Solar Eclipses and the Transit of Mercury
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Moderator: Kay Ferrari
February 22, 2016
2:00 pm CT

Coordinator: Thank you all for standing by. For the duration of today's conference all parties will have an open line.

Please utilize the mute function on your phone or press Star 6 to mute and unmute your line when not speaking.

I would like to inform all parties that today's conference is being recorded and if you have any objections you may disconnect at this time.

I would now like to turn the conference over to your host Ms. Kay Ferrari. Thank you ma'am you may begin.

Kay Ferrari: Thank you very much Amy. Good afternoon everybody and welcome to our Solar Eclipses and Transit of Mercury telecon.

We are delighted to have with us members of the Heliophysics Team at NASA Goddard and from the Exploratorium in San Francisco who will be our presenters today.

Lou Mayo was going to be our first presenter is unable to make it today so in his place we have Dr. Eric Christian who is a Particle Physicist at NASA Goddard Space Flight Center.

He has supported and managed a number of NASA missions including Solar Probe Plus, IBEX, STEREO ACE and Voyager. He is also been actively involved in education outreach.

Welcome Eric. And the first presentation we're going to be doing is Eclipse and Transit or Lou Mayo presentation. So please open that and Eric I'll turn the microphone over to you.

Eric Christian: Okay. Thank you. So I'm not Lou Mayo. I just play him on the telephone. But I'll try to go through his slides and I think I can explain most of it. If you have questions please just ask when they come up.

So go to the second slide which shows four nice views of solar eclipses. Starting in the upper left we have what's called the diamond ring which is what you see in a total solar eclipse.

Just before and just after the actual total solar eclipse where just a tiny little edge of the sun peeking out from behind the moon.

On the upper right is a partial solar eclipse where the moon is partially blocking the sun. And this one is only a minor partial.

But you can get down to thin slivers of the sun depending on where you are during a total solar eclipse or there are some eclipses where you only get partials on the Earth.

The bottom left shows a wonderful picture of a total solar eclipse. And what you see there is the solar corona.

The corona is a stream of plasma of particles and magnetic fields the blowout from the sun in all directions.

You see this is a time I can tell by looking at it this is when the sun is awfully quiet. And what you see is a fairly typical streamer structure with the pole probably the North Pole is pointing up at about 1:30 o'clock. So up to the upper right and the South Pole is down to the left.

I can tell because those are the ones that are spread in the sort of dipole. And I'll talk more about the solar corona when I get to my presentation.

The bottom right picture shows an annular eclipse which I'll describe further on in Lou's presentation. But that's where the moon does not completely block the sun.

And I've never seen one of those. I've seen total solar eclipse but I've never seen in annular eclipse. And, you know, looks really neat but you can't unlike the total solar eclipse you can't look at it with the naked eye you'd have to use protective eyewear if you're going to look at an annular solar eclipse.

So go to the next slide. So we would get a lot more solar eclipses if the orbit of the moon were in the same plane as the orbit of the Earth around the sun but it's not, it's tilted by 5 degrees.

And so that means that if the moon is up compared to the plane of the Earth and the sun which is shown in the picture you can't get a solar eclipse because even if the moon was even if you had a new moon and the moon was in between the Earth and the sun it would be above the sun and wouldn’t block it the way you’d get in total solar eclipse.

So the only time you can get lunar and solar eclipses is when the plane of the moon’s orbit crosses the plane of the Earth Sun orbit and those are called the nodes. And you see those as to red points one in front for solar eclipses and one behind for lunar eclipses. So those are the only times when you can actually have an eclipse.

Go to the next slide. So here you see why sometimes you get a total solar eclipse and sometimes you get it annular eclipse.

The orbit of the moon is an ellipse. And it’s more elliptical than the orbit of the Earth is around the sun. The sun’s size only changes by about 1% or 2% from Earth’s perihelion to aphelion.

But the moons apparent size changes by more than 10% from when its closest approach to the Earth and what it’s furthest away.

And so if you get a total eclipse most of the time the moon will block the sun and that’s what you see in the top there.

And so the umbra the area of full shadow will hit the Earth. But if the moon is too far away in its orbit down on the bottom what’s called an annular eclipse what happens is the shadow of the moon doesn’t the total shadow doesn’t quite reach the surface of the Earth because the moon is too small and you get in annular eclipse.

What isn't shown of these pictures is that there is a wider region around the umbra called the penumbra. And that's the region of partial total solar eclipse.

So that covers a wider range. And even when you get the annular solar eclipse you'll get - you'll be in the penumbra which is the partial eclipse.

Next slide please. So here's a better description of the perigee apogee distance. You can see that it goes from 227,000 miles to 253,000 miles. And so the size of the moon changes noticeably.

So and I think on the next slide yes. So the next slide is a really good showing that the difference of size between perigee and apogee.

At perigee that's almost exactly the size of the sun. That's just a coincidence of nature that the moon is in angular size just about the size of the sun and that's why we get total solar eclipses.

There is no other planet in the solar system that can get a total solar eclipse because their moons are too small.

Well actually I guess maybe on Jupiter. You - some of the - I'd have to check that but certainly, you know, they don't get the sort of one to one correspondence between the moon and the sun the way it is on Earth.

And at apogee you get a smaller moon and so it can't block the entire disk of the sun and you get the annular eclipse.

So the next slide Saros. So the Saros cycle is an interesting thing. There are what you call a month astronomically is actually different depending upon which you - what you pick as your starting and endpoint.

There is a month that goes from new moon to new moon which is when the moon is on the plane, you know, it's in this direction that the sun is although it may be above and below it.

So that's when you get a new moon. And that's longer than the other two months because the Earth is traveling around the sun.

And so by the time you pass through one either anomalistic or draconic month what's happening is that the Earth has moved.

And so the sun has apparently moved in the Earth's sky. And the moon has to go a little bit further almost two days more before it gets in line with the sun again.

So that's the Synodic month. The anomalistic month is perigee to perigee closest approach to Earth and closest to Earth but the node to node which again is different because of the tilt of the orbit and how the plane is close to the anomalistic month but not quite. And remember that only on the nodes can you actually get a total solar eclipse.

So if you multiply all of these out what you find is that there's a natural period to all of these eclipses that is one Saros.

And you can see that that's, you know, on the order of 18 years 11 days eight hours. And that was historically I mean that was one of the first things when people started tracing lunar and solar eclipses which they did geometrically they discovered this period actually a long time ago. So it's sort of a neat cyclical part of the just comes from the orbits of the Earth and the moon.

So here's - the next slide is a map of various total solar eclipses between 1996 and 2020. And you can see they're sort of uniformly distributed about the Earth. It has to do with the time of day that the moon is exactly on the line with the sun and also so the node is where you're most likely to get a total solar eclipse.

But there are if the moon is just slightly above or below the node when it crosses the sun then what happens is it moves the eclipse either northward or southward on the Earth for some distance.

And so the node is not a point it's a spread because the Earth has a finite size. And so you can see what you can actually get eclipses that go really far towards the North Pole and really far towards the South Pole.

There's one in Antarctica in 2003 that I was actually down at McMurdo Station in Antarctica and got a partial solar eclipse down in Antarctica that I saw which was really neat.

So this gives you an idea of sort of how eclipses move across the Earth but a better view was on the next slide which shows the similarities due to the Saros cycle.

And so here you see the period of the Saros period and how as it passes through the - you get eclipses that follow really similar paths every N years.

So you can see actually the 18 year difference between 1955 and 19 on this middle in 1973 on the left.

But the period of the Earth has to be figured in there too. And so that's why the eclipse moves from point of the Earth to other point - another point on the Earth.

So no questions, I'm sort of surprised? This is a really complicated thing and so if anyone's got any questions now is a good time and I'll try to answer them.

Man: The last point you made was that about because of the precession that it would move up and down when you said the period of the Earth is causing that difference in latitude?

Eric Christian: So the reason why it moves up and down is because if the moon was exactly on the node on the Earth's sun line then you would get in eclipse at the equator.

But if it's slightly above or below you'll still get the umbra hitting the Earth. It'll just hit North or southward of the equator.

Man: Got it. Thank you.

Woman: Why is the moon's orbit tilted and off center, any theories?

Eric Christian: So most of the planets are in the same plane and most of the moons are in the planet - in the plane of the planetary equator if you will.

And that's because when the solar system formed there was an angular momentum to the gas cloud that condensed into the sun and the planets. And that was the way that the cloud was spinning. It collapsed down to a disk. And the disk is the ecliptic plane that most of the planets are in.

But collisions can change that. And the moon was actually the current theories of the formation of the moon was that it didn't form at the same time as the Earth it early on in the Earth it - there was a large collision that knocked the moon free.

And so you don't have to stay in the same plane. And it's actually, you know, somewhat of a coincidence that the moon is as close as it is to the ecliptic plane. So it has to do with the whole solar system formation. Does that make sense?

Woman: Yes.

Eric Christian: Okay so if - so Lou had a thing on the math that you can get from knowing the lunar period, and knowing the mass, you know, finding the mass of the Earth and knowing the period and the distance from the Earth to the Moon.

This is - you can derive this equation the period squared equals four pi squared over the gravitational constant times the mass of the Earth time the distance cubed you can derive that from simple gravity.

And that's, you know, one of the things that Newton sort of, you know, and Kepler and when they started determining orbits that's - that was an important feature the, you know, gravity gives you elliptical orbits not necessarily circular but definitely elliptical or hyperbolic if the object is moving fast enough and that there's a close tie between the period and the average distance between the two objects.

So it's a nice little mathematical puzzle that has its base in the fact that gravity drops off like one over R squared.

Loretta McKibben: This is Loretta in Oregon. Could I say something about the formation of the moon for those that might not be familiar with it?

Eric Christian: Sure.

Loretta McKibben: Yes. William Kaufmann K-A-U-F-M-A-N-N I think is the way you spell it is the guy that came up with the impact theory of the moon formation in like the 1970s and other scientists thought he was nuts.

But now they're - but now it's excepted because they think that a Mars sized object formed at one of the L5 points of the Earth's orbit and Jupiter pulled it out of -- Mars size is half the size of the Earth - and it pulled it out of orbit and it collided with the Earth.

And that's why the Earth's outer core is bigger than other terrestrial planets and also why the Apollo astronauts brought back the moon rocks and they exactly matched the outer layers of the Earth.

So look up Bill Kaufmann's theory because they thought he was nuts at first but now his theory is the accepted one.

Eric Christian: Yes although there are still some people who propose some alternate. But I agree that's the most commonly accepted theory. So...Okay so next slide shows a total solar eclipse that's going to be on March 8 locally. It's actually at March 9 there in the Western Pacific because of the International Date Line.

And so this shows the path. The - that goes from, you know, Malaysia, Indonesia and then mostly through the Pacific Ocean not passing very many islands. It goes north of Hawaii. I now there's some cruise ships heading out of Hawaii that'll head to it.

So this map is interesting because there are - there is a group from NASA that's going to Indonesia to do some science. And I'll talk about that a little bit later.

But the Exploratorium has picked probably a better place to see the eclipse. And that's a little Atoll call Woleai which is much closer to the GD marker that you can see on this slide. And GD means Greatest Duration.

So that's when you get the best solar eclipse the longest. It's going to be over four minutes on Woleai.

The other problem with Indonesia is that the eclipse is going to be closer to the horizon compared to Woleai but it - Woleai is a lot harder to get to. And I imagine Nicole will say something about the logistics of this trip so...

And so you can see the next slide shows local circumstances. And you can see some of the places that if you wanted to see this eclipse it's a little late now but if you did want to try to get there the various places in Sumatra, in Sulawesi, and that - where you can see the eclipse and how long the duration is.

And you can see at the start of that line that's on the previous slide the duration is less than two minutes. The NASA science team is going near Maba which is this last Line 9 on the slide.

And they're going to get a little over three minutes of duration. And we're going to get over four minutes at Woleai.

And then if you go to the next slide it's a nice little movie that shows the shaded region is the penumbra and the little tiny dark dot is the umbra. That's where you get the total solar eclipse.

The shaded region is where you get partial solar eclipse. And if you run through that movie you can see it pass all the way north of Hawaii.

But we're going to be Woleai is close to centered on the vertical line in the middle of this map just when the umbra crosses. So that's where we're going to be.

Woman: I don't - I see the picture but I don't see the movie. I guess it didn't download with it maybe.

Eric Christian: Sorry I've got it as a movie. But I've got - are you PowerPoint in presentation mode or are you in some other...

Woman: Yes. I've got I brought down the PowerPoint but I'm on a Mac so...

Eric Christian: Okay so it may be a QuickTime versus Microsoft issue but...

Woman: I've got a Mac and it's working.

Kay Ferrari: Okay. We can - we will resolve this for the archive. We'll get the movie out of it and post it separately so you all can see it.

Eric Christian: Yes. And there's a link at the bottom of the page that probably has the movie. I haven't checked but I'll be willing to bet that it's on our .gsse.nasa.gov/clips has that movie.

Woman: Oh. I had to go into presentation mode full screen and it did pop...I was, I was doing it in preview mode so it wouldn't take over my whole computer.

Eric Christian: No it doesn't do the movie although you can click on it and run the movie manually but presentation mode is needed yes.

Woman: Yes okay, got it.

Eric Christian: Now you see it. Good.

Woman: Yes. And I'm going to be on turn eight.

Eric Christian: Oh great. And talk a little bit about the Transit of Mercury. So again it has to do with orbits and lots of astrometrics. But in - on May 9, 2016 Mercury is going to cross in front of the sun.

This is Mercury is going to be awfully small, you know, the Transit of Venus was nicer because anybody with eclipse glasses didn't need binoculars or anything or any sort of telescope to actually see the disk of Venus. Mercury is a lot harder to see.

But it is interesting. It can be, you know, is historically one of the ways that they determined size of planet and distance to the sun and also sorts of other different things that I'm not an expert on that Lou could probably tell you more about.

So you can see that the Eastern Coast of the US will see the entire transit. The Western Coast will at sunrise be able to see some of the Transit of Mercury.

And if you have the right gear again this is, you know, you need eye protection or Transit of Mercury. It's not like a total solar eclipse. You're still looking at the sun. And you shouldn't do that without the proper protection. But if you do have the right telescope with filters and stuff it's an interesting thing to see. And here is...

Man: I have a quick question on the transit. Would that look better in a H-Alpha Balmer or white light?

Eric Christian: Good question. I actually don't know the answer to that.

Man: H-Alpha. It's always more interesting...

Eric Christian: I would think H-Alpha simply because it's a narrower band it's essentially a narrow band. And so you get sharper edges and stuff.

Man: All right, thanks.

Eric Christian: So if you go to the next slide you can see a picture from Fred Espenak to Mr. Eclipse from 1973 Mercury transit.

And as you can see Mercury is pretty small. This is, you know, one small part of the sun. And but you can see, you know, Mercury blocking part of the sun.

One of the interesting things about transits like this is that this is one of the ways that they find extrasolar planets, planets other suns is that they can actually measure the small decrease in brightness for other stars as planets cross in front of them.

And because they're periodic and because, you know, even if they're small if they get enough observations they can see the periodicity and they can actually, you know, determine something about the size of the planet that's crossing in front of the sun.

So planetary, you know, 100 years ago I don't think anyone would have believed that you could use planetary transits to actually find planets around other stars but now it's done pretty regularly.

Man: Are there any plans to Web cast the Transit of Mercury?

Eric Christian: I don't know of any but I wouldn't be surprised if there are, (Carolyn) do you know?

Carolyn Ng: Eric I don't think our team is planning to do one but I can find out.

Eric Christian: Okay.

Man: And how about for the solar eclipse? Are there any Indonesian or Web casts?

Eric Christian: Yes. So this certainly is a live - the Exploratorium is doing a live Web cast for the total solar eclipse Woleai. And that's at www.exploratorium.com/eclipse.

I think it's also being picked up by NASA TV. And so if you go to www.nasa.gov and grab the NASA TV one of the NASA TV channels it should be there.

And they may even have both there's actually going to be to feeds one that's just going to show the telescopes and the other that's going to have our live show.

Man: Fantastic. Thank you.

Woman: I think SLOOH Community Telescope probably will run a Web cast as well. Hello?

Eric Christian: Yes got it. So in just, you know, and I think this is, you know, the next slide shows the 2017 eclipse the all American eclipse which the Great American Eclipse I guess they're calling it which is going to be really neat because in August 2017 the eclipse will go from Oregon to South Carolina and right across the Continental US.

The entire Continental US will be in more than 60% eclipse. And it - the totality, you know, if the weather is good we're going to get, you know, millions of people along the line of totality watching this eclipse, so this one is going to be a lot of fun.

And NASA is already starting to prep for - and a lot of other people too are - is starting their prep for publicizing this.

It's good to be during the summer so school won't be in but still it's going to be, you know, you're going to see lots about it as we get closer from the news agencies. And I'm sure there's going to be cameras set up all the way along that entire path of totality.

And I think this is his last slide which shows a couple other eclipse resources Stellarium and the Eyes on the Solar System.

There's also eclipse.gsfc.nasa.gov and sunearth.nasa.gov also have resources for you, so any questions on this presentation?

Okay. Then I'm going to move on to my presentation which was - is studying the sun with satellites and eclipses.

So if you bring that up and go to the second slide the sun. So here is a picture of the sun in visible light. And one of the things that a lot of people don't realize is that the sun is variable star.

And that variability is driven by the fact that it's got a magnetic field that gets twisted up and has to release energy in some way.

The way it does that is with sunspots, and solar flares, and internal mass injections and other things like that, that release energy out into the solar system.

The sun's basic period is 11 years. It's variable with an 11 year cycle. It goes from solar max to solar minimum to solar max.

During solar max you have a lot more sunspots during solar min the sun is pretty quiet. But that's in a regular cycle. It's not a very regular variable star.

And the length of that solar cycle varies from like 9 to 13 years since it's been traced. And the way it's been traced is since the 1600s with sunspot numbers.

And there are even times when the sun has gotten very quiet for long periods of time. There - in the late 1600s there was a period called the Maunder Minimum where there weren't very many sunspots for 40 or 50 years.

So - but the sun is a variable star. Its variability is pretty small. And it's, you know, it's what we've evolved with but it is kind of neat that it is variable.

So the sun emits all sorts of photons everything from infrared, to visible, to ultraviolet to x-ray to Gamma Ray photons.

It emits a solar wind which is particles moving at about a million miles an hour flowing out in all directions. And that's what you see when you are looking at the corona.

It emits solar energy particles which are particles that get up to a significant fraction of speed of light. Those mostly come from solar flares and coronal mass injections. And that's what I study. And there's also a magnetic field that get dragged by the solar wind all the way to the edge of the solar system.

The output for all of these emissions from the sun is variable. So it's not just the sunspots that's see the solar variability but that's the standard measure because that's the easiest one to see. But everything about the sun is variable from the solar wind, to the photon to the magnetic field.

So the solar corona which we sometimes called the atmosphere of the sun extends actually way out to beyond the orbit of Pluto.

And we call that bubble that the solar wind has blown in interstellar space the heliosphere. There's a bell wave in front of the heliosphere on the left here and we see in the pictures -- sorry this is the next slide the heliosphere -- that bell wave is caused by the buildup of interstellar material the sun moving through it because the sun has a motion compared to the gas in interstellar space.

There's a heliopause that's the boundary between the gas for the atmosphere of the sun and its magnetic field in the interstellar space and its magnetic field.

There's a termination shock where the solar wind which is what we call supersonic when it leaves the sun has to drastically slow down. And that's at the termination shot that the two voyageurs have gone through.

By the way the Voyager 1 in about a couple of years ago passed through the heliopause. And so that's our first mission to interstellar space.

I've worked on Voyager for 30 years and I'm still considered one of the newcomers but that - it's been working as well as it has since its launch in 1977.

It's gotten to the fact that it's still sending data back from 14 billion miles away. And it is our first interstellar probe. And I think that's really neat.

So some of the...

Woman: Wasn't - didn't Voyager hit heliopause at all about 98 astronomical units or 90 times the distance from the Earth of the sun?

Eric Christian: That was where it hit the termination shock.

Woman: Okay.

Eric Christian: Yes. So that was one of the boundaries. And Voyager 2 hit it later because it's trailing behind but at a nearer distance.

And that's because the heliosphere is actually squashed. It's been pushed in on the south by the Galactic Magnetic Field.

Woman: Okay. Thank you.

Eric Christian: So going to the next slide SOHO the Solar and Heliospheric Observatory. So SOHO which launched in 1995 there's been other coronagraphs things on the Earth and a couple space shuttle missions that did coronagraphs.

But SOHO was really the first spacecraft that had a coronagraph. And what a coronagraph is it's of fake solar eclipse.

You put a disk out in front of your solar telescope, and block the sun, and look at the corona which is a - although it seems bright in the pictures is actually a lot dimmer then the sun.

And that's why on the Earth you can only see it during a solar eclipse. So there are the - a coronagraph is a fake solar clips and SOHO is really the first mission that gave us a regular image of the solar corona.

And it's still operating today. It's orbiting the L1 Lagrange point which is a million miles closer to the sun then the Earth is. It's a sort of semi-stable gravitational point caused by the pull of the Earth and the sun.

And here you can see a composite image that shows three of the telescopes from SOHO whole the green is the Stream Ultraviolet Imaging Telescope which shows the disk of the sun.

The red shows the C2 Coronagraph. C1 is not useful but the C2 you can see the inner edge is the disk that's blocking the sun in C2. And you see the C2 image in red. And then the blue is the C3 chronograph which has a bigger disk but sees the corona out even further.

Now this has been sort of intensity matched in a way. Actually the - as I said the sun is not only much brighter than the corona but the corona intensity falls off as you get further from the sun. So this has had that compensated for.

But actually the corona that you're seeing is much brighter close to the sun then it is at the edge of this image.

So then in 2006 we launched two spacecraft nearly identical called STEREO. And they were in orbits that had periods one slightly more than 365 days and one slightly less than 365 days.

So that from the standpoint of Earth they sort of drifted away even though they were still orbiting the sun at about the same distance as the Earth is they appear to drift away at 22-1/2 degrees per year away from the Earth one ahead and it was called ahead and one behind.

So since 2006 they've gone all the way and crossed over in back of the sun a couple - just a little over a year ago.

And with that conjunction we lost one of the two STEREOs, we lost STEREO behind. And it doesn't seem to be functioning anymore but STEREO ahead is still taking images.

And what's really nice about STEREO is one - as the STEREOs got further and further from the Earth there was a time where we could see for the first time the entire sun at one time because we had cameras pointing at the backside of the sun from the Earth.

The other great thing is that by taking pictures of the corona from the side as relative to the Earth you could do 3-D reconstruction.

If you are looking just with SOHO you see everything, you know, in two dimensional just the flat 2-D. And everything is sort of compressed together on one image.

But you can reconstruct some of the three dimensional shapes of these coronal mass ejections and streamers using the STEREO spacecraft when they were off to the side.

STEREO also has two things that are sort of crosses between coronagraphs and interplanetary cameras. They're things look off to the side so that they don't have to block off the sun directly but they see very dim structures as they move through interplanetary space. That's the blue HI square on this image.

And with that for the first time we were able to trace these coronal mass ejections these big bubbles and storms that come off the sun all the way from the surface of the sun out to the orbit of the Earth.

So that's really helped us a lot understand the how the corona basically becomes the interplanetary medium and how it extends then out through the planets.

Earle Kyle: Question. This is Earle Kyle, Solar System Ambassador in Rochester, Minnesota. When it's behind the sun how did they communicate with it?

Eric Christian: So that's part of the problem is that there was a period where we couldn't communicate with it. The sun is a pretty good radio transmitter.

And so when they were direct, you know, we were able to get close and they started trying to do, you know, move the antenna around to try to get us data for as long as possible. And during one of those moves apparently the spacecraft went into a spin.

But there is a period where the spacecraft is directly behind the sun and you simply can't communicate with it.

Earle Kyle: A second question, when you mentioned the coronal mass ejection when - that the particles come out at close to the speed of light.

Eric Christian: Yes.

Earle Kyle: What about iron atoms? Would they be accelerated at the speed that I've heard that those that come from galactic cosmic rays from a supernova which are close to the speed of light as well?

Eric Christian: So the biggest frontal mass - what?

Earle Kyle: The famous line is that if you got hit with it it would have the same impact as a professional baseball player throwing a league ball at your chest at 100 miles an hour. And, that therefore one could presumably feel it. This is probably not true but people have done the math on the amount of energy on impact.

Eric Christian: Yes they can...

Earle Kyle: CMEs give you the same acceleration as from a super nova explosion?

Eric Christian: No. The very fastest coronal mass ejections only get up to, you know, 95% the speed of light.

Earle Kyle: Okay.

Eric Christian: The highest energy cosmic rays which actually the highest energy ones the ones that you - are more like a Nolan Ryan fastball are actually almost certainly extragalactic and come from exploding galaxies, and active galactic nuclei and supermassive black holes like that.

But they get up to .999999999999999999 the speed of light. So you never get that energy. It has to do with the size both the size of the accelerator and the strength of the magnetic field.

And the sun doesn't have either a big enough magnetic field or strong enough magnetic field to get up to these very high energies.

Earle Kyle: Thanks.

Steve Edberg: I have a question Steve Edberg here at JPL. Can you - is this H1, HI1 blue image on this actually neutral hydrogen?

Eric Christian: So I think most of what they see is electrons. They see Compton scattering from electrons.

Steve Edberg: Okay.

Eric Christian: So it's a white light, you know, image but I think it's mostly the electrons. I mean that's what the coronagraphs see. That's most of what you see.

So there are three types of corona. There's a dust corona, there is an ion corona and there's an electron corona. And the electron corona is mostly the brightest I think.

Steve Edberg: Okay. Thank you.

Eric Christian: The dust corona becomes the zodiacal light out far from the sun. And that's been subtracted from this image.

So the next slide shows an image of the Solar Dynamics Observatory. And the Solar Dynamics Observatory was a real step up in our understanding of the sun because it was like going from a black and white television to high-def.

The camera as, you know, electronics improved and, you know, radio communications improve we could send down high resolution images of the sun at a fairly rapid pace.

The amount of data that the Solar Dynamics Observatory sends down is in the terabytes which we couldn't do 20 years ago with space crafts.

So it's really the first time that we have these extremely detailed movies of what's happening on the sun in four different wavelengths.

And so if you go - if you just do a Google search for SDO at NASA you see, you know, nearly live images and movies of the sun showing these sunspots and everything else really quite impressive.

And these images are so high resolution that you actually can't see them on a normal computer screen.

They're 4000 by 4000. And so you need either something more like ultra-high-def television or we show is SDO movies sometimes on hyperwalls on these composite television screens that get us the full resolution. But you can't see the full resolution for the entire movie on your computer screen. And if you haven't seen SDO movies you should go and look because it's really quite impressive.

So on the last spacecraft I'm going to talk about hasn't launched yet. I'm in the process of building one of the instruments for the Solar Probe Plus that's on the next slide.

And this is going to be our first mission to a star. This is going to be a mission that goes to within 4 million miles of the surface of the sun to study how the solar wind is accelerated and why the corona is so hot which are still open questions.

We've got ideas but we don't have any scientific proof as to what is causing the solar corona to be many times hotter than the surface of the sun and why the solar winds get accelerated up to a million miles an hour.

So we're going to get ten times closer than Mercury is and 25 closer times closer than the Earth in Solar Probe Plus.

And so how do we do that? We hide in the shadows. If you look at this picture the - on the left there is a big carbon heatshield that protects us thermally so that even though the front of the heatshield is over 1000 degrees the back end of it the entire back of the spacecraft is going to be more like at room temperature 25 Celsius or something.

So there are some parts that do stick out from behind this heatshield that don't hide in the shadows.

The wire electrical antennas that you see going off in four directions they're special high temperature materials.

And also the very tips of the solar arrays which are the two wing like structures that go above and below on this image are made out of special high temperature solar cells.

And when we're that close to the sun you don't need as much solar ray as you do when you're at Earth.

And so just the very tips what you see is that where there's a little bend in the solar arrays that little tip is going to extend out beyond the shadow of this heatshield.

So - but it's going to be a really neat mission. Our first mission to get anywhere near that close to the sun.

Next slide sort of shows another graphic of it. It's a pretty big spacecraft, you know, weighs 685 kilograms, 4 meters tall and most of this I've said before so let's go on to the next slide.

So since we're talking about eclipses I thought I'd show, you know, how close the Solar Probe is actually going to get to the sun. And so this is a picture of the solar eclipse in 2009.

And if you go to the next slide I did a fake animation. So the red dot shows how close Solar Probe is going to get.

And even though on this photograph the corona only - doesn't seem to extend out that far it's only because the brightness goes down.

But the Solar Probe Plus will actually be within the region where the solar wind is still being accelerated.

And where and it's where it's being heated. So we're going to actually go to the source to figure out what's going on.

Man: I have a question. You're going to have to use some gravity assist from like Venus or Mercury to get that close.

Eric Christian: Yes. So we only get to about three times as far in our first orbit. And we'll be using over seven year's three Venus transits to get us closer.

Man: Thank you.

Kay Ferrari: Excuse me, we can hear somebody's line. So we can hear some talking in the background. Please those of you who are listening please check your phones make sure that you're muted. I'm sorry Eric. Go ahead please.

Eric Christian: No problem. Yes no problem.

So next slide I talk a little bit about the 2016 eclipse. And I did a Google Map for - or grabbed one and notated it from the eclpise.gsfc.nasa.gov.

And as in the slide that I showed earlier Lou's presentation the GD marker shows the greatest duration of the eclipse. The reddish marker near there is Woleai in Micronesia where the Exploratorium and I will be.

And the science team from NASA is going to be in Maba, Indonesia the other marker on the eclipse path.

And there's an image on the lower right there from the 1999 Turkey eclipse that shows at least a couple of the people who are going to be in Maba and an earlier version of the telescope that they're going to be taking to Maba to specifically to study the electron density of the corona by looking at certain wavelengths that in combination they can get out the electron density.

This is the technology they've been working on as you can see since before 1999. They are continuing to improve it. And they actually get science from these eclipses.

But the eventual goal is to get a telescope like this out into space so they can continuously measure the electron density of the corona without having to, you know, go around the world to different eclipses and only get a couple of minutes of data when the clouds let you.

So - but eclipses from the ground can do science. And for testing telescopes like this one they're using it's a tremendously cheaper way to test it then sending a small telescope into space. And that's it for me.

Kay Ferrari: Well think you very much Eric. We've got time for another question if anybody has one before we go on to our next speaker.

Jeff Nee: Yes. This is Jeff from JPL. Why does the electron density matter and why are you measuring it?

Eric Christian: So the understanding the corona it's for the most part corona the solar wind are neutral but for various reasons having to do with the acceleration process there - it's not quite.

And so the ions are moving at a different speed than the electrons. There's recombination as it gets further away and stuff.

And so it's just one of the pieces of the puzzle in understand the corona. You try to measure as many components of the corona as you can and then try to piece it together to understand the acceleration process.

Jeff Nee: Thank you.

Kay Ferrari: Thank you very much Eric. Okay. We're going to move on now to Nicole Minor. So the presentation you're going to be looking for is Nicole Minor Presentation or Total Solar Eclipse Minor.

Nicole Minor is the Director of a group of media content creators at the Exploratorium in San Francisco.

She provides videos, live Web casts, artist installations, podcasts, music compositions and other content for both the Exploratorium and Web site and the museum floor.

So welcome Nicole. We're delighted to have you join us.

Nicole Minor: Thank you so much. Hello everyone. Can you hear me okay?

Kay Ferrari: Yes.

Nicole Minor: Okay great. Okay well I will just start off with our first slide and I just wanted to mention Eric mentioned where we will be sending our team to broadcast the solar eclipse live for 2016.

At its Atoll in the South Pacific called Woleai. So Woleai is one small island in a series of islands within the state of Yap which is within the Federated States of Micronesia.

And the image that you see in the very first slide of what looks somewhat like a bug is actually a dancer from that part of the world in native dress.

And so it is quite a journey to get out there as Eric mentioned. So let me just get started with a little background first.

The Exploratorium has been covering eclipses since 1998 doing live Web casts. Back then it was about the size of a postage stamp.

And so we've sent crews to all of these locations on this next slide here that says Exploratorium's Eclipse History.

And we've had a lot of wonderful Web casts from the field and partnered with NASA several times to do these projects.

Next slide. This next slide is the eclipse timeline. It's not actually the time of our broadcast but it's for the full eclipse. We wanted to try to make sure everybody had any information that they needed.

As Eric mentioned this is a tricky one because we fall on two sides of the International Date Line. So for some of us it'll be March 8 and some of us it'll be March 9. And it depends kind of where in the world you are.

Next slide please. Eric's already showed this map but I just wanted to show it one more time for you. The path of totality is going easterly from Indonesia across the Pacific. And we will be sending our crew to the Woleai Atoll where it's located right before the greatest duration of the eclipse.

Next slide please. Our programs I wanted to just go over this because we were actually trying to produce quite a lot this time. So I wanted to make sure everyone knew what we had on offer.

We will be producing the live streams of the Web cast as Eric mentioned the telescope feed and the program feed which is our education program.

We actually have two other streams that we'll be presenting as well that also use the telescope feed which is a third stream that will be a live spawnification from the field created by one of our staff. So it will be - the artist will be using the telescope feed to create a live spawnification of the eclipse.

And then the fourth stream is a shorter version using the telescope feed around half an hour around totality.

One of our staff here Dr. Isabel Hawkins will be doing a live Spanish narration over the telescope feed for about a half hour around totality.

So we actually have four streams that we're offering to the world. And we also are producing videos ahead of time.

We have a blog, we have a Web site and most of that information is here on the slide www.exploratorium.edu/eclipse.

And the other thing we're making is an Android app to stream the Web cast live which is very exciting and is something we've been trying to do for a long time.

So the Android app will be available on the Google Play Store. And it will have maps, it'll have the telescope feed, and the program feed and you can also be on Twitter live tweeting while you're watching the broadcast.

And then I just wanted to let everybody know that we also are trying to do as much social media as we can so on any Exploratorium Channel, on Facebook, Twitter, Tumblr and YouTube there's all kinds of things that will be coming out. And today is sort of our start point for really posting a lot of content because we're about two weeks out.

Next slide please. This is information about the telescope only feed. The silent version of the telescope feed is we try to provide that for everybody so that if you want to use this for your own programs or events you can have the telescope feed.

It's a mix of four telescopes that'll be coming out. And the information about the times is there. And then you also have the information about the satellite if you want to pull it down from a domestic satellite.

It'll be available on our Web site. And it will be available on the app. And then it'll be available on NASA TV I believe on Channel 2.

And then the next slide is the program education feed. This is a one hour education program which is hosted by some of our senior scientists and staff.

They'll be hands on demonstrations. We'll have guests from NASA in the program as well and some guests from our location on Woleai.

And the same information as the prior slide there's the time, the satellite information, it's available on the Web site, the app and it will be on NASA TV Channel 1.

Does anybody have any questions so far? Should I keep going?

Kay Ferrari: Yes. You may keep going.

Nicole Minor: Okay. Here we go. So the next slide is the telescope imagery with Spanish commentary. This is kind of an experiment for us.

And the reason we wanted to do it obviously is to offer it to a greater audience. We believe that in 2017 this will really be, you know, something that will be of interest is to get as much Spanish narration and Spanish language programming out there as we can.

So this is our sort of first stab. And what we're going to do is have Isabel narrating over the telescope feed live here at the Exploratorium. And we'll be encoding it and sending it out as another life stream on the Web site.

And it'll be really interesting to see how that works. And we're excited to hear any feedback about that. And it won't be available on the satellite so the only place you'll be able to get it is on our Web site.

Next slide is our script out lines. So this is for the education programs. It just gives you a general idea of what will be happening in the one hour educational program.

We’ll do some establishing shots and welcoming. We’ll talk about the telescopes and the images. We’ll do a little Eclipse 101 with some demo and animations of alignment.

We’ll do moon casting the shadow on the Earth. Then we’ll talk a little bit about the path of totality, the weather and why we chose where we are.

Then there will be a segment on space weather, and the magnetosphere and I believe Troy Cline will be joining us for that part of the program.

Then we’ll get ready for totality. We’ll talk about some of the features during totality.

Then after totality happens which is four minutes and five seconds we’ll be doing a little prep for the 2017 eclipse in the US.

And we’ll end with a how to build your own solar viewer. That’s a hand’s on demo here at the Exploratorium. And then we’ll do some thanks and credits.

Next slide. Additional story ideas, we just put this together for anybody who might have other things that they might be interested in this talks a little bit about how we do our broadcasts.

We have to send 4000 pounds of gear including a satellite dish plus 15 people on a very long journey which takes 22 hours by plane and three days by boat to get to the Atoll in the South Pacific.

We have a little bit about whether and Jay Anderson's Web site. And then we have a little bit here about eclipse history. There's more of this information on the Exploratorium's Eclipse Web site.

And a little a couple of other topics of information like Einstein's theory of relativity and light bending concepts, a little bit about exoplanets and talking about the next major eclipse in 2017.

And the next couple of slides are just fun eclipse facts. These are things we put together here at the museum with our writers and scientists.

And we're using them for social media, we're using them on our Web site, we're using them for blogging and for just various ways to get people excited and interested in the eclipse, so that's the next two slides.

The next slide is a still. So it's not a video. It won't play. But the NASA Vis Lab did a wonderful job of creating some animations.

And so I definitely suggest you all go check those out there for 2016 and 2017. So this one shows you a map of the path and it's really great. We're using it in some of our produced videos as well and I expect it will be included in the Web cast too.

And the next slide is similar. It's another animation. These are again stills.

And then the third slide same thing. They're available for download in various sizes. They're really fantastic. And we're using them as much as we possibly can.

The other place you can look for assets if you need I'm sorry the next slide it says great stills of totality are available at mreclipse.org.

That's the site by Fred Espenak who's one of our most famous eclipse chasers. And he is a retired NASA scientist.

He only asks for credit only on his images which is really helpful if you need something to share with your audiences.

I also just wanted to mention that we are producing a bunch of educational videos as I said. And those are starting to come out now. They'll be on our Eclipse Web site which again is exploratorium.edu/eclipse.

They'll also be on our YouTube Channel. And they'll also be on our home media page which is called explode.tv. So you can get our videos at any point and they are embeddable. You can share them in a variety of ways.

And we'll be adding to this collection over the next two weeks. So there's probably five or six there now and they'll probably be another four or five added. And there on all different concepts and topics as you can see here.

And - sorry go ahead.

Bill Goodman: Excuse me Bill Goodman from Robinson Nature Center in Maryland. Is Exploratorium or more maybe anyone who is listening right now know of any planetarium full-dome productions that are being produced particularly for the 2017 eclipse?

Nicole Minor: I'm sorry can you say that again or can someone translate, it was a little fuzzy?

Bill Goodman: It's full - if you know of any full-dome planetarium digital productions that are being produced specifically for the 2017 eclipse even if they are short subjects?

Nicole Minor: Yes. I did not know of any right now myself. Is there anyone else on the call that might have that information?

Derek Rohl: Yes. I'd be happy to chime in. This is Derek Rohl from the Adventure Science Center here in Nashville.

This is where we have the Sudekum Planetarium. And we are actively producing a show right now. It'll be ready a little bit later on this fall but we'll be ready to distribute it probably in mid-November of this year.

Bill Goodman: Fantastic. I know that - I know your production great.

Derek Rohl: Excellent. Yes. So if you want to find us online or if anyone would like to I'm happy to share contact information just if there are any others who would have use for that show?

Bill Goodman: I just made the move. Thank you. I'll be in touch.

Derek Rohl: Okay. Thank you so much. Yes we're just adventurersci.org. And then you can find the planetarium.

Nicole Minor: Okay. So the last slide I have everybody is just our information for contacts. I'm the main contact here at the Exploratorium.

Most of my crew is leaving in the next week. Robin, our head producer, is heading out into the field though with our senior scientist Paul Doherty.

They're going to be doing education around eclipses in the islands around Woleai and Yap for the next week.

And then the gear is also being transported right now. That's 4000 pounds of gear I mentioned. And the rest of the crew will be leaving at the end of this week or at the weekend.

So I'm your main point of contact here at the museum. And I can help try to help with just about anything you might have questions about.

You can use either my personal email address or eclipse@exploratorium.edu both of which I will try to answer any questions you have.

Is there anything that anybody would like to know right now because I'm happy to help in any way I can?

Man: How you say the name of that island?

Nicole Minor: It's Woleai. Think of it as a woolly eye.

Man: Got you. That makes sense. Thank you.

Kay Ferrari: Are there any other questions for Nicole? If not we will move forward to our next speakers. Troy Cline, have you joined us yet?

Troy Cline: Yes I have. Hi.

Kay Ferrari: Excellent. Welcome Troy.

Troy Cline: Thank you.

Kay Ferrari: And are you using Carolyn’s presentation to address or are you just speaking without a presentation?

Troy Cline: I’m speaking without a presentation. I’m actually in my car between meetings and appointments.

Kay Ferrari: Okay.

Troy Cline: So I’m pulled over so that I could speak just a little bit about the mission.

Kay Ferrari: Okay. Well without ado we have Troy Cline from the Heliophysics Team at NASA Goddard. Troy?

Troy Cline: Hi everybody. It’s a pleasure to be here. And I was excited to work with the Exploratorium to be able to talk a little bit about the MMS mission which may Magnetospheric Multiscale Mission.

And what’s pretty exciting about this particular phone call is we have two other people on line that I know of, I believe I heard Pat Reiff’s voice and I know Eric Christian is on line.

And they both are connected to the mission. And are scientists that actually do work pretty closely with a concept known as magnetic reconnection.

Now what’s really cool and the reason that Exploratorium invited MMS to be part of this Web cast is because MMS is a mission that launched just last

March on - there are four identically instrumented spacecraft that are octagon shaped.

They are about 4 feet high, 11 feet wide and around 26 instruments aboard each spacecraft. There were stacked on top of each other, placed on top of an Atlas V rocket and then launched into space.

And once they got into roughly where their orbit is going to be they were released and began to be individually controlled from ground to go into a tetrahedron shape or a pyramid shape formation.

And they are currently flying at a highly elliptical path around the Earth anywhere between five to 25 Earth radii.

And they are flying in this formation because an adjustable pyramid formation because they are looking for regions where magnetic fields collide.

And when they do that and they touch they actually connect and reconnect, they disconnect and reconnect and they throw particles nearly to the speed of light.

And we know this happens. It happens all over the universe actually. It happens around the sun. It’s one of the main drivers of space weather events.

You’ll see magnetic reconnection happening in the coronal around the surface of the sun, around other stars, and other solar systems and definitely around the Earth because we have such a powerful magnetic field around the Earth.

When the sun its magnetic field comes in contact or collides with the Earth’s magnetic field we have these magnetic reconnection regions where the magnetic field light actually come together and rip apart and hurl particles in two directions which is pretty intense.

Although we know this happens we don't really know how that happens. So that's why we placed these four satellites that are now currently zipping around the Earth passing as around as many of those explosive regions as they possibly can.

So we're talking about the connection of magnetic reconnection to the eclipse. So when people are looking at the corona they're talking about space weather they'll also know that we have a current mission a really exciting mission that is taking for the first time three dimensional data views and data sets of this region called magnetic reconnection.

And so I'll be talking about that and sharing more information about where you can get some pretty cool activities related to the mission.

And I believe Carolyn has provided somewhere I believe in one of the slides that she has I believe there's a link to the education section for the MMS mission which is essentially mms.gfsc.nasa.gov. And I'm sure we can share that out with you.

But when you get there definitely look for the education section. Pat Reiff and I several others have spent a lot of time putting together some really cool hands on some make and take activities that you can use where kids can actually download the paper model of the spacecraft.

If they want and put it together they can down load Lego models that have been designed that are pretty close to accurate as far as Legos go.

And we also have a 3-D printable model that is online but yet we're improving it right now.

And then Eric Christian and I are developing a test plate out of a 3-D about a five by fine inch piece of 3-D printed material which is PLA plastic that we're putting a series of different five holes in that will actually be downloadable at some point in the near future for people to use as pinhole projectors. We can just hold it up about four feet three, four feet from the ground.

And when the eclipse is happening you'll be able to see a partial eclipse or solar clips as you're holding that piece of plastic view it and see what the eclipse looks like as it's happening overhead.

Now Eric came up with a really cool idea that I totally jumped on and this is going to be cool is we're going to find the best thickness for 3-D printed material and size of the hole that will make the best image on the ground so that we will help you and we'll put materials up and directions up.

So we're going to people to design 3-D printable sheets of plastic or even a cardboard where you can put these little holes in a formation to spell out your name, the name of your school a monogram so that when the eclipse is happening in 2017 in America and even you'll be able to hold this little piece of plastic up and shoot your monogram, or your school's name, or a symbol onto the ground and take a picture of it. It's completely made out of the unique Great American Eclipses all across the ground.

So that's just one idea. And the last thing I'd tell you now is we just released - actually we haven't advertised it a whole lot yet but we released something called the MMS Big Data Book.

And it’s on the education site with MMS under a section called Digital Storybooks. And it’s an online book and a downloadable teacher’s guide and downloadable guide for students as well that teaches kids how to go online safely and find data points through like Google Analytics or Google Trends and a few other tools that they tell you about.

And kids can pick any topics that they want to put together and do a little bit of research on and create a research report at the end. And it walks you through all the steps different tools that you can use.

And for instance you could put in there or a student might want to know are eclipses in any way connected to goose migrations? Just name it.

And they can go out and likely find some pretty interesting data sets based on Google Trends and Analytics that they might be able to put a story together to prove or disprove or just investigate type of research project.

And we’re going to be looking into using that book as a way to promote some topics that kids might want to do ahead of the 2017 eclipse as well.

So I think that’s it. I’d like to turn it back over unless there’s some questions.

Kay Ferrari: Any questions for Troy? Troy thank you very much for being with us this afternoon and now you can continue your journey.

Troy Cline: Thank you very much.

Kay Ferrari: We’re going to move now to the presentation entitled Solar Outreach Resources-Ng. If you’re on NASA Nationwide if you’re on the Museum Alliance is Carolyn Ng presentation.

Carolyn Ng is an Education Specialist at the NASA Goddard Space Flight Center. She has supported many NASA Earth and space science projects as well as the Sun Earth Day programs. Welcome Carolyn.

Carolyn Ng: Oh thank you Kay. I didn't expect to speak. I thought Troy will cover everything. But I just put together a list of nine or ten activities as well as tips to observe the eclipse.

So earlier on Eric and Nicole described where and how to view the eclipses. Of course a lot of people are concerned about eyes safety. So we have a link to the place where you can, you know, read the precautions.

Also Nicole already pointed out the visualizations available for your own uses. And there are other hands on activities. And Troy touched on a couple of those.

And then also not just for eclipse chasers but on a day to day basis especially when you are in a museum or in a classroom outreach environment you can point out the SDO images available in a kiosk mode and you can show the sun in one or two or six frames.

There are also mobile apps beyond the eclipses. One was developed by the Lawrence Hall of Science. And you can download the app and do the hands on activities.

And then of course PowerPoint slides for your own adaptation. And then FAQs or fun facts that Nicole also mentioned. And we have it also on our sun of day Web site.

Most of the links are provided are from 2006 and 2007 when we had the pleasure to travel actually with the Exploratorium in 2006 to Turkey and then 2008 to China.

We did not plan on working a lot on the 2016 eclipse that happens in two weeks but our focus would be on 2017.

So some of the materials be updated and there will be new ones added to our Web site that will be announced shortly. So that's all I have questions, suggestions?

Kay Ferrari: I'd like to point out too that all of the links on this page on Carolyn's presentation if you're on the NASA Nationwide Web site I have included those right above the NASA wave links.

So you can go directly to those Web sites the one that Carolyn - the ones that Carolyn referenced by clicking on those links.

And I will also be providing the videos that were - the one that was in Lou's presentation and then the ones that Nicole referenced as links underneath the presentations on the NASA Nationwide Web site for your convenience. We want to make sure that you can easily get to those wonderful resources.

So do we have any questions for Carolyn on the resources that are available or questions for the other speakers who may still be on the line?

Regina Conrad: I have one question.

Kay Ferrari: Go ahead.

Regina Conrad: Regina Conrad, Solar System Ambassador. I'm asking about the Mercury transit. It was mentioned that you need a binoculars or a telescope you can't just see it was solar eclipse glasses? Is this true?

Eric Christian: So I - if seeing if the atmosphere is really clear you might be able to see it but it would be awfully hard I would think. I've never tried but I would think it's enough smaller then Venus that it would be tough.

Regina Conrad: So we would need to set up a solar telescope.

Eric Christian: Yes.

Regina Conrad: Is there another way? Would we be able to do like a projection that you would do ours or Web site that I can go to find out other ways of getting the most number of people to safely see it?

Eric Christian: Yes. I mean fortunately that was Lou's picture. I don't know of any Web site but there probably are. I'm sorry Lou would probably be able to answer that. But yes I think Mercury is going to be too small to - unless you've got really clear skies to be able to see it.

Steve Edberg: Mercury is only going to be about 1/5 of the diameter of Venus at - during its transit. So it's very small.

Regina Conrad: Okay. Thank you. I saw Venus.

Steve Edberg: It's not a naked eye, it's not a naked eye event. It's definitely with a telescope. I'm Steve Edberg by the way at JPL.

Or it is it might be possible with a projection system but it'll need to be a pretty big image that you can that you get.

So projecting through a telescope or through a pair of binoculars it won't melt is a possibility as well but all of the safety protocols apply for that.

Regina Conrad: Right, right. Okay thank you.

Steve Bullock: Is Eric still on the line?

Eric Christian: Yes I am.

Steve Bullock: Yes. This is Steve Bullock, Solar System Ambassador from the Virgin Islands. I have a question with the Solar Probe Plus.

Why is it that the shadow that would be cast to protect the primary array why it wouldn't protect the secondary area and you would have to use a pump fluid system to - as a coolant to protect the secondary array?

Eric Christian: So there is a coolant a pump coolant system. But the part of the solar array that'll extend out on closest approach is specifically designed to be able to take the high temperatures.

But you need to see the sun in order to get the power from it. So you've got to have something out at least in partial sun in order to generate any power.

Steve Bullock: Right makes sense yes. But since the secondary array would be too far behind the shadow and then you would have to have them I guess oriented towards the sun as you said so they would need that secondary backup to - so the fluid would not vaporize.

Eric Christian: Yes. So I mean they - the second - the non-high temperature array hides in the shadows and actually unfolds as we get further away from the sun to collect more power at - with a smaller sun.

But they cannot - much of the spacecraft cannot see the sun at closest approach. I think I estimated at one time that our - my instrument would melt within 90 seconds if we - if they get the orientation wrong and we get in full sunlight at closest approach.

So it's been an engineering study. I mean we've done a lot of good engineering to get to this point but I think they've got it all worked out.

Steve Bullock: All right. Thank you.

Loretta McKibben: Hi. This is Loretta in Oregon again. Solar System Ambassador. I just have a suggestion for Solar System Ambassadors and teachers who don't have a telescope or don't know how to use them.

There are a lot of amateur astronomy clubs throughout the nation. Before the eclipse in 2017 I suggest you contact them and ask if they'd be willing to help with your events because a lot of guys and gals spend a lot of money on their telescopes and they love to do public events.

And they really love it when a Solar System Ambassador shows up who can explain things well to the people because a lot of times amateur astronomers love astronomy but they don't know how to, you know, explain it to fifth graders or adults who are new to science like Solar System Ambassadors do.

But if you develop a relationship with them you could probably have a fantastic set up. You know, it costs a lot of money for your events and they'd be thrilled to help you with it.

All you do is give them, you know, credit with it and that's astronomy clubs small and large. I mean you just have to Google your area and see who the nearest club is.

Like here in Portland there's a giant astronomy club the Rose City Astronomers. And then there's a smaller one here where I live, Heart of the Valley Astronomers. So they're a great resource. And they really like to help out with things.

Kay Ferrari: Thank you Loretta. And I would like to remind everybody along those same lines that we have the NASA Night Sky Network which is for astronomy clubs.

And they are nationwide. And they are getting the same trainings that the Solar System Ambassadors do. And they will be focusing on the eclipses as well.

So you could go to a search engine for NASA Night Sky Network. And you could come - they have a tool on the Web site where you can search for your closest your nearest astronomy club.

And as I said they'll be getting the same trainings and information as ambassadors and the museum alliance. So that would be a good opportunity for you to hook up with a club and collaborate for a big event.

Loretta McKibben: Yes. And there are a lot of smaller clubs that haven't - part of the Night Sky Network. Like I'm here in Corvallis had never heard of it before.

So if you do find a smaller club encourage them to join the Night Sky Network because it is really fantastic. I worked with it in the Tucson Club. And it's really a great resource to help you with all of your events. Thanks.

Kay Ferrari: Excellent, thank you, Loretta. Somebody else have a question?

Man: I was just going to comment one of the challenges we're having in Maryland with our own amateur astronomy club and scheduling and trying to plan for some 2017 events is all of our outreach people are going to be eclipse chasing. So we will be along the path and not in Maryland. So...

Kay Ferrari: Okay. Do we have any other questions, comments?

Alan Gould: This is Alan Gould in Berkeley.

Kay Ferrari: Go ahead Alan.

Alan Gould: Yes. Just a quick mention it occurred to me about the Mercury the Transit of Mercury. There was one in 2003.

And the - we were - the education people on the NASA Kepler mission put Kepler Web site information about transits of Mercury. So there's an article that Edna wrote. So that's kepler.nasa.gov under the education section there is a transit page.

Kay Ferrari: Great, thank you Alan. I'm going to add this to our telecon page too on the NASA Nationwide Web site. That's a good resource. Thank you.

Alan Gould: Okay.

Woman: Thank you.

Kay Ferrari: We are about a minute away no here we are its 1:30 PM in California. So we have time for maybe one or two more questions?

If not then I'd like to remind everyone on Wednesday the day after tomorrow on the 24th of February at 3:00 PM Pacific 6:00 PM Eastern Time.

We are going to have Dr. Fran Bagenal doing an update on the New Horizons mission. Hope to see you all on the telecon at the time. Thank you everybody for joining us. Have a good night.

Man: Thank you.

Man: Thank you.

Woman: Thank you.

Man: Thank you.

Man: Thanks Kay.

Coordinator: That concludes today's conference. Thank you for participating. And you may disconnect at this time.

END