The James Webb Space Telescope (JWST): A new window to the infrared Universe – Transcript of audio

Hello, everybody.

Please stand by for realtime captions.

Hello, set the volume on your phone or computer speakers. We will get started in five minutes. Hello, for those of you who just joined us, the opportunity to set the volume on your phone or computer speakers, we will get sorted into minutes. Hello, everyone, welcome to FDLP Academy, my name is Donald Sensabaugh, today's webinar is entitled the The James Webb Space Telescope: A new window to the infrared Universe , a presenter today is Lewis Barbier, a PhD scientist experienced analyst list with over 30 years of experience. He serves as an adviser to the masses chief scientist. Prior to his prior current position, he was at the Goddard space flight Center, measurements of solar particles, radioactive nuclei and GammaRay burst. He holds a PhD in physics from Louisiana State University. He has worked on seven spaceflight instruments and has over 13,000 vacations to his public published works. Before we get started with the webinar, Louis is going to be sharing his screen press, when that happens, the chat is going to disappear. To reactivate the chat, there is going to be a blue bar at the top of the screen, Chet is going to be the fourth option from the left unmet blue bar, click it to reactivate the chapter for that, I will handed over to Luis. Louis, you are muted.

Can you hear me now?

Oh, great, thank you. Let me share my screen. Great, thank you for that introduction, I hope I am on the right page. Let me check real quick. No, I am not, hold on. I apologize for the short delay here to get going. I want to share my screen, okay. That is not working for some reason, hold on. Why is it not working? I can't advance to the next slide. Why not? Why can't I advance my slides, all of the sudden.

Your sharing your screen and have your power point open, it should work.

They are not working, I agree, they should work, but suddenly, they are not working. I apologize for the delay, I thought we had this worked out last time.

Did you have your one slide that you sent me in advance or your whole slide deck?

I have the whole slide deck. There goes! Can you see that now?

You are not sharing anymore.

Oh, okay, hold on. I apologize, this worked so smoothly the other day. View, share, my desktop, can you see my desktop now?

We can see your present -- there we go!

Is that correct, you can see my second slide?

That is correct, we see contents.

I need to turn my video off, I don't want the distraction. Give me a second. Stop sharing, go back here, let me do my introduction first. Thank you very much, I apologize for that kerfuffle, like you very much for the opportunity to talk to this group today about the NASA James Webb Space Telescope. It's really exciting, a fantastic and amazing and wonderful mission. One of the best, most advanced space telescopes that NASA has ever produced. It is doing amazing science, I am happy to share that science with you today. As you all heard, in the introduction, I have been at NASA for about 35 years now. My particular background is in hard x-ray and GammaRay astronomy, but I am happy to talk to you about the infrared universe as seen through JWST today. My particular involvement with JWST goes back about 15 years. When I left my research job at NASA Goddard space flight Center and I went to NASA headquarters, where I am now, one of the first missions I was assigned to for tracking was James Webb Space Telescope. I stayed with that mission for about four years until they had their replan in 2011, and I am really excited to share and see what has happened in the last 11 years. This mission got off the ground and began doing phenomenal science. Thank you all for that. I am going to go ahead and turn off my video, you won't see that annoying hash box on your side and you will be distracted by my background or, since I am at home, my dogs and cats wandering in. Potentially, at the wrong time. It might improve everybody's bandwidth, so I am going to go ahead and turn off the video and I will turn it back on later. I think my talk will take about 40 minutes, maybe a little bit longer, there should be plenty of time for questions at the end. Thank you for your being here and let's talk about JWST! Okay. Okay, thank you very much and let's just go ahead and get started. First of all, I'm going to talk, first, a little bit, I'm going to show her to two video clips. The launch, what happened shortly after lunch, and how this whole mission gets going, so to speak. And then we will talk a little bit about infrared light, this is an infrared focused mission and we will see what that means and how it is different, for example, from Hubble, which I'm sure most people are familiar with. Hubble has been in space since 1990, returning fabulous images. Mostly in the visible light, James Webb is entirely focused on infrared and we will see what that means in a little bit. Then, we will talk a little bit, what was James Webb designed to do? What was the point behind it? What was the science it was trying to do and we will see, what has it done? How does what it has done compared to what it was supposed to do? I think you'll find that you will see, it is doing everything it was supposed to do and even more. First of all, I want to go ahead and share a little video, a short little video about the lunch. There won't be any sound for these two little video clips, I will talk over them and narrate a little bit about what is happening. Don't worry if you don't hear the sound from the video. Let me go ahead and do that. This is a little video clip, this is from the European space agency spaceport, which is in French Guiana in South America. This is the area in five lock-in, you see, that is the capsule in the top, the James Webb space telescope is folded up using very, amazing, complex mechanisms, folded up and that capsule. And getting ready for launch here in a few seconds. It is one of the most reliable launch vehicles on the market. We are very happy that our European colleagues provided this rocket for us and here goes! This is Christmas day, 2021. Just a little over 13 months ago. Kind of, a cloudy, cloudy day, but that's no reason to stop the launch. Beautiful launch, it went exactly as planned and, maybe, even a little bit better than planned, let's say. You can see, beautiful takeoff through the clouds, carrying the instrument, you can see the excited people there. In the control room. December 21st -- December 25th, 2021. Go back to the next slide, then. Is may not be as smooth as it should have, I apologize. A few days after the launch, things really start to happen, as I said, the spacecraft is all folded up inside of that nose cone of the rocket for takeoff. Somehow, it's got to get opened up, it's got to unfold, so here's a nice little video that shows a little bit about the unfolding and deployment of the different parts of the spacecraft. Just about a little bit over a minute and a half, so here is the folded up James Webb Space Telescope, you can see, the mere folded over in the middle. All of the pink stuff that you see here, that is the cover on the sunshield and you can see, a few days after launch, the sunshield begins to open up. The two different wings, coming down, on either side.

And then, in the center, you will see the instrument in the mirror segment rise up out of the spacecraft, you will see a radiator to play on the far side, you see this pinkish, purple color cover over the sunshield gets thrown away and you see these booms start to extend, first on one side, then on the other side. These booms are actually pulling the sunshade out of the spacecraft, out of the configuration. You will see it keep stretching out, all the way to the other side and then, there are 139 separate actuators which deploys the sunshield and tension this giant sunshield. This launch sunshield is five layers, it is, the other layers are 1000th of an inch thick. The other four layers are each thousandth of an inch thick, you saw the mirror unfold. The mirror comes in three segments and unfolds to make the final composed mirror. And the other optical elements deploy. If we go forward, let's just go forward a little bit. Here's a little bit of what it looks like after all of those deployments happen, after the sunshield is deployed and the optics are deployed, this is what it looks like from two different views. There is a hot side and a cold side, the sun facing side, would you see here on the right, this is the bottom of the sunshield and this is where the guts of the spacecraft are, you can see the antenna for communicating with Earth. You see the star trackers on the bottom and there is a steering and control mechanism and power systems all there on the, sort of, the hot, son facing side. On the observing side, you have the optics, the large mirror, and the instruments. The son facing side, that is about 400 degrees Kelvin, that's about 260 degrees Fahrenheit -- centigrade, Fahrenheit. 260 degrees Fahrenheit. On the cold side, it's about 40 degrees Kelvin, that is 40, that is about 390 degrees Fahrenheit. It is quite a difference in temperature, that sunshield does a remarkable job of keeping instruments passively cold, we will talk about the instruments in a second, but the idea is to keep the instruments passively cold because we want to see infrared light. And that is disturbed by any other heat sources that might be around. There is one other instrument on here which requires even more cooling and so, there is a separate cryo- cooler, which actually cools one of the instruments down to about seven degrees Kelvin, which is about -477 degrees Fahrenheit. The way this works, the son facing side always faces the sun and the observing side always faces away. We will see a little bit more about that in just a second. Let's talk for a minute about the mirrors. Here's the Hubble mirror, for comparison. Excuse me, let me get a sip of water. So the James Webb Space Telescope is composed of 18 hexagonal segments. The entire mirror is 6.6 meters across, that forms a, sort of circular shape. There's a hole in the center where the light comes through and reflects to the secondary optic. For comparison, the Hubble mirror, which is about 2.4 meters in diameter, the segments on here, each segment is individually adjustable and adjusted. It has three actuators on the beak of each segment, so the mirror can get the exact, final shape we need for the beautiful images that you're going to see. The mirrors are coded coated with gold, gold is the best material to reflect infrared light, the coatings on the mirrors are about 1000 Adams thick, so pretty thin coatings. Let's talk for a second about the science. The actual guts of the thing, so to speak. JWST has four instruments on board, near Speck, FGS, and Mary. The NIR in the first three stands for near infrared, so Louis NIRSpec spreads it out into its constituent wavelengths, much like a prism spreads out the light, the sunlight onto a piece of paper. As a poster and spreads it out into red, orange, yellow, green, blue, et cetera. The NIRSpec is the spectrometer instrument. You will see some specter from NIRSpec later on. FGS is the fine guiding sensor. It helps the instrument point very stable and, very case carefully at the objects that are being observed, the NIRISS is a sleepless spectrometer, so NIRSpec, the way it works, a slit with the light that comes through, that splits the light into the spectrum. NIRISS is a different spectrometer without a slit and it can take multiple spectrums at the same time. Is another spectrometer on there, NIRCam in the upper right, NIRCam is the camera for James Webb Space Telescope. It is the primary imager and it can deliver really high resolution imaging for a whole host of investigations and it can be used to track the motion of exoplanets, for example, or orbit around stars. Those three instruments all operate in the near infrared, hence the NIR in the names. Then we have MIRI, the mid infrared instrument. Still infrared, but longer wavelengths. We will see in a little bit a little bit more about infrared light and what that, perhaps, means. Where in the world is James Webb? Here is a little graphic, you see the sun and the earth and the moon, out beyond the Earth's orbit, you will see this thing called L2, that is a stable point called the Le Grand point and JWST will be orbiting around this point for its entire lifetime. It will be tracking around, staying away from the earth and away from the moon. It is oriented so that, as I said before, the hot side of the spacecraft always faces the sun. Keeping that heat away from the delicate instruments and the cold side always faces away, out into deep space. At any given time, -- oh, by the way, this is from the earth to the orbit of James Webb, it's about 1 million miles, just under 1 million miles, roughly speaking. At any given time, JWST can see about 39%, maybe 40%, of the sky at any given time. That, hopefully, orients you to a little bit where JWST is. This is not to scale, of course. What is infrared light and why do we want to look at it, as opposed to say, Hubble, which is mostly in the visible. The main point is, looking at different parts of the electromagnetic spectrum, you can see different things. Here's a good example. On the left-hand tide site, you have images of meerkats and a freshwater crocodile, you have the same images on the right with infrared. If you look at the infrared pictures, for example, you see these meerkats and they seem to be glowing, just coming right out of the page, so to speak, at you. So much brighter than the background. That is because of the high metabolism, these animals have high metabolism, generating a lot of heat. That's exactly what shows up in these kinds of infrared images. And you can see, from the scale on the right, at their hottest points, they are right around 38 degrees centigrade or right around 100 degrees Fahrenheit. They are, sort of, human body temperature, so to speak. And then, you can compare that to the image on the far right, which is the crocodile, the crocodile has just been in a warm body of water and has come out and sat on the ground and now it is cooling off. So you can see, from the scale on the right, it is not glowing, of course, it's a reptile, it's not glowing like that meerkats. It's cooling off. So it is, sort of, in that mid temperature range, somewhere between 50 degrees Fahrenheit and 100 degrees, it's probably in that 60 to 70 degree range and it is cooling down. You can still see it, but it is definitely not glowing like the meerkats are because they have such a high metabolism. Here is, kind of, a limited little bit more about where infrared fits on the electromagnetic spectrum. On the very far left, you have the GammaRay, x-ray world, the super high energy energetic phenomenon. Then, you have the visible light part of the spectrum, that's the part that Hubble mostly focused on, Hubble did have a little bit of a, sort of, a bleed over into the infrared area with a little bit of overlap with JWST. On the far right-hand side, you see the Spitzer space telescope, that was an entirely infrared mission, it covered the very long infrared wavelengths, almost out of the microwave. On the very far right, you have the radio waves, then, JWST fits really nicely into this gap between Hubble and Spitzer. It covers all of these infrared intermediate wavelengths from visible up through the, sort of, 28 to 30 micron-ish infrared wavelength, 28 to 29 microns. The beauty of infrared is that is is not blocked by rest, visible light, as you know from your everyday life, I visible light does not penetrate through dust, through clouds, through deeply debris, infrared light can penetrate those things, so we can see all kinds of events and things that we could not see if we were just looking in the visible. We will be able to see cool stars, which may not be in visible in other ways, we will see warm planets, that will give us a new window on the world, compared to Hubble, for example. Again, one more example, here is the -- nebula, just for comparison, visible light on the left, you can see big red clouds, you don't know what is inside them, but if you look in the infrared, right there in the middle, well, you can see so much more detail. Compared to the image on the left. I mean, I think it is pretty obvious how much more you see when you move into the infrared, compared to just looking in the visible. It's just a really fantastic window on the universe. One of the real goals of JWST is to understand the early universe, the very earliest parts of the universe. When you see the very earliest -- we believe the universe created in this Big Bang about 14 billion years ago and the very earliest stars and galaxies started to emit light and when that light started to travel toward us, it's coming toward us at the same time that the universe is expanding. You know, the universe is now just huge, so as the universe expands, this light expands with it. The visible light that was omitted from these early stars, these early galaxies, it stretched and stretched and stretched, so the time it reaches us, it's no longer visible light, it infrared or microwave or radio. JWST will focus on this infrared relic light, which has been stretched over time, and JWST will go back about 13.8 billion years to the very , very earliest parts of the universe. That is one of the main things that JWST is designed to do. JWST has multiple science goals, but there is about six or seven things, what was the universe like shortly after the Big Bang? What are the, kind of, characteristics of the galaxies back in the early universe? How do galaxies, kind of, evolve over time as the universe evolves? How do stars form? We will be able to see, and these dense, for starforming regions, we will see how more stars are forming, how they live, how they die. We will be able to see around all the dust around planets, around exoplanets, get close up views of our own asteroids and moons and planets. And then, look at planets in other exoplanet systems. We know of lots and lots of exoplanets now and JW ST will be able to help look at those in great detail. We will also look at really energetic phenomenon from a different point of view, look at black holes and active galactic nuclei. How do they go? How did they interact? What happens today to them after their life? There's a lot of things that JWST is expected to do. In the early universe, there was a time when, you know, everything was neutral, there was no way for, really, like to get through, everything was okay.

The far left here, on the set of diagrams, on the fire right, that is where we see the universe today. Where we can see through the universe, we can see the stars and galaxies. So this is called the re-ionization phase and these two things in the middle, we don't know a lot about. How did the universe go from this dense, opaque space on the far left to the universe that we see today. And JWST is going to help us to understand this process and see how this whole thing evolved by looking at the first, earliest galaxies and the first earliest stars in the universe. Excuse me. This is a Hubble picture of one of the earliest galaxies in the universe, it's 13.4 billion years old and JWST will be able to see galaxies even older than this. This is a fantastic, you know, result from Hubble, JWST will do even better. It will show us galaxies even earlier in the early universe. And then, we will be able to, sort of, make this, sort of, both of how galaxies evolve. This is one of the real, big goals that JWST can do, we can look at galaxies throughout their evolution of the universe and we can see how they form, how galaxies grow, interact and die. We will see some really nice, nice images from JWST in a few minutes that show all of this. In great detail. Finally, black holes, I already mentioned, JWST will be able to image very carefully, the material around black holes. The temperature, the speed of the material, the composition of the material, sort of, this feedback loop between the black holes and the starforming regions around them. These are some of the brightest objects in the universe, these quasars that are forming the active galactic nuclei of other galaxies and JWST will be able to tell us so much about them. Here is another example of a planetary nebula that we will see with JWST, you can see the enormous extra detail you get in the infrared, penetrating all of those dust clouds and molecular clouds in the visible. You can see so much more detail on the right. As these wins from all of these hot stars are just shining through and beautifully shining through. We will be able to detect molecules, where there are starforming regions, we will be able to detect molecules in between there. Look at the evolutionary lifecycle of SARS, evolutionary stages. Look at them in these dark cocoons, look at the cold, molecular clouds that are collapsing to form new stars. And look at all the material in between the stars, all of the interstellar material. Here is an infrared picture of Jupiter, we will be able to see things like, just like in our own solar system, understand Mars, it's atmosphere, mapping clouds on Jupiter, on Saturn, on urine is. Study season and weather on these other planets, there will be phenomenal information that JWST can do in our own backyard, as well as on other planets. Here is an example, this is an exoplanets system with four stars. You can see the stars orbiting around the central -- you see the four planets orbiting around the central star, which is blocked out. You want to block out the light from the central stars that you can see the planets, which are much dimmer, orbiting around. Let's see, in theory, I can draw an arrow. No, I don't see where my arrow is, but I would just stop there. Here, you can see four planets really orbiting around another star and JWST will be able to do phenomenal things like that. And we will be able to look at, this is the last, sort of, example, this is the atmosphere of earth. Of course, JWST will look at the earth, but it will be able to look at other planets and other solar systems and make spectrum just like this, not looking for just water, carbon dioxide or ozone or methane. We will determine what those atmospheres of those other planets are like. Here we go, that is, kind of, what JWST was designed to do, that was the background science and some Hubble and ground-based pictures of what JWST was designed to do. Now, let's look at some JWST images. This was the very first image, but was produced by JWST. It was released to the public in July of last year, this is a deep field and this little image contains thousands and thousands of galaxies. If you happen to see when this image was released, you might have seen administrator Nelson point out that if you took a grain of sand or a grain of rice, let's say, and you held it at your arm's-length and held it up in the sky, that is the size on the sky that this image contains. There are thousands of thousands of galaxies in this image. This is a cluster that is about 4.6 billion years old. It's a pretty old cluster, and what you see is, I wish I could get my arrows to work, somehow, --

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Louis, we can see your mouse, if you want to just use your mouse.

I might need help from the GPO people, how do I get my arrow for pointing?

Louis , we can see your mouse.

Try to use your mouse as a point of your

I think this is it, it shows up as the hash marks.

I lost my arrow again, let me try again, annotate. I apologize, I'm trying to get this little arrow so that I can point to things here. That's not working, where's my arrow? There it is. Okay. I apologize for that delay. Here, you can see, there's a galaxy cluster here, you can see, what I want to point out is all of these little arcs, you see these little orange arcs that are going around here. This little, sort of, ring of orange arcs out here, this is gravitational lens. This galaxy cluster here, these galaxies here, it's forming a cluster and that is imaging the galaxies behind it. This is what's called a gravitational lens. So this is just a beautiful example of the kinds of things that JWST can do. This is only a 12 hour image, and a similar picture I will show from Hubble took about two weeks and convened contained much, much less information. This is the same field of view on the left, this is the MIRI image of the same cluster, on the right is the NIRCam image. If you look at the MIRI image of the stents, galaxy cluster, you can see these different temperatures. The annotating doesn't work quite as well as I had hoped, hold on, how do I move this, let's see. If you look over here, in this MIRI image, you see things that are red and blue and greenish, of course, all of those things have different meetings, so the blue thing here, these are galaxies with stars and almost no dust. Lots of hot, young new stars and almost no dust in them. Very, bright, very blue. Compare that with the ones in orange, these are galaxies which are just loaded with dust, very heavily, very dusty. And then, you see the ones in green and yellow, those are rich in hydrocarbon, so those have some already involved evolution to them and they produce lots and lots of hydrocarbons. By putting all of these things together, you can start to understand, sort of, the history of this galaxy cluster, you can see the type of galaxies, you can see how these galaxies are all different. Is a really phenomenal example of the kinds of things that JWST can do. Just for comparison, this is the Hubble image of the same galaxy cluster. If you look you're on the right, this is the JWST NIRCam image, and this is the Hubble image of the same thing, Hubble took about two weeks, this took about two hours. You can see how much better JWST is at collecting lights than Hubble peer. Exoplanets, nothing can be more exciting than exoplanets. Excuse me. Is one of the other known exoplanet systems, it's known to have multiple exoplanets. We know about 5000 exoplanets exists in our Milky Way galaxies, from the Kepler mission. You see a beautiful example of JWST's exploration of one of those exoplanets purposes W.A.S.P.-90 6B. You can unequivocally absolutely see water in the atmosphere of this exoplanet. You take an image of the star, you take its spectrum. And then, when the planet moves in front of it, you take another image of the spectrum and then, if you subtract those two, one from the other, what is left is the spectra of the atmosphere. Unequivocally signs of water, there are probably clouds on this planet and further investigation will probably show us methane and carbon dioxide. Maybe, even other elements in the atmosphere. But we will be able to study the atmosphere, this is an example of what it can do for many, many, many exoplanets. Ones that we arty know about, this time type of -- spectrum allergy is really important. This is the most detailed exoplanet atmospheric spectra we have today so far. Nothing compares to it. We will be able to determine how much water vapor is in the atmosphere, the abundance of the elements in the atmosphere, carbon and oxygen, and the temperature of the atmosphere and its optical depth. That is a tremendous amount of data that we will be able to get something from this, it's truly exciting. Here is something else that is exciting. Beautiful southern ring nebula, it's beautiful to look at, incredibly complicated, lots and lots of information in here. At its heart, what you see here is a planetary nebula, it is a ring nebula. At the very center, again, let me pull up my thing for annotating. So I can point a few things out. Let's see if that works, nope. First of all, on the right here, we have a MIRI image, this is the longer wavelength over here on the left, we have the NIRCam image and over here on the right, I want to point out, at the heart of the system, there are two stars. There's a very bright young star here, which is the one you see here, shining here, here, you only see the one star. This star at the NIRCam wavelength, you can see the companion. But you can see it over here at the longer wavelengths, it is shrouded in dust, you can see that it is shrouded in dust. This companion, this older companion is what has created this nebula. It has blown off in a series of events, blown off its shell of different materials. Hydrogen and oxygen and carbon and nitrogen. It has just blown those off in different events and that is the material you see streaming out into the interstellar media here. The sort of, very complex form. These two stars are orbiting around each other, so you have this material just mixing together. What you see is, kind of, like a forest of material, something shooting through it going in this direction. Maybe, you can see it better over here. That tells you right away that there is more than just two stars here, there are a couple of other stars here, probably, at least for stars here. Maybe even hints that there are five, that are contributing material to this nebula and causing this very bizarre shape. What you see here over on the left-hand side, all of this, sort of, foamy structure here in the near camp NIRCam image on the left, that is molecular hydrogen and the inner blue region on the left, that is hot gas, hot ionized gas from the young companion star. And then, you will see these swirls of material on the outside, in the MIRI image, the blue that you see on the outside there, that is all hydrocarbon grains that are forming on dust grains that are being carried away from the nebula. In time, of course, all of this will dissipate and will evaporate into the interstellar medium and it will be gone at some point. It will just all disappear. It's a beautiful example of a planetary nebula, sort of, the power of JWST. Two, kind of, study this kind of system. We believe that the sort of analysis, the central star, the older star, the dying star, was about three solar masses about at its peak, now, most of its material has been lost and blown off into the surrounding nebula. This is a really complicated system, but a really beautiful system as well. Here we have one of the more famous galaxy clusters that is known about. This is Stephan's Quintet, let me see if I can annotate this as well. Let me get my annotation going here. If I can do this, so this is NGC 7320, this is much closer to us than the other four galaxies. Is about 40 million or so light-years away from us, these other ones are closer to 300 million light years away. JWST is so powerful, it can actually see individual stars in this galaxy right here, and even go down to the center of this galaxy. What you see here is a pair of interacting galaxies, this is 7318 a and B, you can see them colliding with each other, you can see the huge shock ways that are being thrown off as they collide and how they interact with each other. Then, up here, you have 7319 and you can see a huge PGN near the center, powerful admission from the center here. Huge shock ways, again, coming out from this galaxy as these all move together. It's a phenomenal image of a Galaxy cluster, a very famous galaxy cluster. This is the kind of thing that JWST will help us pin down. This AGN up here, by the way, is putting about as much energy, we believe, about 40 billion Suns. So 40 billion times the energy of our son is coming out of this AGN or this black hole at the center of this galaxy right here. Really, really an amazing system. Closes annotation. Here is another starforming region, like I showed you, the earlier one, the example of what we were hoping from JWST, here is what we are getting from JWST. This is the Karina nebula, a beautiful example of the process of star formation, off the top of this image, you don't see here is a whole bunch of young, hot stars putting out tons and tons of ultraviolet radiation and stellar winds. Those winds and radiation are blowing down into the nebula, eroding this nebula away, and the size of this thing, let me say something about the size of this thing. I'll get my annotator back here again. This little hill right here, this feature right here is probably about seven light-years tall, so the scale of this is enormous. All of this, sort of, haze that you see down here, coming off of the nebula, that is all dust and gas being blown away by the winds from the stars up here, off scale, that you can see. This intense radiation, coming down and blowing all this dust and gas away. On the flipside, this is where stars are formed and this material in the nebula wants to compress and wants to form new stars. So what you have here is a real, sort of, fight between the material being eroded away by radiation and winds from the young hot stars nearby and the new material that wants to collapse and form new stars. There is this, kind of, give and take between these two processes going on here. JWST will enable us to focus on regions like this and really see some great detail in what is happening and how these processes involve peer really phenomenal images. Just beautiful. A couple of more things, I think I'm getting near the end of my time, but a couple more things. This was recently released, the first exoplanets that JW ST has discovered. We arty know about 5000 exoplanets or so already, from the Kepler Andy test missions. Excuse me. This is a planet that is, sort of, like a gas giant or a Jupiter or Saturn in our system. It's about 365 light-years away from us, it's very close by, probably, about 20 million years old or so. The little stars in the bottom panels, the little stars are actually blocking out where the actual star is, the actual star is about 10,000 times brighter than the planet that you see here. Again, that shows the power of the technique that JWST can do. You see, in the NIRCam and MIRI images on the far left and far right, you can see how bright the planet is in the MIRI on the far right, how it shines rightly in the longer infrared wavelengths, so JWST will be able to study planets like this in great detail. We will learn so much about them that we don't already know. When you form planets, you are usually left with some stuffed left over, you have a debris disk. We have an asteroid belt, which is debris left over from the early formation of the solar system, we have the Oort cloud outside with a lot of other debris. Here's another example, this is a you microscopically and we know this system has two planets, exoplanets. This is about the size of this thing, the discs that you see, from one end to the other, they are about twice the distance from the sun to Neptune. So this is about twice the size of our solar system. You see all of this debris, two different short wavelengths, this is a NIRCam image. 4 1/2 microns on the bottom, you see a lot of detail and we can study the dust now in these debris disks and see how these debris disks interact with the planets and how they dissipate over time. It will be quite an interesting study. Galaxy evolution, which already mentioned several times before, it is one of the main things for JWST. Here's a zoo of galaxies, let's see if I can get my annotation back again. I can point out a few things. Here is the field of view, you see all of these different images, over here on the far right, you see this galaxy with a little tale, actually, stripping off is a little tale through this galaxy. Here's a whole bunch of red, old galaxies here. And then, this is, kind of, over here, this is a group of galaxies and in the middle, where that little arrow is pointing and where I am pointing now, that is a supernova that JWST has discovered now. Not know before, so that is a new discovery from JWST, a supernova right here in this cluster group. Here is a bunch of interacting galaxies, here's a whole bunch of galaxies like the Stephan's Quintet, like I showed you before, but maybe, even older. They are all red and dusty and collecting with each other. Here, you see an arc of galaxies, if you look in the second image. You see a whole bunch of small galaxies that look like they are forming an arc, so that is just really interesting, to see what has caused that to happen and are these all related to one another in some way? What's going on here? I guess, is something we need to look at in the future, going forward. This whole idea of galaxy evolution, as we go back in time to the age of the universe, that is going to tell us so much about what is happening. Let's see, thing of coming to the end of my JWST things. Right here in our own backyard, here's a couple of pictures of Neptune. The first image of Neptune we got from Voyager 2, back in 1989, you can see that. And then, you see in the middle, you see Hubble, a Hubble image of Neptune and on the very far right, here is the James Webb view. What you see, immediately right away, you see the rings. Beautiful rings around Neptune, which aren't available and immediately obviously in the other two images. See all of the clouds, the clouds, the bright omissions from the planet. You can see the clouds, possibly, Aurora, you can see the haze around the planet. Just remarkable detail and here is an even better view. In the bottom right-hand side, you see a view of Neptune and you can see seven of its 14 moons. You see there are six identified at the bottom, at the top, the large moon Triton, the largest moon. We know Triton has geysers, we have identified and seen geysers coming off of Triton, so we have every reason to believe it has a large, underground interior ocean. That will be a fantastic place to search for life, for extrasolar -- extra alien life, let's say. A beautiful result, right now her own backyard. We will be able to make images of Uranus as well, all of the outer planets, we will get fine detail on all of them. Two last little bits really quickly, to finish up, what is going to come after JWST? Just as a teaser, we have the Nancy Grace Roman telescope. It will have the same size mirror as Hubble, but 100 times the field of view. It is optimized for looking at dark energy, it can be able to scan the whole sky over the period of its time and it will really help us nail down what is going on with dark energy. That is the whole focus of that mission. It will be able to -- I think I've said it, it has the 2 1/2 meter mirror just like Hubble. After Nancy Grace Roman, we have the habitable worlds observatory, which looks a lot like JWST , in design, it is, in fact, it is even better. It is designed to look for alien life, it will be designed to focus on the 25 nearest known exoplanets. Which we have already identified and it will be able to identify an exoplanet even if the star that is orbiting around outshines it by about 100 million times brighter. So that is an amazing capability that is coming in the habitable worlds observatory. I think that is the end of my talk, thank you all for listening, I hope some of this has been of interest to you and giving you some of the excitement that the astronomy community has a JWST. I think, with the time remaining, I'm happy to answer any questions! You very much! 2 all right, Louis, can you hear me?

Stop sharing my screen, somehow. Let me do that. What's. There we go. Let me turn my camera back on, I guess. Can I do that? Yeah, okay.

Louis, can you hear me?

I'm hoping I can still be heard and, maybe, scene?

Louis, are you able to hear us?

I don't know if you can hear me, anybody have any questions or comments? Was that useful to this audience, did anybody find that interesting?

We can hear you, you can't hear us.

Hello, Donald, can you hear me? Hello, Donald?

Louis, obviously, I'm not sure what happened with our presenters audio, we can hear him, but he can't hear us.

It's unfortunate.

Hello?

We are going to see if we can get in touch with him, I'm going to send him a message.

Hello, can you hear me? Hello? Donald? Ashley? Can you hear me at all? What's going on? Can nobody hear me? Does anybody not hear my talk? Hello? Is there nobody there?

Doesn't seem to be able to see the chat either.

Hello? I can see the chapter

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did he hear me just now?

I can hear you!

There we go. Let me try and go to the questions really quick, I'm so happy you can hear me now. 2 I don't know what happened, I've been trying to talk to you for a while now.

It might have been the earlier issue, it might have come back in the middle of the presentation, we can hear you just fine.

You hold her presentation right?

Yes, behold heard the hold whole presentation. If you had a question that you put in while we had the ICU audio issue right now, please put them back in the chat. Where is the best way to find the latest archive data and images.

I don't have that right in front of me, but I can send that to you to distribute to this group later. There is a webpage at the space telescope Institute that has the latest stuff. I will find a link and I will send it to you, Ashley or Doug or both of you and you can distribute it to this group.

That would be fine, we can do that. The next question is going to be, how do you figure out the age of the galaxy?

The age of the galaxy, you study the age of galaxies by looking at the red shift. You can look at the cut typically, you might look at the, say, molecular hydrogen lines. By the amount of redshifts, you can determine how far away it is and by how far away it is, you can determine how old it is. There are multiple ways and that is just, probably, one way. That is, probably, the most common way.

The next question is, can these images from the James Webb Space Telescope be used to determine if there is a level of life on the exoplanets?

It can't determine life, that's what the habitable worlds observatory will be designed to do. What James led can do, it can look at the atmospheres of these exoplanets, excuse me, let me see if I can find my -- I'm trying to find my -- I don't know, can you see me? I'm waving my hands around, I don't know if you can see me or not, I don't know what's going on.

We can see you. We can see your camera.

JWST can look at the atmospheres of these exoplanets and determine what the composition of the atmospheres is , but that's about all it can do, is there carbon dioxide? Is there oxygen? Is there methane? That's about all it can do. None of those things by itself will tell you that there is life, but the habitable worlds observatory will focus on 25 of the really nearby exoplanets and it will be specifically defined designed to look for signs of life. Specific things that can only occur with biological processes. Unfortunately, I am not very knowledgeable about that, I'm not really a biologist, so I can't say much about those processes. But that is what habitable worlds observatory will be able to do.

The next question is going to be, do you have a timeline for the Nancy Grace telescope and the habitable worlds telescope?

The Nancy Grace telescope will be launched in 20 to six, the latest I heard was 2027, three or four years from now. The habitable worlds observatory, probably four years out of that, so 21 2031, something like that, there is no real timeline for the habitable worlds observatory, but the Nancy Grace Roman is definitely 2026, maybe, early 2027.

The next question is, how do you know before launch range of the spectrum the telescope will be able to detect?

You can only design what you can design, right? The instrumentation determines that, see you designed the instrument to detect what you can, right? What you are able to do within the region you want to study, for example, I showed early on, there was this gap between what Hubbell was doing and what Spitzer was doing. I'm not sure I can -- I cancel my can't show my side now anyway, I showed the spectrum and I showed, JWST fit really nicely in this in between region between Hubbell, which was almost all visible, and Spitzer, which is the really, very long wavelength infrared. And JWST covers the gap right in between, so from just a few microns up to about 28 or 29 microns. That is, kind of, the wavelength range. You design your instrument to cover that gap and then, you know, you see what you see.

I'm going to ask one more question, we are about out of time, though, if you could explain the galaxy for book a little bit more?

It's just an idea of, once JWST has made lots of observations, it will be able to, sort of, compose, kind of, a history of galaxies, right? You will have the nearby, sort of, galaxies that are close to us, not so old, then you will able to go back and back to these galaxies that have formed right at the 400 million years or so, right after the beginning of the universe. So we will be able to make this, kind of, evolution with something that will look like the evolution of the average galaxies or types of different types of different galaxies. Whether new things are young or new things are old, that is your perspective. It will be able to trace the ways that galaxies have evolved over the lifetime of the universe. To me, that is quite exciting, to see how that works out.

All right, we are at time. I would like to thank Louis Barbier for presenting this webinar, I would like to thank Ashley for doing tech support, please make sure you check out upcoming webinars. Another on prices and wages on February 9th, also if you have not, we have a link to our survey in the chat, please give us feedback on this webinar or any topics you would like to see us get presentations on. Thank you all so much for attending this webinar and have a great day!

Thank you! Happy to be here! All right, bye-bye!

Bye! [Event concluded] [Event Concluded]