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Moderator: Michael Greene
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Brian Day: Thank you very much David and thank you all for joining us tonight. This is, indeed, a very special time. As David mentioned, LADEE is in orbit around the Moon. Things are going well and I will be giving you a current update on the status of the mission.

But let's start out with a little bit of historical context. So I'm going to advance out the title slide. Let's go to Slide Number 2. A lot of the impetus behind the current study of lunar volatiles and the lunar atmosphere came about from a realization that there are craters at the poles of the Moon whose floors never received sunlight. The sunlight is coming in essentially horizontally across the...

And so there are craters whose floors have not seen sunlight in over a billion years. And people started realizing if volatiles were going to be concentrating anywhere on the surface the Moon this would be a really good place to look.

Moving to Slide 3 we see that latest information coming from the Lunar Reconnaissance Orbiter as it actually takes temperatures across the surface of the Moon -- shows that these permanently shadowed craters really, really do get very, very cold -- down to about 25 Kelvin.

This is the coldest we have yet measured in our solar system -- even colder than the daytime side of Pluto. So indeed, these are really good places to look for volatiles.

Moving onto Slide 4 we see that there was early evidence for water accumulating in this permanently shadowed craters -- it was provided by two probes back in the 1990's -- the Clementine Probe and the Lunar Prospector. But it was just a possibility.

The data could be interpreted any number of ways and so it was a tantalizing hint that there might be water in those craters.

Moving onto Slide 5. We decided to get our hands wet -- to actually excavate one of these craters to see if, in fact, there really was water ice there. And we did this with the LCROSS mission. The idea behind LCROSS was that a robotic spacecraft would hold onto the upper stage of our Atlas V Moon Rocket and release that upper stage with a mass of about two metric tons, moving at 2.5 kilometers per second, flying straight down into one of those permanently shadowed craters, slamming into the ground and excavating hundreds of tons of stuff, flinging it up into the sky of the Moon. And then our little robotic spacecraft would fly through the debris, sample it, sniff it, and actually see if there was, in fact, any water ice there.

Moving onto Slide Number 6. You see the dark permanently shadowed area of the crater Cabeus near the south pole of the Moon. This picture was taken by the LCROSS spacecraft. And if you look closely, you'll see that little blip of light right in the center of that shadow, that is the flash from the impact of the center upper stage hitting the ground.

Moving onto Slide 7. Looking at that shadow now we see this kind of light patch that is the cloud of debris rising up out of the shadow. The cloud of debris that the LCROSS spacecraft eventually flew through and that's how we, in fact, discovered that there is indeed water ice in these permanently shadowed areas of the Moon.

On Slide 8 we see the water ice is actually more widespread than we had previously thought. We were kind of expecting to find it in these permanently shadowed areas. But it turns out that just beneath the surface -- even outside of those permanently shadowed areas.

Just beneath the surface there appears to be layers of permafrost. At the poles, the sunlight is coming in at such a shallow angle that it does a very poor job of heating up the ground. And so there is potentially a lot more water than we had previously thought.

Moving onto Slide Number 9. (Unintelligible), surprising and fascinating result came from India's Chandrayaan probe. We discovered that there was a thin veneer of water molecules in the soil of the Moon -- even away from the poles.

We didn't really expect to see that. Now it's not a lot. You'd have to excavate about a football field worth of area to come up with one standard drinking water bottle worth of water, but that's not as dry as we thought the Moon once was.

So moving onto Slide 10. The question is where did this water come from? And we're not altogether sure, but we have some clues. We know that for billions of years the Moon has been bombarded by comets -- which contain large amounts of water -- and a variety of meteoroids and asteroids -- some such as carbonaceous chondrites contain large amounts of water.

In addition, the solar wind -- there's a stream of high energy, high speed, hydrogen atoms slamming into the surface of the Moon. Those hydrogen atoms can actually interact with oxygen atoms in the silica's of the lunar minerals. And as a result, you could form water on the surface of the Moon.

One thing we initially felt very certain of was that this water was all external -- it did not come from the Moon, but the Moon itself was initially very, very, dry because of the high temperatures under which it formed.

Well, we're having to question that now because it turns out that we're getting indications that the magma of the Moon actually had a far higher water content than we had initially thought. So we're still learning a whole lot about the Moon. And it has a lot of secrets for us.

Moving onto Slide 11. So the whole concept of a lunar atmosphere is actually a pretty provocative idea. I know I grew up going through school learning that the Moon does not have an atmosphere. But, in fact, it does. Now it's a very thin atmosphere. A cubic centimeter of Earth's atmosphere here at sea level contains about 10 to the 19th molecules. If you're to do the same thing on the surface of the Moon -- take a sample of the atmosphere -- it'd only contain about 100 thousandths to a few million molecules.

That's very similar to what our astronauts experience in the outermost fringes of the Earth's atmosphere when they do a spacewalk at the International Space Station. Now as thin as it is, it's not inconsequential. It turns out the Moon's atmosphere is energized by the Sun and it glows.

You're actually seeing a picture from here on Earth of the glow of the Moon's atmosphere taken through a coronagraph. Now you may have never noticed the glow of the Moon's atmosphere, but that's because it's always right next to the big bright Moon.

If somehow you could remove the Moon and leave this atmosphere in place, then from a dark sky you'd be able to look up and actually see the glow of the Moon's atmosphere with your unaided eye.

Moving onto Slide Number 12. Technically the Moon's atmosphere is what we'd call a surface boundary exosphere. What this means is that the atmosphere is so rarified that it is essentially a collisionless environment.

Here on Earth -- at the surface of the Earth -- the motions of the molecules in our atmosphere are dominated by collisions between those molecules. But in a exosphere, it is rare enough -- the atmosphere is thin enough -- that it is essentially a collisionless environment and the molecules are free to carry out ballistic paths governed by the amount of kinetic energy they have and the gravity that is acting upon them.

Moving onto Slide 13. We see a really interesting animation here showing that the Moon's atmosphere is actually blown out into a comet like tail. This tail actually extends well beyond the diameter of the Moon's orbit about the Earth.

As a result, once every month the Earth actually passes through that tail of lunar atmosphere. Similarly, the Earth's atmosphere is blown by the solar wind into a long tail too and once a month the Moon passes through that tail of the Earth's atmosphere, so we really are a system. We are not as separated and isolated objects as we had once thought.

Moving onto Slide Number 14. We believe that there's also a dust component -- an active dust component to the lunar atmosphere. We got our first hints about this from the robotic surveyor probes that led up to Apollo. And when these robotic probes would land on the moon, at times they'd look out to the horizon when the sun would be just below the horizon.

And they'd see this strange glows above the horizon. Now if the Moon's sky was empty, you would not expect to see a glow like that because there would be nothing to be reflecting the sunlight into the camera, but, in fact, those glows were there.

And the initial thoughts were that perhaps this was dust somehow levitated above the surface of the moon.

On Slide 15 we see continuing support from this came from the Apollo Mission when on a number of occasions astronauts in orbit around the Moon in the command module would look out the window and, again, with the Sun just below the horizon they would see these beautiful jets and streamers rising high into the sky above the Moon -- even up to the level of which they were orbiting.

Surface instrumentation left on the Moon by Apollo 17 astronauts actually gave some further support showing that there appeared to be transported dust across the terminator - across the line between day and night on the Moon.

Moving onto Slide Number 16. We see that the lunar environment is, in fact, a far more complicated and dynamic place than we really had ever thought. There is an atmosphere there and it has numerous inputs -- solar photons coming in and blasting material off the surface of the Moon.

Solar energetic particles also can liberate molecules from the surface of the Moon. The solar wind - meteorites impacting the Moon -- from very small micro meteorites to large impacts.

We have out gassing from the interior. We have chemical reactions on the surface of the moon. We have a large variety of things happening and that it is complicated by the fact that you have this electric charge that builds up differentially between the day time side and the night time side of the moon. So we have actually a pretty complicated dynamic environment.

Moving onto Slide Number 17. We can picture a day in the life of a molecule in the lunar atmosphere. Starts out by sitting on the surface of the Moon waiting for some energetic event to give it a kick -- might be a micro meteorite, might be a high energy photon, might be a charged particle, but one of those events happens and our molecule gets a kick.

If it has enough energy, it escapes the Moon altogether, otherwise it will carry out a nice parabolic path, arching up into the sky and landing on the Moon surface again waiting for the next event.

And as a result, it can take a random walk around the surface of the moon. Eventually that random walk may take it to one of those permanently shadowed craters where it ends up freezing out into one of those deposits of frozen volatiles.

But even there there's lot of high energy radiation that can sputter the surface of that ice and return those molecules back to the system. As a result -- imagine this the water molecule -- you have here the equivalent of a lunar water cycle -- which is a really wild idea. We had never thought of saying something like that, you know, ten years ago. Really interesting stuff.

So moving onto Slide Number 18. Why do we care? Why does any of this matter? Well, it turns out that this type of atmosphere that the moon has, this surface boundary exosphere is an example of the most common type of atmosphere in our solar system. The moon has one, Mercury has one, larger asteroids, many of the moons of the giant planets. Even a number of the distant Kuiper Belt objects, icy world out beyond that too.

This is the most common type of atmosphere in our solar system and we know very, very, very little about it. But we just happen to have one in our own backyard. How lucky is that?

So moving onto Slide 19. We are going to study a surface boundary exosphere -- the surface boundary exosphere of the Moon. So we're doing that with LADEE -- the Lunar Atmosphere and Dust Environment Explorer. Its mission is to determine the density, composition and time variability of the lunar atmosphere. And to do that before it is perturbed by further human activities. There are a lot of missions planned to the moon and when a mission goes to the moon -- where it's got - of course if it's got humans, you know, humans exhale and belch and whatever else they may do. And they come on vehicles with thrusters that fire and put vast amounts of exhaust.

All of that could overwhelm the very thin lunar atmosphere. We estimate that with the Apollo missions, each of the lunar module journeys - when that lunar module would fly down to the moon and leave the surface again, it would temporarily double the mass of the lunar atmosphere just from the exhaust of the lunar modules. So the time to do this exploration is now.

Moving onto Slide Number 20. It's actually, you know, even though we're a small mission, it's a big effort. And it is being accomplished by people in a wide variety of places. Mission Control and Operations, the mission is managed out of Ames Research Center here in Northern California.

The Science Operation Center is at Goddard. We have payloads from a variety of locations. And our program office is at Marshall Space Flight Center. So it's definitely a collaborative effort.

Moving onto Slide 21. You can see a diagram of the LADEE spacecraft. It's not very tall. It's about two meters tall. It has a mass of 330 kilograms. Fifty three of those kilograms are the actual payload mass. We like to say it's a big science with a small spacecraft.

Moving onto slide 22. Let's take a closer look at the payload. We have three scientific instruments. We have a math spectrometer and an ultraviolet and visible light spectrometer that will sniff out the composition of what it is we are flying through.

We also have the Lunar Dust Experience which will analyze the amount of dust that may be lofted into the lunar sky as well as the size of the dust particles and any electric charge that may be on them.

And then we have a technology demonstration -- the Lunar Laser Communications Demo. And the idea there is to try out communications instead of via radio -- the way we have always done it in the past -- to now try something different -- to try doing communications via a laser beam.

This provides us with a signal that does not spread out and therefore we get superior signal strength -- and therefore data rates. And it also frees us from the crowding that is happening in the radio spectrum now.

The idea is to bring broadband speeds to the Moon with a goal of getting up to 622 megabits per second.

Moving onto Slide 23. Here you see an image of the LADEE spacecraft going through the integration process -- as it was being assembled here at NASA and Ames Research Center.

Slide 24. LADEE was packaged up and sent by truck across the country from California to Virginia for launch at the Wallops Flight Facility.

On Slide 25 you see LADEE at Wallops being prepared for integration with the launch vehicle.

Slide 26. LADEE has now been mated to the fifth stage of the Minotaur V rocket that carried us into space. And you can see the payloads ferries are being placed around LADEE and the fifth stage.

Continuing to Slide 27. LADEE was then lifted and placed on top of the four stages that had been stacked for the Minotaur V rocket at Pad 0B on Wallops Island on the Atlantic Coast of Virginia.

Slide 28. We had a spectacular launch. I have to tell you it put on one heck of a show -- and not just for those of us there at Wallops, but also for many millions of people all across the East Coast. We lit up the sky and put a show from South Carolina up through Canada. It was exciting.

Slide 29. Here you see the view that we had from Wallops as people watched the rocked streaking into the sky.

Slide 30. This is the view from New York City. You've probably seen this picture. Very, very spectacular.

And, of course, on Slide 31 -- I could not do this talk without showing the frog, yes, the poor unfortunate frog that was in a pond near the launch pad. And the blast wave hit that pond and sent the frog flying. This went all over the web and to my surprise and consternation, it was even featured on Meet the Press the Sunday following the launch. I could not believe it.

Moving on. Slide 32. So we did, in fact, launch on September 6th. We were the first deep space launch from NASA's Wallop Space Flight Facility. We were the first payload to fly on the brand new Minotaur V rocket. We spent one month going through three phasing loops going out to the moon.

We went into retrograde orbit around the moon and initially went into a checkout orbit at 250 kilometers for about a month. After everything checks out, then we drop down to our science orbit varying from 20 to 75 kilometers for a 100 day science mission.

Moving onto Slide Number 33. So again, we did have that launch on September 6th. We did our - successfully did our phasing loop maneuvers at the perigee approach of each of those three phasing loops -- those happened on September 13th, 21st, and October 1st.

Those got us out to the Moon and on October 6th we had our encounter with the Moon, firing our engine to go into lunar orbit insertion. That initial burn put us into a 24 hour orbit around the moon.

The second burn on October 9th then dropped us into a four hour orbit around the moon. And our final lunar orbit insertion burn on October 12th dropped us into our commissioning orbit with a two hour orbit around the moon at 250 kilometers.

After that we started doing our commissioning orbit. And during that time we're checking out all the instruments, checking out the systems on the spacecraft. Spacecraft systems checked out okay very quickly. We went through our science instruments, checking those out.

And at the same time, that's when we did the tests of the laser communication demonstration. So that was during the commissioning phase. Now when I set these slides out we were looking forward to then dropping down out of our commissioning orbit into our science orbit.

And at the time we were predicting November 14th we would drop our periapsis down to the science altitude keeping our apoapsis up high. And then we would take the second step down, finally into our science orbit on November 24th.

Well, things have gone very, very well in our commissioning orbit. And so things moved a little faster. We have already dropped our periapsis down. That happened on November 10th. And we anticipate doing the final step down into our science orbit on November 20th. So things are going well.

Moving onto Slide 34. Let's talk a little bit about one of the fun things that happened during the commission phase -- and that was the demonstration of lunar laser communications. So there was the laser terminal on board LADEE itself talking to three ground terminals. The primary one was at White Sands, New Mexico. And secondary stations were in the San Gabriel Mountains in California and Tenerife on the Canary Island.

So moving onto Slide 35. You can see a diagram of how this works. On LADEE there's a 10 centimeter aperture telescope with a .5 watt laser that would communicate to the ground. On the ground station you had a series of four 15 centimeter aperture telescopes that would shoot a 10 watt laser. Those were the signal up to LADEE. And then there four 40 centimeter telescopes that were the receivers to receive the information from LADEE.

So LADEE could send information down and successfully send information at 622 megabits per second and it received information at 20 megabits per second. It worked very, very well. So lunar laser communications has been successfully demonstrated.

Moving onto Slide Number 36. This is getting up to an exciting time now with these science operations of LADEE. And there are ways that amateur astronomers can directly participate in the science of the mission. Now recall that one of the sources for the lunar atmosphere is meteoroid impact slamming into the moon.

We are very interested in understanding just what - how important a role those impacts play. And amateur astronomers are uniquely positioned to be able to do this because the flashes from meteoroid impacts on the Moon are best observed with 8 to 14 inch telescopes -- something that is very common in the amateur community.

And so we'd like to establish a network of observers around the world watching the Moon during the course of the LADEE mission so that we can compare impact events with any changes that LADEE's instruments see in structure and composition of the lunar atmosphere.

Moving onto Slide Number 37. You can see that the minimum system requirements -- we wanted eight inch telescope that was tracking the Moon, an astronomical video camera -- doesn't have to be anything very expensive or fancy. A lot of - some of the security cameras are turning out to be the best options. -- a digitizer to take the analog signal and digitize it for your computer, and a computer to store the video file.

We also want to have a time encoder so that we have accurate time stamps on the video so that if there is an impact, we know exactly when it happened. And we are able to provide free software that you can use to analyze your video to, in fact, see if there are impact flashes.

So going onto Slide 38. You can see the schematic of a typical system here. The telescope with a video camera, the signal from the video camera gets joined by the time signal from the GPS system. That combine signal goes to an analog digital converter that has been - and then that is stored on a computer for later analysis.

Moving onto Slide 39. When you look, well, phase actually matters. You don't want to - you see these flashes against the dark portion of the Moon -- the night time side of the Moon. So obviously looking around full moon is not a good idea. Looking around new moon is not such a good idea either because, well, the Moon is not in the night time sky long enough to make observations.

Quarter moons are pretty much ideal, but not all quarter moons are created equal. First quarter moon versus third quarter moon -- during the first quarter moon you're actually looking at the leading edge of the Moon and so are more likely to see impact flashes.

Looking at third quarter, you're looking at the trailing edge and so you're less likely. Even so, we'd still like you to look because we see these impacts regardless of whether it's first - near first or near third quarter.

On Slide 40 you see an example of one of these impacts. This was taken by an amateur astronomer (George Barrow). And flash and the video loop that you see in the lower right is probably something about the size of a walnut slamming into the surface of the moon.

Slide 41. Well, this is all good and well if you happen to have a 8 to 14 inch telescope with video camera. But there are a lot of people out there who don't, who would still like to participate. And they can. As it turns out, the majority of impacts striking the Moon are actually very small -- on the order of one micron in diameter.

And you would never see an impact flash from something that small from here on earth. However, because the Earth and Moon travel together through space, they encounter these strings of debris together. And when even a small piece of debris hits the earth's atmosphere, it lights up the sky as a meteor. The typical meteor that you see in the sky is caused by an object typically about the size of a grain of sand.

So by looking up in the sky and counting meteors in the Earth's night time sky during the course of the LADEE mission and seeing how that number varies from night to night, we can then make inferences as to what is happening on the surface of the moon at that time.

So by doing meteor counting you can actually contribute to the science of the LADEE mission. The beautiful thing about counting meteors is there's virtually no equipment requirement. You do not need a telescope. You do not need binoculars. You do not need hardly anything at all -- although we do recommend a lawn chair. You might as well be comfortable.

And as of the case with almost everything these days - moving onto the next slide, Slide 42 -- yes, there's even an app for that. NASA has come out with meteor counter. It works on an IOS and on Android and your Smartphone knows where you are, it knows what time it is. So you take this app out and you look up at the sky and you start tapping the screen whenever you see a meteor.

Tap on the right side for a bright meteor, left side for dim meteor, in between for an in-between meteor. It records your count and at the end of your observing session, uploads this information to NASA.

Continuing on. We are now on Slide 43. And we can see some of the meteor showers that are going to be happening during the course of the LADEE science mission. As you'll also notice, the Moon -- in a number of cases -- is not real favorable for us.

The waxing crescent in - for the quadrant is pretty thin. Other than that we've got a great big bright moon. But even so, even on nights when there is not a meteor shower going, folks in NASA's meteorite environment office have been looking at these meteorite impacts on the Moon with a 14 inch telescope. They're typically seeing five sporadic impacts a night. That's, you know, outside of meteor shower activity. So, again, it's good to be watching even when there is not a shower.

Continuing on to the next slide, Slide 44. Radio observations of meteors -- this brings up an interesting point. Even when the sky is bright or cloudy you can still do meteor counts. You can even do them during the daytime through amateur radio, ham radio operators have known for a long time that meteors -- as they come in -- leave an ionized trail that actually reflects radio signals and they can actually hear a meteor through listening on their ham radios.

And so you can do counts of radio meteors. An advantage of this, again, is lighting conditions, weather conditions, doesn't really matter.

Moving on to Slide 45 though we see that, again, there is a preference -- you'll detect more meteors listening between midnight and noon than from noon to midnight because, again, you want to be on the leading edge of the Earth as it moves through space.

Slide 46 we see that there are a number of daytime showers -- showers that you can only detect via radio. These are very, very, very poorly characterized. So this is a really interesting opportunity to learn something more. There are probably a number of showers out there that we don't know about. So if you are a ham, if you are into amateur radio, this is also an opportunity for you to participate in the science of the LADEE mission.

Continuing on. Slide 47. As you interact with the public as the Night Sky Network so ably does, one of the things you may want to let the public also know about is a wonderful new way they can explore the Moon through the Lunar Mapping and Modeling portal.

This is a Web site that they can go to and get the latest information from LRO and from a wide variety of probes. And in very, very fine detail conduct their own explorations of the surface of the Moon.

Moving onto Slide 48. An exciting thing is that they've just come out with a mobile version of LMMP -- of the Lunar Mapping and Modeling Portal -- this is called Moon Tours and allows you to explore the Moon from the comfort of your own mobile device.

Right now it works on IOS. We are anticipating - in fact I'm beta testing right the Android version. So we're looking forward to that coming out. So with that we'll open it up to questions and go from there. Thank you.

Coordinator: Thank you. If you would like to ask a question, please press Star 1 at this time. That's Star 1 for questions. Record your name slowly and clearly when prompted. That's Star 1 for questions. One moment please. All right. Our first question comes from (Darian O'Brian). Your line is open.

(Darian O'Brian): Hello Brian. That was an excellent presentation. Thank you very much. I really enjoyed it. I have a question for you. Two questions. One is the ability to interface the timing coder, if you do have a telescope with a video camera hookup, is there any software required to do that? Or any suggestions you have? I've never accomplished that piece of the puzzle on your example of lunar impact monitoring system configuration.

And the other question is how do you get a hold of the Lunar Scan software that's available to free download?

Brian Day: Very, very, very good question. In terms of getting the Lunar Scan software - if you go - if we look back on Slide 36 -- which was when we first introduced the meteorite impact observation campaign -- there is a URL at the bottom. It talks about how to get involved.

And so if you go there, it'll take you to (unintelligible). Basically massive Meteorite Environment Office has a download of the software. So you can get it for free just by following the links. There's actually several links to go follow here to get a wide range of information.

Now there has been some changes lately with regards to the time encoders. And currently probably the recommended time encoder is the IOTA BTI. And this is something that is used very commonly by our friends who do oscillation timing. Maybe some of you are involved in this.

And this is a nice self-contained little unit that takes and input your analog video stream and it will then add the time encoding to the proper channel of the video stream that's already been establish. So no, you don't need any special software.

And then that video signal comes out of the output of the time encoder and plugs into the analog digital converter. So take a look at the IOTA BTI for your time encoding.

(Darian O'Brian): Thank you.

Brian Day: You bet.

Coordinator: Our next question comes from (Carol Kiley). Your line is open.

(Carol Kiley): Hello Brian. Early on you mentioned about water being in the magma. Can you explain that a bit more?

Brian Day: Yes. We initially thought that the magma was going to be exceptionally, exceptionally dry. And sure enough, a lot of it was. But let's start out with some of the samples that brought back by the Apollo 17 astronauts -- you may remember Apollo 17.

One of the things that they discovered as they were wondering across the surface of the Moon was this very strange orange soil.

(Carol Kiley): Oh. Yes. Yes.

Brian Day: And they gathered that up and it turned out to beads of volcanic glass that had been erupted in fire fountains. And when they brought that back, of course, they analyzed the water content in those beads and it was very, very low.

But you expect that because, well, if you're erupting magma in a vacuum -- even if there were lots of volatiles in that -- they would outgas very quickly. But inside those little beads there were these tiny little crystal (em cations) -- all being crystals that have formed deep beneath the surface before this lava was erupted.

And as these cases formed, they encapsulated some of that deep magma. And just within the past three years the technology was developed to actually go inside those tiny little magmatic inclusions and actually sample the magma that had been encapsulated in them and protected from outgassing.

(Carol Kiley): Oh my.

Brian Day: And to everybody's surprise, the water content in that magma is essentially the same as the water content that we find in lava that has erupted here on Earth in our mid oceanic ridges. Nobody saw that coming.

(Carol Kiley): Wow.

Brian Day: Yes. The Moon still continues to surprise us. Great question. Thank you.

Coordinator: Our next question comes from (Lynn Zalinksi). Your line is open.

Brian Day: Hi (Lynn).

(Lynn Zalinksi): Hi. I have two questions. One is are you familiar with Radio Joe and is it possible to detect the meteors in our atmosphere through Radio Joe? And my second question goes back to your beginning of your PowerPoint where you talked about the rays of light coming off the atmosphere of the Moon as seen by the Apollo astronauts. And I was wondering if there were any actual images of that captured.

Brian Day: There - so going with your second question first, we have verbal descriptions and we have actual sketches. The most famous sketch was done by Gene Cernan. Now there were some photographs taken and if you look at the photographs you don't see very much.

But the situation is what I consider to be analogous to what many of you may be familiar with in terms of the Gegenschein. And for years, and years, and years, and years people would look up and they would, you know, from a dark sky location you'd look up in the sky and you would see the Gegenschein.

And people had an immensely hard time photographing the Gegenschein. Now more recently with the really high powered CCD cameras that's become easier. But for a long time the Gegenschein was far easier to see than it was to record on a camera -- especially a film based camera.

Keep in mind film based cameras are what we had aboard Apollo. And so what the astronauts were able to see actually ended up being far greater than what they were able to photograph. So there has been some analysis done of some of those photographs and there may be something there.

But we want better information. And so by flying down through that dust and sampling it, you know, if it's there we're going to find it. So that's - we're going to try to answer this mystery from Apollo with the LADEE mission.

In terms of Radio Joe, yes I am familiar with it. Now whether or not you can do that to detect meteors -- possible. It depends on, I guess, the frequency you're attuned to because what we want to listen to actually are terrestrial signals. We're using what's called forward scatter detection of meteors.

So what you typically want to have the situation be is that you're attuned to the frequency of a transmitter that you do not have a line of sight to that is over the limb of the Earth. And so you would normally not be able to hear that signal, but when the meteor occurs and creates that trail, then you can get a bounce - an indirect path from the transmitter to you antenna.

Now in the case of Radio Joe, if you're normally using a line of sight detection of your source and you're tuned to a frequency that may not correspond to a transmitter that's just over your horizon. That doesn't mean that it couldn't happen. I've just heard that this is done commonly amongst the radio amateurs. In fact they actually use this technique to be able to talk amongst each other over distances that they normally would not be able to.

But it'd be interesting to see if Radio Joe could be somehow used to do this. That's an interesting thought (Lynn). And I have not thought of that before. Thank you.

David Prosper: Okay. We have time for one more question and then we're going to have to wrap up.

Coordinator: Our next question comes from (John Cox). Your line is open.

(John Cox): Thank you for that interesting talk. I have a couple of questions. Was the operating altitude for your spacecraft governed by orbital mechanics or was it science? And the other question is could that plume you described that extends from the Moon, can it be detected in Earth orbit or is it too thin to be detected?

Brian Day: Great question. So our orbital altitude is determined by science. Now, but yes, orbital mechanics does play a role. We are tied to the laws of orbital mechanics, but fortunately because the moon has such a thin atmosphere we can get down as low as we want. So we are going to start in this 20 to 75 kilometer range. But eventually, as we approach mission end, our orbit will degrade and we will continue to collect information all the way down to the surface.

We're operating in the 20 to 75 kilometer range. That should give us good access to the lunar atmosphere and lofted dust if it's there. But in operating around the Moon you have this really weird lumpy gravitational field -- the mascons that you have heard about -- and those definitely act to degrade your spacecraft's orbit.

And the lower you are, the more it will be degraded. So in order to carry out - have 100 days for a science mission we want to stay for as long a period of time in that 20 to 75 kilometer range. Otherwise we'd be burning our fuel to boost ourselves up so frequently that we would have a far shorter science mission.

Please remind me again of the other part of your question.

(John Cox): I was just curious about the plume, the atmospheric plume.

Brian Day: Yes, yes, yes. So the tail.

(John Cox): It extends from the moon. Can it be detected in Earth orbit or is it too thin to be detected?

Brian Day: It has even been photographed. In fact, it was discovered photographically from here on the surface of the Earth. There was a team that was out of Boston University that was actually studying the sodium plume around Jupiter. And so they had a special camera - they had a camera with a special filter that was isolating the light of sodium.

And they were looking at this glow of sodium around Jupiter in a very wide, wide angle camera. And interestingly one night this bright blob kind of went through their field of view and they thought what in the world was that?

And it turned out that that bright blob was actually in the anti-lunar position. It was essentially - the Moon - we were at new moon phase. And so directly opposite the Sun and the Moon you have this bright patch that was going through the sky.

What that meant was that we were passing through that tail and looking down the tail directly away from the Moon and the Sun. Because we're looking right down the tail, the column density was high and we were actually able to see it.

So it has been detected by professionals. What I would love to do would be see the first amateur image of this phenomenon. Again, you would need, you know, a narrow filter centered on sodium. That's typically a line we try to avoid because of street lights, but those filters do exist. And getting away from the lights and having a wide angle view, you know, someone is going to be the first amateur to get that image. And boy, I'll be very excited when I see it.

Does that answer your question?

(John Cox): Yes sir. Thank you so much.

Brian Day: Thank you.

Dave Prosper: Awesome. That's great. That's all the time we have for questions this evening -- and they were awesome. So thank you Night Sky Network members for your excellent questions and a huge thank you Brian for giving us so much of your time and your excellent presentation.

But before we sign off, let's have a drawing for our prize -- the signed copy of How It Began as well as a copy of the gorgeous Astronomical Society of the Pacific's calendar. Operator, can you remind us how to queue up? We'll take the lucky seventh caller.

Coordinator: All right. Once again, in order to queue up you only need to press Star 1. That's Star 1. One moment.

Dave Prosper: And while we wait, I'd like to thank the Norton Books and the Astronomical Society of the Pacific for donating our prizes for tonight. And I am here actually downloading some of those lovely apps Brian was demonstrating early. I'm looking forward to trying them out over the next few weeks. So thank you again Brian for that.

Brian Day: Glad you're doing that.

Dave Prosper: As long as my girlfriend doesn't see my phone. She already makes fun of me for how many apps I have on there anyway.

Coordinator: All right. It looks we have a winner.

Dave Prosper: Awesome.

Coordinator: (Ron Konkley) your line is open.

(Ron Konkley): Hello.

Dave Prosper: Hi there congratulations.

(Ron Konkley): Thank you.

Dave Prosper: You're welcome.

(Ron Konkley): I've listened to a number of these talks and I find them very, very interesting. I continue to encourage other people to listen to them too.

Dave Prosper: Cool. Thank you so much. Just send me an email at dprosper@astrosociety.org or the regular Night Sky Network email. And I will get your shipping information and get your prize sent to you ASAP. And thanks again and congrats.

(Ron Konkley): Dprosper at what was that?

Dave Prosper: Astrosociety.org.

(Ron Konkley): Astrosociety.org. Okay.

Dave Prosper: Awesome. I look forward to it. And excellent. And that's it for tonight. Congratulations and you can find this telecon along with many others on the Night Sky Network Web site under Astronomy Activities. Just search for telecom.

Tonight's presentation with the full audio and written transcript will be posted by the end of this week. Good night everyone and keep looking up.

Brian Day: Thank you very much.

Coordinator: That does conclude today's conference. Thank you for participating. You may disconnect your lines at this time.

END