

NWX-NASA-JPL-AUDIO-CORE

Moderator: Anita Sohus

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2:30 pm CT

Anita Sohus: Thank you. Welcome everybody to another of our monthly or more Hubble Science Briefings. We're very pleased today. We have the Impact of the Hubble Space Telescope Outreach Education and Culture. And to present is Dr. Mario Livio at the Space Telescope Science Institute where he's the head of the Office of Public Outreach and he's also a research astrophysicist. So he leads a terrific team back there at Space Telescope and I am now going to turn it over to him.

Frank Summers: Hi this is Frank Summers from the Space Telescope Science Institute and I usually host and so what I will be doing is as Dr. Livio goes through his presentation we'll pause after certain numbers of slides to ask for questions. So we want this to be a conversation not just a presentation where we're lecturing to you. We want to actually have a conversation with you. So please be ready to come up with some questions during the talk.

And so turn it over to my boss, Dr. Mario Livio. Mario.

Mario Livio: Hi. Hi everybody. This is Mario Livio speaking. So the way I designed this very informal presentation is I want first to give you an idea of the impact that

the Hubble Space Telescope has had on the public, on education, both formal and informal, and on culture if you like in general.

I will then spend a little bit of time just to show a few spectacular Hubble images because certainly these images are the things that led partly at least to this impact that I am talking about.

And then I'll describe very briefly one particular outreach activity that we conducted last year which was very interesting in many ways.

And I will finish just with a couple of things related to the current - the recent servicing mission that has just ended and with which we are of course extremely pleased.

So if I can have the next slide please.

Frank Summers: Okay moving to Slide 2.

Mario Livio: Yes. So basically I'm going to very quickly run through what the different branches of the Office of Public Outreach at Space Telescope are doing.

We have a news branch.

We have a formal education which is now combined with an informal education branch.

We have an online outreach branch.

And we also run the Origins forum which is doing things for a variety of NASA missions. It's about to end but proposals for new types of such a forum are currently in the hands of NASA so we are still waiting to hear what is going to happen with that.

Then I'll talk a little bit about what I call the "crossing the boundary" between science and culture in general and then I'll talk a little bit about what I call the "Hubble achievement."

So if I could have the next slide please.

Frank Summers: Okay Slide Number 3.

Mario Livio: So in terms of news then of course all of you have seen Hubble stories in the news. Our news office at some level drives much of the rest of the activities of the office in the sense that many things that start as news releases end up as producing education products, informal education products, certainly things for the web and so on.

And I just threw in there a collection of - a random collection of things that - where Hubble has made news. The news in particular we are of course proud of that New York Times - this was after the servicing mission that installed

the Advanced Camera for Surveys or ACS where four Hubble images made it actually above the fold on the front page of The New York Times.

Next slide please.

Frank Summers: All right. Slide Number 4.

Mario Livio: Yes I should have said that, you know, we are trying to get into a variety of new media as well. As you know as print media are somewhat disappearing we are doing a whole series of podcasts, of vodcasts.

We now have a blog on our website.

We Twitter.

So we try to use every single outlet that is out there in order to get the word on Hubble.

This particular metric that I describe here, the Greg Davidson Science News metric, is really only very one particular type of thing. There is a magazine called Science News and science stories appear there. Greg Davidson has a way to rank those stories on whether or not they are major stories or medium important stories or minor stories.

And he then gives a cumulative effect of all these stories in Science News. And this is presented for a variety of NASA missions. And you don't even have to see any particular numbers or anything just to see that the Hubble line which is the black line there in terms of cumulative effect is very very prominent and far above essentially all other NASA missions.

Next slide please.

Frank Summers: Well hold on. Before we go off of this slide Mario, this goes back like 30 years because I see Apollo and Viking and Voyager from the 70s...

Mario Livio: Right so...

Frank Summers: ...on that.

Mario Livio: ...it even includes some of these. I don't know why actually the years disappeared from this plot because on my original plot there were years but...

Frank Summers: Maybe it's a Mac versus PC issue. Sorry.

Mario Livio: It's possible yeah. Yeah because my presentation was for the Mac. It's probably that's what it is. Okay.

Next slide please.

Frank Summers: All right Slide Number 5.

Mario Livio: So Slide Number 5 shows now general news coverage on a variety of missions. Hubble is again the green line.

And there are two things to take away from this. Number one is that when you see these very sharp peaks in news coverage those are usually associated with servicing missions. In particular the last complete peak that you see actually, believe it or not is related to the cancellation of Servicing Mission 4 where many news stories were of course related. But of course you can see the start of the rise towards SM 4 and I'm sure that there will be another strong peak there.

But another thing to take is that, you know, if you follow even something like the purple line or for Cassini or something that usually they generate some peak of interest and then they kind of fade away. But with Hubble yes there are peaks in relation to servicing missions but actually the level remains high at all times.

Next slide please.

Frank Summers: There's a question that people I think would probably ask is to what do you attribute the continuing lots of news stories that we get over here? I mean because we're just well above the other places.

Mario Livio: Yeah well part of the thing is of course the longevity of Hubble because, you know, we may still get science stories that result from observations that were performed five years ago or - and so on. So it's not as if, you know, once you do something it's done.

And the second is the continued servicing of course introduces new capabilities and then you have a whole variety of new types of new stories and so on.

Frank Summers: So this is really one of the reasons for having such a general purpose observatory that can do many different things...

Mario Livio: For this particular...

Frank Summers: ...over many years.

Mario Livio: Yes. Next slide, Slide Number 6.

Frank Summers: Slide Number 6.

Mario Livio: So I move now into the area of education and here I did - kind of divided into formal and informal education although at the moment these two branches are really unified under one roof.

Now the situation here is the following. You see there are some tens of millions of students in the U.S. and the only way to actually get to these students on a continuous basis is to actually manage to get astronomy-related and Hubble-related information into their curriculum.

If you don't manage to get it into the curriculum then there is no way that these materials are going to be used or taught. Part of the reason is that as you may know under actually No Child Left Behind science was actually left somewhat behind and teachers don't actually teach things that are not needed for the tests.

So the only ways to get it into the curriculum and one of the sort of stealth ways that we have devised for this is to get even astronomy-related and Hubble-related materials into the reading requirements of schools. And the result of this, at this point, Hubble materials are present in all 50 states and in 42 out of the 100 largest school districts in the U.S.

So this is a very serious success here. We've reached over 6 million students and over 500,000 teachers and - in service and pre-service. That means sometimes the idea is to actually reach the teachers in their pre-service stage because then, you know, as they become teachers they're already aware of the existence of these materials and they use them as they become teachers.

Next slide please.

Frank Summers: Why don't we pause here and say does anybody on the telecon have a question for Dr. Livio?

Mario Livio: Okay. Let's move on then.

Frank Summers: All right.

Mario Livio: Slide Number 7.

So the map here simply shows places where it's not just that the materials are being used but actually we also conducted a variety of evaluations on how materials are being used and, you know, to what extent they are being effective.

I note here on the left-hand side that we are in the process of conducting a very special study as to how new technologies reach the age group 18-24. This is a relatively hard to reach age group.

And so we're looking a variety of things, you know, like YouTube, blogs, Second Life and so on, MySpace, MyFace, My-everything-that-exists-out-there, Twitters and so on because we want to - you know, as we do our strategic planning for what things to use and especially with the changing face of the media we want to be able to first of all not neglect any age groups but also find the most effective way of reaching them.

I should have mentioned that many of you probably know our product Amazing Space which is used by formal education on the Web. That is - you know, has won prizes and awards and is recommended really by every organization that has ever thought of space science.

There is a website which lists the - I forget something like 32 best websites to learn about space. Amazing Space appears as number one there. And HubbleSite which is our general website also is on that list.

Next slide please, Number 8.

Frank Summers: Slide Number 8.

Mario Livio: I'm moving now a little bit to informal education. So again the philosophy here is the same, namely, you know, you have something like 42 million people visiting museums and planetaria every year. The only way to reach those people is if you can get onto the permanent shows that these museums show.

And the product that we currently have that achieves that is a product we call ViewSpace. I'm sure that many of you have it or have seen it and so on. It's a self-updating series of things. It's self-updating from the perspective of the museums that have that. Of course there is a whole set of people here who do the updating.

And those currently exist in 211 I think was the last count I've seen...

Anita Sohus: Twelve.

Mario Livio: Two hundred twelve I'm just told. So museums and planetaria across the country again in 46 states, many many cities--very very successful. And of course a variety of other things as well.

Next slide please.

Frank Summers: Okay Slide Number 9.

Mario Livio: Yes. So this just shows a number of - so yeah the slide here on this says 210 museums as I said. It's 212 now. It's very difficult to actually update the slides at the rate at which the museums that participate appear.

You see a model of the James Webb Space Telescope as we put it on the Mall in Washington D.C.

And we had something that I will come back to as a special thing happening, an exhibit at the Walters Art Museum which I will come back to a little bit later in the presentation.

Frank Summers: Let me just pause you there because if you click forward to Slide 10 the images will appear in that Walters Art Museum...

Mario Livio: Yeah.

Frank Summers: ...image on the lower left.

Mario Livio: And I will talk more about that in a bit. So next slide now, Slide Number 11.

Frank Summers: Okay Slide 11.

Mario Livio: As I'm sure many of you know we are - well I hope that all of you know that 2009 was declared by the United Nations to be the International Year of Astronomy or IYA. And for that we of course are conducting a whole series of activities.

One of them is in the informal science arena where we created these spectacular panels called Visions of the Universe. There are 12 such panels.

Each one of them is devoted to a particular concept or topic but sort of very concise topic. And with text and images it tells the story of that topic or concept.

This traveling exhibit is exhibited currently at 40 libraries. And we just got funding to expand these to 30 more libraries because it has been so successful.

If we can go to the next slide which is Slide Number 12 you actually see these panels being exhibited in places ranging from Ontario, Canada to Topeka, Kansas and to Snyder, Nebraska which has a population of some 2000 or thereabouts I forget.

Frank Summers: I think maybe 5000 but yeah really small.

Mario Livio: Small place. I mean the idea here was actually in particular to bring this exhibit to places that don't normally enjoy the same type of serving, you know, that somebody who lives in New York City, you know, might get from a whole series of museums and so on. And so we designed it, you know, to go to libraries in small places where they don't have that much knowledge neither about IYA nor about space science.

Next slide please, 13.

Frank Summers: All right. Why don't we pause here for any questions.

Mario Livio: Okay.

Frank Summers: All right. No questions let's move on to Slide 13.

Mario Livio: So online outreach: many of you I hope have logged on to our website. To log on to this is just hubblesite, that's one word, dot org, dot o-r-g.

We get about 2.2 million web sessions per month, about 200 million hits per month.

Our website has won in 2007 the Webby Award which is given by the Academy of Digital Sciences.

It also got the People's Choice Award.

And in 2008 it again was recognized as one of the best websites for science.

Next slide please, 14.

Frank Summers: Slide 14.

Mario Livio: Again in the context of the IYA we had this spectacularly successful activity which we called You Decide where we have put on our web six possible targets for HST. None of those targets has previously been observed extensively by HST.

In fact four of them have never been observed at all by HST.

Two have been observed but very very short times.

We've put them there and asked people to vote. We got about 140,000 people voting on this even though the vote only lasted a few weeks.

They included many many students in a variety of places.

The winner was Arp 274 which is a set of interacting galaxies. And we announced the winner. We sent images of the winning thing.

And one particularly nice thing was that teachers and classes would sign up for follow-up activity of creating Hubble collages from various Hubble images. We got a few dozen entries to those collages. And actually we selected now the two winners.

And the two winning schools there are going to get visits. I will actually personally go to at least one and maybe Frank will go to the other one or I will go to both of these schools. We are going to go there. We're going to give some lectures. We're going to talk to the kids, the teachers and so on.

I felt particularly good about this in that unbeknownst to us it turned out that one of the winning schools actually was a school for dyslexic children which we actually did not know when we - when the winner was chosen which I think is particularly heartwarming. I was very very pleased to hear this.

Next slide please, 15.

Frank Summers: Okay Slide 15.

Mario Livio: The Origins Forum as I told you deals with many many missions. I just highlighted a few things here.

The Origins Forum leads for us the activities on IYA.

There were two books written in Braille published. You can see in the top image on the left there kids who use the Braille book. One was devoted just to Hubble, the other to all the great observatories, that is Hubble, Chandra, and Spitzer.

Hubble books now - sorry Braille books now use this transparent material to create the Braille writing so that people who can see actually can read the text and see the images. The blind people of course do use the Braille writing which is from this transparent plastic material on the pages.

Next slide, 16.

Frank Summers: All right Slide 16.

Mario Livio: So, again as I said, you know, there are many missions involved that we represent in this Origins Forum.

They create things like educational posters like the one you see on the right-hand side on the electromagnetic spectrum and many other activities.

Next slide please, 17.

Frank Summers: All right, Slide 17.

Mario Livio: So I now - I've now describe to you briefly what the different branches of OPO are doing. OPO is the Office of Public Outreach.

But I now want to talk a little bit about this crossing the boundary between science and general culture.

Frank Summers: Right, so Mario before you start a new topic I mean you might want to tell people just how many people we have in OPO that accomplish all the various things that you've done...

Mario Livio: Yeah so...

Frank Summers: ...that you talked about.

Mario Livio: So OPO has 34 people which sounds like much when you hear it the first time. You say, "Wow. What, 34 people doing outreach and so on."

But actually when you look at the wide variety of activities that we do and the amount of these activities you realize that actually we only have, you know, maybe a handful of people for every particular thing.

Like, you know, we have a handful of people doing formal education and a handful doing informal education and a handful of people doing online outreach, you know, and so on.

So it is really with very - you know, I can definitely say we are short-staffed for how ambitious we are in terms of what we want to do in the arenas of education and public outreach.

Frank Summers: Yeah but I mean that's what makes us able to do so many different things is that we are fully-staffed in a variety of areas.

Mario Livio: Right.

Frank Summers: ...very few outreach places have that luxury being...

Mario Livio: Correct. And it's all professionals by the way. You know, like in our formal education we have actual teachers working.

And we have, you know, people who give evaluation of curricula that are working.

In our informal education we have actual museum people working, you know.

Our web people are people who really - they are really computer geeks who deal with computers. And, you know, that's what they do and so on.

Frank Summers: All right. Go ahead.

Mario Livio: So crossing the boundary between science and general culture: the reason I put Einstein's picture on the left there was to remind you that in the year 2000 Time Magazine chose the person of the century and they chose Albert Einstein. You know they choose every year a person of the year but in 2000 they chose the person of the century.

And this was very unusual. I mean because most of the people who make it to be person of the year are politicians, you know, world leaders in one form or another and so on. So it was very unusual for a scientist to have been selected as the person of the century.

And the only way that you can understand this selection is by the fact that really Einstein's ideas literally crossed the boundary or the - you know, the border between science and the general culture. You see Einstein's ideas now represented in areas that have almost nothing to do with science, you know, in literature, in theater pieces and so on.

And what Hubble has done is really something very similar and I want to give you some examples of this.

So let's look at the next slide which is Slide 18.

And what I have put here is a collection of things none of which is actually related to science precisely but which uses Hubble images or Hubble information.

So there are things from the cover of a rock album by Pearl Jam that has the planetary nebula MyCn18 on the cover on the right-hand side.

The recent book that teaches music for the trumpet which because it's called Explorations it has a Hubble image on its thing.

There is a collection of stamps both in the U.S. in the top and from the UK in the middle.

There are cartoons that use the Hubble Deep Field in the top left side.

There is a museum publication from Germany that has a Hubble image on its back cover and so on.

Next slide, 19.

Frank Summers: Nineteen.

Mario Livio: Hubble has also become a standard of excellence. So, on the right-hand side I have a New York Times report on technology which actually talks about the

particular new super - IBM super computer. But look what it says in the middle. It says, "For..

Frank Summers: Moving...

Mario Livio: ...some...

Frank Summers: ...to Slide 20.

Mario Livio: Slide 20 yes.

"For some computational scientists it's like a Hubble telescope." So they use the word "Hubble telescope" as a symbol of excellence.

On the left-hand side you have a story from the New York Times when they started the Large Hadron Collider in Geneva working. Now unfortunately once they started working it they had to stop because of this explosion in the tunnel. With any luck they will go back to work at the end of September or beginning of October.

But I just highlighted there a line on the left-hand side at the bottom which says - look what it says. It's talking about the LHC. It says, "Scientists hope the machine will be a sort of Hubble Space Telescope of inner space." So they really want to describe a particle accelerator but they use Hubble as a symbol of excellence.

Next slide, 21.

Frank Summers: Twenty one.

Mario Livio: There were numerous editorials about Hubble. In fact one just appeared last Monday. But this one is from 2002 which I particularly like talks about the Hubble achievement.

And I've highlighted at the bottom on the right and this is Slide 22 what it says. It says, "It has taught us to see the properties of a universe humans have been able for most of their history to probe only with their thought." This is the type of impact that Hubble has had.

Slide 23.

Frank Summers: All right so...

Mario Livio: So now I move to the second part of my talk so maybe I should stop and ask if there any questions on this part.

Frank Summers: Any questions out there on the telecon? Please feel free to speak up.

Mario Livio: Is it because everything is so clear or because everybody is just stunned?

(David Abou): I do have a question.

Mario Livio: Please.

(David Abou): Okay hi this is (David Abou) from Stafford, Virginia.

Mario Livio: Yes.

(David Abou): Yeah I did an outreach session at my son's elementary school yesterday.

Mario Livio: Yes.

(David Abou): And I gave them the HubbleSite, hubblesite.org.

Mario Livio: Yes.

(David Abou): And the kids and the teachers really enjoyed that. As far as outreach is concerned: hardcopy materials the kids love walking away with something. And Kay Ferrari had sent me a bunch of IYA 2009 bookmarks which I gave out yesterday. Does your office also send out hardcopy things like that for outreach in addition to the online materials?

Mario Livio: Occasionally we do. Let me put you in touch here with Carolyn Slivinski who sits right next to me here.

(David Abou): Okay.

Mario Livio: She can give you her email address. Why don't you do that Carolyn and...

Carolyn Slivinski: Sure. My name is Carolyn Slivinski so being a good Polish name it ends with S-K-I and all the vowels in it are also "I(s)" so it's S-L-I-V as in "Victor," I-N-S-K-I.

(David Abou): Okay.

(Carolyn Slivinski): ...at s-t-s-c-i dot e-d-u.

(David Abou): Okay great.

Mario Livio: So send her an email and we will try to send you some stuff.

(David Abou): Great I appreciate it. Thank you very much.

Mario Livio: Okay. Sure. So now continuing, you know, over these presentations I'm sure that most of you, and probably all of you, have seen some absolutely spectacular images taken by the Hubble Space Telescope so I'm going to breeze through a few of those. I did not put very many here.

I mean I could have put ten times more images but I am sure you have seen most if not all of them. So I don't want to bore you with them. I've just put a few. It's a chance that maybe some of these you have not seen.

So I'm going to go very quickly through them. I put them here mostly for their attractiveness but I'll just say a couple of words about what they are and what they mean.

So Slide Number 24, next slide. So this is part of the Eagle Nebula. Of course the Eagle Nebula is best known for the famous what was called Pillars of Creation. But this is another one such pillar.

Very bright stars at the top sculpt the entire surrounding by radiation and winds.

Only the densest material remains.

You can see material boiling off the top of the pillar.

For those of you who know the Swiss sculptor Alberto Giacometti he has a sculpture of a man that looks just like this. In fact look it has even the pedestal at the bottom of this there is - like in the original sculpture.

Next slide please, 25.

This is the Carina Nebula. I will be amazed if you have not seen this yet.

A very active region of star formation.

I could talk for hours on what's happening here but I don't have the time.

You can see on the very left-hand side, about the middle of the image, there is a famous star Eta Carinae about 120 solar masses about to explode any minute as a supernova.

If we'll go to the next slide there is a highlight of one of these pillars there.

And just behind the pillars there are stars being born and young stellar objects emit jets.

And you can see a very powerful jet on the right-hand side and it has a bow shock right in front of it.

And another powerful jet emitted on the left-hand side and you see a bow shock in front of it.

Next slide.

Frank Summers: This is Slide 27.

Mario Livio: Slide 27. I'm actually going to run now through a series of about five slides but let me just tell you first what we're going to see.

This is called V838 Mon. This star brightened suddenly in 2002. And as it brightened, the pulse of light started propagating outward.

Now the series of slides that I'm going to show you were taken just a few months apart. You know usually in astronomy things happen very very slowly. I mean watching phenomena in astronomy is like watching paint dry. But in this particular case in just a matter of months things have changed quite dramatically.

It will look to you as if you see something expanding but actually nothing is expanding there. It's just that light propagates from the center and illuminates farther and farther regions and then that light is reflected back to our eyes so this is why it's called a "light echo."

So it's a bit like seeing, you know - imagine that you had a pulse of light and light moves at let's say 1 foot per second. Then, you know, if you look 1 second later you will only see things that are 1 foot away from you.

If you will wait 2 seconds you will see the things that are 2 feet away from you.

At 3 seconds you'll see things that are 3 feet....

So this is what we are seeing here. Pulse of light will illuminate the surroundings and show us the entire history of mass loss from this star.

So I'll just ask now to go through the series of images. So 27, now 28, then 29, and then 30, and then 31.

And you see how we get the entire history of mass loss and I cannot help but noting that the things at the bottom of the image - I'm an art fanatic so they remind me of brush strokes by Van Gogh but I hope some of you can see that too.

Frank Summers: Now you talk about history of mass loss. What you didn't say - I mean so all of this gas was previously ejected from the star...

Mario Livio: From the star that's right.

Mario Livio: So all this gas and dust was previously ejected from the star. We actually still don't know for sure the cause of the brightening in 2002. There is some speculation that this may have actually represented a stellar collision. But I will say that I did not find this particularly convincing because there seems to be some evidence of previous outburst and of course it could not have been previous collision.

There have been another very speculative paper of a series of planets having been swallowed by this star and each one when it was swallowed it produced some sort of a burst. That for a variety of reasons that I don't have time to get into seems even less likely.

Frank Summers: All right so 838 Mon was a nova but we don't know if it was a recurrent nova.

Mario Livio: No. Yeah we don't know actually almost anything about really what caused this brightening.

Thirty two.

Frank Summers: All right Slide 32.

Woman: Could I ask a question about this?

Mario Livio: Please do.

Frank Summers: Sure.

Woman: What's the period of time over which this was happening?

Mario Livio: What was the period of time?

Woman: Yeah.

Mario Livio: So all these images were taken something like a few months so the whole thing maybe is a year or two years something like this, the whole series of images.

And we're actually continuing to observe this so there are more than the five that I've shown you. I mean they continue to monitor this star.

Mario Livio: Thirty two.

So I've shown you a region of star formation, a star that's doing something while it's alive.

Here are stellar deaths. This is the famous Cat's Eye Nebula. This is a planetary nebula.

When stars about like the sun, up to 8 solar masses, when they die they eject their outer layers, expose a very hot core.

This core radiates the material around, ionizes it, and causes the whole thing to kind of fluoresce and this is what we see as the planetary nebula.

The process itself is gentle. It happens over about 10,000 years. It's not an explosion.

There is a lot of structure here. We don't actually fully understand the rings that you see here. They may have represented multiple mass ejections.

But they also may have - but the time scale looks wrong because for reasons that I will not get into it doesn't correspond neither to dynamical time nor to thermal time.

It could be that it actually - that material was ejected continuously but some dust instability in the ejected material forms this ring.

There is also the image is point symmetric. Anything you see on wide side if you reflect about the middle you'll see on the other side. We're not yet completely sure how you form that.

It could indicate two opposite recessing and wobbling jets that formed this. But there are many questions here.

Next slide.

Frank Summers: Okay Slide 33.

Mario Livio: So when stars much more massive than this, more massive than 8 solar masses explode they result in a supernova explosion. This is the result of the Crab - this is the Crab Nebula.

The explosion itself happened in the 11th Century. It was observed by Japanese, Chinese, Korean, and Native Americans. And it was recorded in particular by the Chinese. This is what remains from that explosion.

In the middle of this there is the famous Crab Pulsar a very compact object a mass of about 1.4 times the mass of the Sun, spins around its axis in 33 milliseconds. So this is a very intriguing object in itself.

And the nebula of course is truly spectacular.

Next slide please.

Frank Summers: Okay Slide 34.

Mario Livio: Thirty four moving now to galaxies. This is a barred spiral galaxy, NGC 1300.

Our own galaxy, the Milky Way, is a barred spiral although perhaps not as extreme as this.

You see this bar of stars that connects everything. And you see the spiral arms.

You can see that the spiral arms are threaded by a whole bunch of star clusters. These are where new stars are being born and they act as the tracers that let us see so nicely these spiral arms.

If you look very carefully you can also see dust lanes emanating from the spiral arms in the form of some sort of spikes. Those actually are the result of a particular magnetohydrodynamic instability that produces those.

Next slide please.

The Sombrero Nebula. You must have seen this. It's one of my favorite images because of the three-dimensional effect that it gives with this lanes of dust and gas.

Next slide please.

Last fall we had the situation that was very bad in that a certain board that connects - it's a data handling board on the telescope that connects the computers to the instruments stopped working and the telescope was not working for a while.

Within - fortunately that board has two sides. It has a redundant side to it and we switched to the second side and then the telescope resumed working.

By the way in the last servicing mission this board was completely changed and we have a new one now in that works and it has now both sides working.

But because we had this period when the telescope wasn't working but then I knew that it was coming back to life we chose this target. I actually made a special proposal to observe this target because I already had in my head what was the title we were going to give to this observation. And the title said, "Upon returning to operation Hubble scores a perfect ten." And we chose this because you can see that these two interacting galaxies almost delineate the numbers "1" and "0" on the sky.

It's actually a very interesting pair of interacting galaxies. The galaxy on the right looks a bit like a ring but in fact it is really more like a screw.

What used to be the center of the galaxy is just about at 7:00 on that ring. That's where the center was. And the galaxy was completely sheared to form these two long tidal arms. The other galaxy interacted with it.

Next slide please.

Frank Summers: Okay Slide 37.

Mario Livio: Slide 37 we released very recently to celebrate the 19th anniversary of the telescope. We called this the Fountain of Youth. And the reason was that first of all I mean those clusters of newborn stars look almost like drops of water dripping from one galaxy to the other but also because they are actually clusters of new stars, young stars.

Now it's very interesting because actually the image revealed many things that were not known from the ground.

From the image now you can tell that that tidal tail actually comes in front of the galaxy at the bottom. And it's not impossible that the galaxy on the bottom is not even interacting with the galaxies at the top.

On the other hand what you now see very clearly is that at the top there are actually three galaxies at least two of which are interacting. They are kind of on the left side of the image one above the other and they are strongly interacting.

And then there is a small galaxy that's a little bit to the right of that which may or may not be interacting with the others.

Next slide please, 38.

Frank Summers: Here you go.

Mario Livio: This image was the image that was selected in the You Decide where people voted.

Again a pretty spectacular image. I mean people voted for a very very nice target.

Again the image revealed some things that, you know, we weren't so sure about before. I mean as it turns out believe it or not the galaxy on the far most left and the one on the far most right are at about the same distance from us.

The galaxy in the middle is actually not. So most probably the galaxy in the middle is actually not interacting with the other two and we're not sure whether the two on the two sides are actually interacting. But the image is certainly spectacular.

Next slide, 39.

This is the last official WFPC2 image. Wide Field Planetary Camera 2 was taken out from the telescope in Servicing Mission 4.

And you may know that there were some problems actually getting it out because of a certain latch that wouldn't open. But eventually after using a whole series of tools and things it did open and that allowed for the installation of Wide Field Camera 3.

I should say that there were a few observations in particular two snaps that were taken after this image. But this was kind of the image that was selected in a way to represent one of the very last WFPC2 images.

Frank Summers: Right but I mean they would take observations with Hubble right up until servicing mission started right?

Mario Livio: More or less yes. And this was taken a little bit before that. But - you know, but this was a selected target especially for this purpose.

Next slide.

Frank Summers: All right Slide 40.

Mario Livio: Okay so this is - finishes what I called the “sheer beauty” section and I now will just...

Frank Summers: Should we pause and ask for questions then?

Mario Livio: Sure. Yes. Are there any questions on this part?

Woman: ...research a particular image where would be the best place to go on the web to find out the science behind that image?

Mario Livio: Well you can go to HubbleSite. And once you go to HubbleSite - again the website is hubblesite.org. And once you go there you can click on ScienceCenter - sorry NewsCenter, sorry NewsCenter.

And when you click on NewsCenter it allows you on the right to enter what it is that you are searching for.

And once you search for under that it will give you all the news releases that were related to that particular thing that you searched for. Okay.

Frank Summers: And you can search for images by type of planetary nebulae or galaxies or star forming regions or, you know, black holes, etc. So it has...

Mario Livio: Yeah there are...

Frank Summers: ...pretty complex...

Mario Livio: ...all kinds of categories but you can also search, you know, by the name if you know the object name and things like this or if you know the name of the researcher that was involved or things like that.

(David Abou): Yeah what was - again this is (David Abou)...

Mario Livio: Yes.

(David Abou): What was the object name again in Slides 27 through 31?

Mario Livio: V838 Mon.

(David Abou): "V." "V" as "Victor."

Mario Livio: "V" as in "Victor," the number 838...

(David Abou): Okay.

Mario Livio: ...and then the letters capital "M" and then "O" and "N."

(David Abou): For Monoceros.

Mario Livio: Exactly yeah.

(David Abou): Okay great because I want to incorporate that into my PowerPoint slide...

Mario Livio: Yeah V838 Mon.

(David Abou): Great thank you.

Frank Summers: I will note that we have several press releases on V838. So when you go to HubbleSite and search for it you'll find a whole slew of press releases...

(David Abou): Great.

Frank Summers: ...because each time we had a new set of images we would release a new press release.

(David Abou): Okay thank you very much.

Mario Livio: And of course the fact that - I should mention that the fact that that is a light echo, namely that it is light that propagates there, it can be used for a very accurate determination of the distance to that object. And that has been done.

And actually it was shown that what was previously thought to be the distance was wrong by about a factor of 2 or so.

I now want to describe very briefly a very special outreach activity that we did last year because just to show you how sometimes with a little bit of creative thinking you can do something that is very unusual and, you know, was never done before.

So last year the Walters Art Museum which is a major art museum in Baltimore had a very special exhibit which was called Maps. This was an exhibit of maps, of maps from the world. You know there were maps drawn by Leonardo da Vinci.

There was the first underground map of the British - of the London underground. Things like this--very very important maps.

So we met with people at the museum and with a person that is an art teacher at Johns Hopkins University and we said, "You know, we would like if you will give us a small room at the museum we will present a small exhibit of Hubble images in the context of this Maps exhibit because after all the Hubble images are in some sense maps of the universe."

And everybody got very excited. And this art teacher who is actually the person that is most left on this image, kind of blonde but with the shorter hair. Her name is (Elizabeth Rodini). She was teaching a class of curating, of students who want to learn how to curate exhibits.

So what we decided was it's the students that will curate this exhibit. And what happened is that we brought the students here to Space Telescope Science Institute.

We gave them a few lectures about, you know, what Hubble does and what the science means and so on. Showed -them the images and so on.

And then they were supposed to curate this art exhibit in the context of the Maps exhibit. Here what you see them doing is we gave them a room--this is actually a room in one of the lecture halls in our building--where they were trying to, you know, put - mount images on the wall to see how they would look.

But then, you know, they came back and said, "Ah but, you know, the room at the Walters doesn't quite look like this." And the Walters won't give them the room before the exhibit because they were preparing for the exhibit.

So what we did then and that you see on the next slide...

Frank Summers: Slide 41.

Mario Livio: ...Slide 41 is we asked our - one of our animators, graphic designers, Greg Bacon to create a virtual reality three-dimensional model of the room, the real room, at the Walters for them to try things on that.

And this is where you see this model.

If you look at the next slide...

Frank Summers: Slide 42.

Mario Livio: Oh well actually sorry. I forgot that I took a little bit fewer slides here from this.

We created some of the things - to make a long story short the kids actually did this exhibit and the director of the Walters said that per dollar spent this was the most successful exhibit they ever had.

But something else happened and you have already seen some of this before but in smaller images. The museum has this place which is called the Palazzo or their sculpture garden. And in this Palazzo they had these niches on the wall where there was nothing there, never, since the museum existed.

We said, “You know, since you are already hosting this exhibit we could make images for you to fit into those niches.” And we did.

And that’s how that wall looks with the images in it.

And in fact on the wall facing this, I don’t have an image of it here but on the wall facing it where there were no niches on the wall we created similar image to make this symmetric.

By the way if you look at the presentation it looks as if the images have a marble frame to them. Well actually that’s printed on paper. So it’s just, you know, a faux marble that’s printed on paper and it looks like this.

Now this was so successful that when the Maps exhibit had finished in the last summer the director wrote to me and said, “You know what, we would like to keep those images in the Palazzo for a longer period of time” with which of course we agreed. And actually today these images are still there. You know, they are going to take them down soon because, you know, museums they don’t like to leave everything in the same place for too long and this has been now more than a year almost after the end of the exhibit. But this is how these things happened.

Next slide please.

Frank Summers: Slide 43.

Mario Livio: So Slide 43 we're getting very near the end here. There is a reason why I put this slide in and let me just tell you what this is.

In 1994 some of you may remember comet Shoemaker-Levy 9 collided with the atmosphere of Jupiter. This picture is a true picture taken without the people there knowing. I'm there too by the way but with much darker hair, at the back there. This is as we all collected around the computer screen here at the Institute to try to see when the first fragment was about to hit.

The reason I put this image here is not to show you what happened when the comet hit. I put the image here to show you the curiosity on the faces of the people here, when they don't know that they are being watched how these people look.

The reason I put this here is because it is this curiosity that drives every single one of us who works here and I'm sure many of you in what we actually do.

We do this because of this burning curiosity to see and understand the universe.

Now in the next image we still don't move to it yet. I've put a painting painted by Rembrandt which is called The Anatomy Lesson. And when the painting first appeared it was considered revolutionary because most paintings before

that of Anatomy Lessons concentrated on the corpse that was being operated on.

Rembrandt's painting was very different and you can see it in the next image, 44.

Frank Summers: Forty-four.

Mario Livio: Look at the curiosity on the faces of the people who hear about the Anatomy Lesson.

If you can flip a little bit back and forth between these, 43 and 44, just compare the expressions on the faces of these people.

Do you all hear this? So look at the expressions on the faces. This is really what drives science and what we do.

Okay I want to finish now with next slide quickly with just two or three images from this last servicing mission.

This was the launch on May 11, a spectacular launch. I was there at Kennedy Space Center. This is an image taken from Banana Creek. That's not the site I was at because I was at the press site. But this is roughly what it looked from most sites--spectacular launch.

Next slide. These are the astronauts when they already worked on the repair. So you can see them here. Of course those of you who watched the servicing if you had the chance to watch this on NASA TV or somewhere else this was really very very thrilling to watch.

The person in this image is John Grunfeld who - this was his third visit to Hubble. He's the ultimate Hubble hugger. I mean we're all Hubble huggers but he is the ultimate Hubble hugger. Three times he serviced the Hubble Space Telescope.

Next image. And this is when the Space Telescope was released after the repair ended. This was on May 19, the release, and Hubble with two entirely new instruments, two repaired instruments, in fact the largest complement of instruments it has ever had now ready for this new phase in its life.

And of course that this saga if you go to the next slide will be continued.

Thank you all very much.

Frank Summers: All right. Thank you Mario for a wonderful presentation here.

We have a lot of content there to ask questions on but if you have questions on anything in this presentation or other things about Hubble Mario knows just about everything there is to know about Hubble so feel free to ask.

Man: Yes I have a question.

Frank Summers: Go ahead.

Mario Livio: Please.

Man: Yeah I'd like to know when we can expect public pictures from the new Hubble...

Mario Livio: Yes.

Man: ...camera.

Mario Livio: So the - currently we are progressing to early release observations on September 9.

Man: Thank you.

Man: I have a question about ViewSpace.

Mario Livio: Yes.

Man: What is the cost to the participating institutions in that?

Mario Livio: Actually there are two people here who can answer that better than I so I'll let them answer that.

Woman: The cost of the program itself is - there's no cost to that.

The cost that is involved is for the software that's used...

Man: Okay.

Woman: ...in order to create and play it on your computer. And the cost of that software is \$794 for the first year. And then there's an annual subscription fee that's \$163.50.

Man: Okay thank you very much.

Mario Livio: Are you speaking from the U.S. by the way?

Man: Yes.

Mario Livio: Okay because for foreign participants it's somewhat different.

Woman: It's a little different.

Frank Summers: Yeah and information about ViewSpace is available not on HubbleSite but on HubbleSource which would be H-U-B-B-L-E-S-O-U-R-C-E dot S-T-S-C-I

dot E-D-U. That is our informal science education website for museum and planetarium professionals. And the information on ViewSpace is available there.

Man: Right.

Man: Great thank you very much.

Man: Sure.

(David Abou): I just have a comment.

Frank Summers: Please.

(David Abou): Yeah this is (David Abou) again, Stafford, Virginia. And when I did my outreach session yesterday at my son's elementary school his particular class -they had 25 students in there. Before I talked about Hubble I asked the entire class if they had heard about Hubble. I said, "Everyone raise your hand that's never heard of Hubble" and only two students raised their hand out of 25 fifth graders in the first group.

So that's not bad, you know. Pretty good outreach.

Mario Livio: No. We are very good - we are very happy to hear this. We of course feel that that is the situation. I mean I've been quoted last week in The New York Times saying that this is not just a telescope; it is the people's telescope.

(David Abou): Absolutely.

Mario Livio: And indeed this is what Hubble has done.

(David Abou): Yeah...

Frank Summers: And we want to thank you for cleaning up those last two people that we missed so make sure to get them next time.

(David Abou): They are aware. They have the HubbleSite. And oh yeah they're good to go. They really enjoy the images. I have about a half a dozen images on my PowerPoint of - you know, from Hubble and those are always the ones that get the "oohs" and the "aahs."

Mario Livio: Good. Maybe you should return next year to see whether those two students still say that they've not heard of Hubble.

(David Abou): That's true. I've been doing it at my son and daughter's school for the last 11 years so I plan to attend...

Mario Livio: Excellent.

(David Abou): ...next year.

Mario Livio: Excellent.

(David Abou): Thank you again.

Mario Livio: Sure.

Frank Summers: Other questions please.

(Bob Caplow): Yes I've got one. (Bob Caplow) in Dundee, Illinois.

Mario Livio: Yes.

(Bob Caplow): It seems you're so successful publicizing Hubble. What can you teach other NASA projects on how to get the word out about what they're doing?

Mario Livio: So, you know, this is not a very - the answer is complex because the question is also complex.

So Hubble of course is somewhat different from all other missions. First of all in its longevity. You know Hubble has been around for 19 years.

Hubble has renewed itself multiple times by servicing.

There has been drama related to Hubble in that, you know, the original there was a flaw in the mirror and all this and so on which generated a lot of interest and so on.

And it was the first telescope of its kind, you know, for an all-purpose telescope in space.

So it is an act that it is hard to follow.

And also because it was such a successful experiment, you know, arguably, you know, maybe even the most successful scientific experiment in history quite a bit of attention was devoted to its outreach program.

And the result of this, you know, we still have 30-plus people, you know, working in education and public outreach.

Now not every mission can afford this type of staff and does not have this type of longevity.

But the idea I think would be to try to occupy the particular, you know, niche, or particular topic in which you are strongest. I mean, if you have a relatively small mission it would be unwise to try to do everything, if you have a very small mission to try to do education and outreach and news and I don't know

what's in this, you know, you don't have the staff, you don't have the funding, you know, and so on.

Try to find something that is very particular to what you have and also where your strength is.

The other advice I would give which, you know, has proved here to be phenomenal in terms of what we do is that the Institute by its construction combines scientists with people of education and public outreach. So we use this interaction between scientists and educators and outreach professionals to really enhance, you know, what we do.

And I think that this is really our most important strength - source of strength that we have this combination where we - you know, we need to do something about planets we have planetary scientists to talk to.

We need to do something about galaxies we have galaxies people to talk to and so on.

Yeah so again try to emphasize your - what is very special about your mission and try to capitalize on your strength.

Man: Thank you.

Frank Summers: I would also note that in the Office of Public Outreach we do a lot of collaboration with other missions especially missions that are small and don't have the resources that we have.

So for example in ViewSpace we don't just put out only Hubble news in ViewSpace. We also put out Cassini news. We put out - I mean Cassini has a great public outreach by the way, but we have other smaller missions.

And we collaborate with the Spitzer Space Telescope folks and the Chandra Space Telescope folks.

So we have - because we are well funded we do feel it's an obligation for us to work with other smaller missions and see if we can add our expertise to help them.

Mario Livio: And also I mentioned our Origins Forum or what will turn out into division support groups, you know, once this proposal goes through. They also try to work with the smaller missions and put them in touch with the right people and so on, you know, to help the smaller missions to get their word out.

Frank Summers: Okay any other questions?

Woman: This is (unintelligible) from Hawaii calling. And I was wondering what are the plans for future servicing missions of Hubble?

Mario Livio: So currently there is no plan for future servicing missions. This has been officially declared as the last servicing mission for Hubble.

Now Hubble is expected to work with its new instruments and the repaired instruments for at least five years. But there is no reason why it couldn't work more; you know, six, seven, eight, maybe even ten years.

Whether or not at some point in the future somebody will raise the question where, "Well should we rethink this and have another servicing mission to Hubble?" this will largely depend on the funding situation at that time, on what will be the status of other planned missions at that time, on recommendations from the Decadal Survey Committee which is currently underway, you know, which will come up with a whole series of recommendations for other missions and so on so forth.

So currently there is no other planned servicing of Hubble.

Sorry one small thing. There should be one probably robotic servicing that will attach a propulsion module to Hubble to direct it into the ocean because NASA cannot afford Hubble to just decay - its orbit to decay by itself because the mirrors may survive all the way to the ground and the risk of something happening is somewhat higher than the risk that NASA allows for its mission.

So the astronauts at the current servicing actually attached a soft capture mechanism to Hubble that will allow eventually for that propulsion module to be attached.

Frank Summers: Okay any last questions before we finish up?

All right well then thank you very much Mario. It was a wonderful presentation.

And thank you all for attending our Hubble Science Briefing Telecon. And Carolyn do we have a date - an exact date for the next one? We have a speaker for next month but he is - because of Servicing Mission 4 and the activity's called the Servicing Mission Observatory Verification of the instruments he's got - his schedule is flipping around so we're not exactly sure of the date but we will make sure we get it out to Anita.

All right thank you Anita.

Kay Ferrari: Anita had to leave. This is Kay.

Frank Summers: All right. Thank you Kay.

Kay Ferrari: You're very welcome Frank.

Mario Livio: Thank you.

Kay Ferrari: Thank you and thank you Dr. Livio.

END