astronomers?

Pamela: A couple of different things happen. First of all, there's random meteors on any given night. They're not all associated with comet tails, sometimes we actually intercept a small asteroid in space and if it's small enough, nothing bad happens and usually those aren't detected until they decide to come down.

There was one recently found in the Great Lakes region when a bunch of people observed a bright object in the sky. Scientists took all these observations, calculated an assumed trajectory, and went in search of the meteorite (when something hits the ground, it's a meteorite; when it's going through the atmosphere it's a meteor; before it gets to the atmosphere, it's a meteoroid or asteroid).

Fraser: We had something similar happen in Yukon about 4 years ago – same thing, lots of people saw the trail, they calculated that it was big enough to make it through, and it ended up hitting a frozen lake in the middle of the winter.

Pamela: Oh geez.

Fraser: So they were able to pull the fragments out and they were perfectly preserved.

Pamela: That's awesome.

Fraser: So it hadn't gotten rusted or anything.

Pamela: So if you see one of these and it seems noteworthy, write down what you see before you have a chance to forget anything. Write down where you were looking from, and where things appeared relative to objects with known locations that aren't moving. Then, listen to the news. A lot of times when this stuff happens, the news will say, "if you saw something call up a scientist, go to this website". There's also amateur observing clubs that track these things.

This is particularly true with meteor showers. We work to figure out the exact orbits of comets by keeping track of when we intercept the most dense region of their tails. So, their tails go through space, leave behind a trail of material. As the Earth passes through the edge of where the tail used to be, we start getting an increase in the number of meteors and shooting stars that we see. We get more and more of an increase, and the moment we have the largest number of shooting stars per minute is when we're going through the densest region of where the tail once was. Then the numbers go down as we exit the place where the tail used to be.

Fraser: I guess this depends on how long ago the comet came through our neighbourhood, right?

Pamela: From year to year, we get a different number of meteors per minute. We get a different level of storm, based on how recently the comet that caused the meteor shower passed through this part of the solar system. Over time we pick up more and more space junk, and it's not there to be picked up on the next pass through, and it dissipates through

space over time. The years with the most significant meteor showers are the years right after the comet has gone through the inner part of the solar system.

Fraser: So what are some of the comets causing the meteor showers?

Pamela: What's kind of cool is the most famous comet of all, comet Haley, is responsible for one of the minor shower. The Eta Aquarids, which are visible primarily in the southern hemisphere, are caused primarily by comet Haley. The Earth actually passed through Haley's tail in 1910 while Haley was in the inner part of the solar system. This caused widespread panic, chaos, mass buying of gas masks. People were actually afraid that as we passed through the comets tail, there would be poisonous gas put into our atmosphere. People in their paranoid fear went out and bought lots of gas masks. Generally this is a pretty mild meteor shower, but when you're actively going through the tail, it's pretty significant.

Comet Enke, another fairly well-known comet, is also responsible for a meteor shower, and is also quite possibly responsible for a great amount of destruction. Nowadays we have these two meteor showers, the southern and northern Taurids. Comet Enke comes through the solar system every 3.3 years. This is a pretty good meteor shower and gets replenished fairly often.

Comet Enke is believed to have once been a much, much bigger comet. A couple thousand years ago, it is thought to have broken up. When it broke up, some of the chunks that used to be part of the comet landed in the Middle East, possibly in the Fertile Crescent. When they did this, it affected our atmosphere, it affected civilizations in general. It's thought by some that the prosperity of several Bronze Age civilizations was brought to a sudden halt by the impact of these comet fragments.

It's also thought that the Tunguska event in 1908 may have been another fragment of this comet that now a part of it is comet Enke. Comets can seriously impact civilizations. Luckily this doesn't happen very often, but it does still happen and it could still happen again in the future.

Fraser: What are the best (apart from Comet Enke raining debris across the hemisphere) meteor showers and storms we can look for?

Pamela: The storms that can be counted on the most are the Perseids (caused by comet Swift-Tuttle) and the Geminids (which are actually caused by a dead object, 3200 Pantheon which is thought to be a now defunct and not producing a big tail former-comet that has been crusted over with cosmic dust).

Every year these two storms, which occur in August and November… they come, shower, it's consistent and it's pretty much always a good storm you can count on for a fun time out looking at the sky.

Fraser: Yeah, the Perseids are my favourite, mostly because it's warm. We can lay outside and the kids don't cry too much – "Daddy I'm cold!" – and we can watch the meteor shower and they love it.

But I think my favourite one ever was the Leonids just a few years ago.

Pamela: Yes.

Fraser: It was like nothing I'd ever seen.

Pamela: There was a really, really fabulous storm a few years ago because the comet that causes it had actually recently passed through this part of the solar system. Tuttle's on a 33 year orbit, and back in '99 it had just finished going through the system and we got a fabulous storm related to that.

Fraser: Yeah. I was in Vancouver at the time. I went out and wasn't even sure if it would be too bright (though it was very cold). It was clear though – which was great (normally in Vancouver you don't get that, you just get rain). It was astonishing. In the middle of the city with super bright lights it was just streak after streak every couple of seconds. I was out there for probably three or four hours, I just couldn't believe it.

Pamela: Some of these storms can be really spectacular. You can get hundreds, sometimes thousands per hour that you can see. It's actually even led to songs. Back in 1833, there was a Leonid meteor shower that was referred to as it was basically raining meteors. Again in 1933, there was a fabulous storm that was particularly spectacular in Alabama, that led to the writing of a jazz standard called "Stars Fell on Alabama". So from year to year you can get various storms and sometimes it literally looks like it's raining stars.

Fraser: I know that for many things in astronomy it kind of depends on where on Earth you live. If you're trying to see an eclipse and you live on the part of the Earth that doesn't have the shadow falling across it, you just don't get to see it. Does where you live on the Earth matter for what you're going to see with a meteor shower?

Pamela: Yeah, unfortunately it does.

In general you can see part of the meteor shower no matter where you are on the planet. It takes time for the Earth to pass through the debris trail. The most concentrated part of the debris trail might be quite small and only impacting our atmosphere for an hour or two.

When we talk about meteor showers, we're naming them after the constellations the meteors appear to radiate from. If you go out to see the Leonids next month, they peak around November 17th. You want to look up at the constellation Leo. You'll see the meteor trails all appear to streak away from the constellation Leo. To see the best part of the storm, you want to be on the part of the planet that has Leo straight overhead so that

it's high in the sky far away from all the sludge along the horizon at the moment that the Earth is passing through the densest part of the debris.

The whole planet can't have Leo straight overhead at the same time. Where you are, it has to be dark (unfortunately you can sometimes go through the densest part of the debris trail while it's still daylight) and you want the constellation to be high in the sky.

Now, we have done lots of calculations using year after year of observations to figure out exactly where the densest parts are, and where you need to be on the planet. There are websites out there that all you have to do is Google the name of the storm you're interested in and they'll pop up maps showing when (or if) you'll be able to see the storm from a given location, and how "good" a show it will be.

The other thing you also have to keep an eye out for is where is the Moon. The Moon produces a lot of light. If you go out during a full Moon, it actually casts giant shadows and you can read very big letters in newspapers.

Fraser: Yeah, that's what we had with the Perseid meteor shower this year. The Moon just totally washed it out. We saw some, but it wasn't anywhere near as good as the year before when there was no Moon.

Pamela: Yeah, it was almost full. This year's Leonids will occur around new Moon, so it won't impact our ability to see the Leonids. Unfortunately for those of us in the United States, we're in the wrong part of the planet. To really see them well you need to be in Europe, but we'll still see some shooting stars over here.

Fraser: So as with eclipses, sometimes it's your year to see the meteor shower and sometimes it just isn't. It's just about where you live on the planet.

Pamela: Exactly, and sometimes the oceans are the only ones in luck. Then you need to get on a boat.

Fraser: What can you do to improve your chances and improve your meteor shower experience?

Pamela: You want to go somewhere with dark skies, and do it strategically.

Say that from you are, Leo is a constellation that you have to go north to see. If you live on the south side of a big city, you may think, "let's just drive south – the nearest dark skies are south of me" then you're looking north over the big city, to see Leo. Your most light pollution is on the same horizon that's closest to the constellation you're interested in. that's bad strategy.

You want to figure out the direction the constellation is in, drive in that direction and find dark skies. Go somewhere dark, where the horizon nearest the constellation is also dark. That will really help. Most of all you want to lie down and look up.

The entire sky will get meteors. They'll all appear to be radiating from roughly the same point, but they may get a different distance from the constellation Leo before they start to light up. Lie down, look up, unfocus your eyes and wait to see motion and focus your eyes where you see the motion. Use wide-angle cameras to try and catch them on film.

Something else you can do is actually try to record where you see them coming from, and make your own diagram to prove that they're all radiating away from Leo (or whatever constellation is associated with the meteor shower you're able to go out and see.

Fraser: Won't you see some just as the Sun's going down?

Pamela: Yeah. There's all sorts of neat geometry things going on. If, say, the Perseids are going to be straight overhead at midnight, that means right around sunset you have the Perseids occurring low on your horizon. Sometimes, the dust particles, the grains of sand that are impacting the atmosphere, actually skip across the atmosphere like skipping stones on a pond. We can end up getting Earth-grazing meteors when we're at a right angle to where the actual storm is taking place.

Fraser: These are pretty slow and bright. Yeah.

Pamela: They're slow, bright, and really cool – a little bit explosive sometimes. There's all sorts of different combinations and on any given night, different parts of our atmosphere are hitting rocks, dust and sand. Very, very rarely, does anything make it to the surface of the Earth, but we're fairly constantly hitting things that you can see at any time and any day of the year.

Fraser: Let's talk about the big showers and storms of the year so people can kind of mark their calendars.

Pamela: They're going on a regular basis. The next big one coming up is the Leonids which is November 17th.

Fraser: Hold on – even though this conversation is happening in 2006, they happen every November 17th-ish.

Pamela: They happen every mid-November. Exactly which day they happen varies year to year. Comets' orbits are getting slightly tweaked by Jupiter. Days may vary, but right around November 17th.

Fraser: Even if this is 2007, and you're in early November, the Leonids are coming.

Pamela: Yes.

Then, there's my personal favourite: the Geminids, because I was born during the Geminids. It occurs around December 12-14 every year.

In January we have the bright Quadrontids. That's early January, to bring in the new year. In late April (around April 22nd or so) we have the Lyrids. In May we have the Eta Aquarids, the ones caused by Haley's comet. As we were talking about, we have the Perseids in August and the not-quite-so-well known Orionids in late October, around the 21st.

Fraser: So right now, plan a trip in the winter if you can handle the cold or I guess if you're in the Southern hemisphere it's nice and warm. Plan a vacation for the time of the Perseid meteor shower. Organize to get a bunch of your friends –

Pamela: Or the Leonids.

Fraser: Or the Leonids. – a bunch of your friends and family to get outside and watch them.

Pamela: The Moon is being good. Both the Leonids and Geminids shouldn't be too affected by the Moon this year.

Fraser: That's perfect. Anything else, have we covered all the meteor shower madness we can imagine?

Pamela: The coolest thing to do is go out, look up, take some friends and something hot to drink.

Fraser: Be patient.

Pamela: Talk all night, and use it as an excuse to get to know the sky. Challenge yourself to get to know constellations while you're waiting for the next meteor to shoot across your field of view. Just have fun.

Fraser: If you're the knowledgeable one, use it as an opportunity to point out the constellations to your friends.

Pamela: Take us along and feel free to play us to annoy all your friends with our voices as we talk to you about what's going on in the skies above.

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