INTERVIEW OF

DR. JOHN PHILLIPS

October 18, 2013

Conducted by Troy Cline

P R O C E E D I N G S

DR. PHILLIPS: Hello?

MR. CLINE: Hello, John?

DR. PHILLIPS: Yeah. Is this Troy?

MR. CLINE: Yeah, this is Troy. Can you hear me all right?

DR. PHILLIPS: Yeah, I can hear you fine.

MR. CLINE: Awesome. Well, thanks for your time. You're coming through loud and clear, and we're recording -- started the recording session now. And then --

DR. PHILLIPS: Okay.

MR. CLINE: -- of course, we'll edit everything out that we need to with the "uhs" and the "ands" and my explanation.

DR. PHILLIPS: Okay.

MR. CLINE: But, yeah, with the shutdown, I'm really glad you're able to still do this and pull it together. This is going to --

DR. PHILLIPS: The shutdown doesn't really have anything to do with me.

MR. CLINE: Oh, is that right?

DR. PHILLIPS: I'm retired. So I'm sitting here in my house in North Idaho.

MR. CLINE: Oh, nice. All right.

DR. PHILLIPS: Yeah.

MR. CLINE: I'm in --

DR. PHILLIPS: Yeah, I retired from --

MR. CLINE: -- Pasadena, Maryland.

DR. PHILLIPS: Oh. I retired from NASA in 2011.

MR. CLINE: Oh, okay. All righty. Nice. Well, congratulations on that.

DR. PHILLIPS: Oh, thank you.

MR. CLINE: Well, I think the questions that we have -- what we do with the interviews, just to kind of recap, unless -- I think Carolyn mentioned it in the emails -- is for the Space Weather Living History Project, it's pretty much done kind of like an NPR interview. We -- I will just introduce the question, and then -- as a way to get the conversation started. And then --

DR. PHILLIPS: Okay.

MR. CLINE: -- if you wouldn't mind, just

kind of, in your answer, just repeat the question in a way, you know, just as you get started, like you typically would with any interview that you've done, I'm sure. And then go on with your explanation. And I will likely not say much, because what we'll try to do for the purpose of this tool that they're creating with the interviews and all this is to -- they'll edit me out as much as possible so we get the majority of the people being interviewed.

And then every once in a while, though, I will interject. I keep notes, or if something comes up and I really want to bring something out or ask a question, I'll go ahead and do that, and we can have a conversation around that if we decide to. But so it's pretty open-ended. And --

DR. PHILLIPS: Okay.

MR. CLINE: And this is -- generally, we're shooting for about an eighth grade-ish audience, just general public audience.

DR. PHILLIPS: Okay. I got the impression from the emails that you guys didn't really know much about my background. Is that a --

MR. CLINE: Right.

DR. PHILLIPS: -- true statement?

MR. CLINE: That's true for me. I don't know about Carolyn, so …

DR. PHILLIPS: Okay. Let me just tell you what it is. It might help you with the questioning a little bit.

MR. CLINE: Okay.

DR. PHILLIPS: I was a Navy pilot for ten years; had nothing to do with space weather. And then I went to grad school at UCLA and got a PhD in physics with a specialty in space plasma physics.

MR. CLINE: Uh-huh.

DR. PHILLIPS: And my research work involved the planet Venus.

MR. CLINE: Oh, wow.

DR. PHILLIPS: It didn't really have much to do with space weather on Earth, although I had to be aware of that sort of subject, but my research work didn't involve it much. And then I went to Los Alamos National Lab as a postdoctoral fellow and then as a staff member. And I worked with a variety of

spacecraft observations. Most -- a lot of my work had to do with the Ulysses satellite, which went -- launched in 1990 and went out to Jupiter and then went over the poles of the Sun. So we were studying the Sun and the solar wind, but in an -- in an area far from Earth. Okay?

MR. CLINE: Uh-huh.

DR. PHILLIPS: And I was somewhat involved with space weather in the sense that I did some research with satellites called the International Sun/Earth Explorer, which were orbiting Earth, and so I cared about that subject, but the focus of my research was much further out in the solar system.

And then I got hired by NASA as an astronaut and went to NASA in -- from 1996 to 2011 and flew in space three times, including a six-month flight in 2005, and that's kind of -- that six-month flight is probably the period under which I could -- the time under which I could say most about space weather that people might find interesting.

MR. CLINE: No, that sounds perfect, actually.

DR. PHILLIPS: Okay. So but in general, the focus of my career has not been space weather. However, I have some maybe unique outlooks on it.

MR. CLINE: That sounds great, and one of the questions somewhere, unless we already -- you interject it just because it's what you're talking about, when you're talking about your work in space and then you bring in that space weather aspect, anything that ties that in would be great. Maybe -- I don't know if it had to do with effects on humans in space by any chance or …

DR. PHILLIPS: A little bit. I can talk about my dosage, radiation dose and --

MR. CLINE: Oh, that's a great one.

DR. PHILLIPS: -- its context in the solar cycle and that sort of thing.

MR. CLINE: Yeah, that sounds great. I'm typing a few notes here as we talk.

DR. PHILLIPS: What might be the thing that's most interesting to -- for your purpose is a few little tidbits of information about my six-month flight in space --

MR. CLINE: That would be great.

DR. PHILLIPS: -- and our dosimetry and what I saw and what I witnessed and what my dose was.

MR. CLINE: What you saw and witnessed. Okay. You know, what I'll do -- that actually sounds fantastic for this. It's perfect because what we're trying to do in a lot of this is let people understand, like your experience in space and with space weather, what influences that actually has on people's knowledge of space weather and why it's so important, what impact it has on humans, and why that's important for us as we explore space, and all of those kinds of aspects come into this, so that sounds absolutely perfect.

DR. PHILLIPS: By the way, do you consider space debris as part of space weather?

MR. CLINE: In -- I have never heard -- I've never been asked that before. In what way would it be? That sounds really interesting.

DR. PHILLIPS: Well, it's like satellites, for example. Satellites get hit by space debris. We've got -- and, in fact, on the International Space

Station, a couple times a year, they have to maneuver the space station because it's threatened by something. It could be a natural thing, like a micrometeorite, or it could be a piece that came off of another spacecraft. And, in fact, in my six-month flight, we maneuvered the spacecraft once to avoid debris.

MR. CLINE: No kidding? So --

DR. PHILLIPS: I could tell --

MR. CLINE: -- there is a little bit of truth to *Gravity*.

DR. PHILLIPS: Yeah.

MR. CLINE: To the --

DR. PHILLIPS: Yeah, well --

MR. CLINE: -- the movie *Gravity*.

DR. PHILLIPS: A little bit, yeah.

MR. CLINE: Only a tad. Well, so it's --

DR. PHILLIPS: I actually thought that it --

MR. CLINE: -- actually been moved.

DR. PHILLIPS: I thought it was a pretty good movie, but there were a whole lot of real wild inaccuracies.

MR. CLINE: I actually did want to ask you about that. It wouldn't necessarily be part of the interview, but, you know, what some of those inaccuracies were. I mean, everybody focused on the hair, of course, that wasn't moving, but then I'm sure that --

DR. PHILLIPS: Oh, no.

MR. CLINE: Yeah.

DR. PHILLIPS: But if you think about the -- well, first off, all those -- there are basically four spacecraft involved in the Hubble Space Telescope: the space shuttle, the International Space Station, and the Chinese Space Station. And those are in -- the Hubble and the two space stations are all in three different orbits. You can't get to one from another. So that's a really fundamental thing that was wrong.

And another thing that was wrong that most people wouldn't even realize is toward the end, Sandra Bullock does two spacewalks from a Russian Soyuz capsule. The exits -- she goes out through a hatch that doesn't even exist in the real vehicle, and she's wearing a suit -- I don't know if you'd know this, but

her suit doesn't look like a spacewalk suit. It's very sleek.

MR. CLINE: Yeah, it didn't. Yeah.

DR. PHILLIPS: It doesn't have a backpack on it. She doesn't have a source of oxygen.

MR. CLINE: Oh, my --

DR. PHILLIPS: She'd be dead in a minute. I mean …

MR. CLINE: Oh, that's perfect. So she's apparently just using the oxygen in her suit, which would go for about 30 seconds.

DR. PHILLIPS: Yeah. So, I mean, that's -- those are a couple examples of some pretty wild inaccuracies. But nevertheless, I thought it was a pretty good movie.

MR. CLINE: It really did, it kept me -- I gripped the seat the entire time when I was watching it. There was one scene a friend of mine asked about, and he said (inaudible) capsule it was she left, but she didn't have propulsion to get from one capsule to the next or one vehicle to the next, so she used a canister, like a fire hydrant. And he said --

DR. PHILLIPS: Oh, it was a --
MR. CLINE: Wouldn't that explode?
DR. PHILLIPS: It was a -- it was a fire extinguisher, yeah.
MR. CLINE: That's it.
DR. PHILLIPS: CO2 fire --
MR. CLINE: A fire extinguisher. That's what it was. And I knew that that could give thrust, but the question was wouldn't that explode as soon as it went out into space and the pressure difference? I didn't know.
DR. PHILLIPS: No, I don't think so. I mean, think about a scuba tank. A scuba tank contains three -- let's see. Two hundred atmospheres of pressure. So why was a -- why would -- if he can hold 200 atmospheres of pressure in one atmosphere that it's normally in, and then you take it to zero atmospheres, I mean, that's just a one-atmosphere difference in something that holds --
MR. CLINE: Oh, that's a good point.
DR. PHILLIPS: -- that holds 200 atmospheres. So I -- no, I don't think it would

explode. The fire extinguisher, I think, is similar kind of pressure. I can't remember for sure. But, no, I think changing -- this is something with a lot of pressure inside, and then you take the outside pressure from one atmosphere to zero. You've only changed it by one atmosphere. I think it would hold it just fine.

MR. CLINE: Oh, great, we have a telephone ringing in the background. Hold on just a second.

DR. PHILLIPS: Okay.

MR. CLINE: Make sure he can edit that out.

DR. PHILLIPS: Okay.

MR. CLINE: But, yeah, there's actually parts of the conversation that you've already mentioned that, if need, they could go back into and pick out pieces and parts of that --

DR. PHILLIPS: Okay.

MR. CLINE: -- which will be -- which will be just great. So that makes sense, yeah.

DR. PHILLIPS: I'm choking on -- I'm choking on my coffee here, so give it a minute before -- I won't sound very good on a …

MR. CLINE: It'll give you --
DR. PHILLIPS: -- on the --
MR. CLINE: -- that deep, husky voice, yeah.
DR. PHILLIPS: Okay. Well, I guess -- I guess I'm ready to get started again.
MR. CLINE: Okay. I'll just -- I'll start with the questions, and then I'll keep an eye on some of the notes that I've been taking. And if --
DR. PHILLIPS: Okay.
MR. CLINE: If I haven't heard you say it, I might bring it up in a question, depending on where we are in the conversation. So we'll just kind of play it by ear. And then at the end, if there's anything else you need to add, we can certainly do that, and that won't be a problem.
DR. PHILLIPS: Sure.
MR. CLINE: All right. So the -- so, John, I really appreciate your time here with us today. Thanks so much for working with us on Space Weather Living History. And, first of all, I'd for you just to tell us who you are, just a little bit about yourself, and then we'll get started with the first

question about your primary research interest.

DR. PHILLIPS: Okay. My name is John Phillips. I was a NASA astronaut from 1996 to 2011. I had three space flights. Before that, long before, I was a Navy pilot. Then I went to grad school at UCLA, got a PhD in space plasma physics, and then worked at nine years -- worked nine years at Los Alamos National Lab in New Mexico, working on spacecraft instrumentation and observations from a variety of spacecraft.

MR. CLINE: Now, what area now and -- or most recently and that you would like to talk about would you consider to be your primary research interest?

DR. PHILLIPS: My primary research interest were the Sun and the solar wind, which is a charged gas, an ionized gas that flows continuously, but variably, out from the Sun and which envelops the Earth and is the main driving -- or one of the main driving factors in what we call space weather.

MR. CLINE: And what is it that you believe that influenced you most to actually be drawn to this

area? What is it that you like so much about it that it became such a primary focus?

DR. PHILLIPS: You know, actually, it was kind of serendipity. I picked my program at UCLA out of a catalog. This was before the Internet, and you looked up university information in a catalog. And I went to the San Diego Public Library one day. I was in the Navy in San Diego and read this description of a program called space physics. And I didn't exactly know what it was, and I applied for it and got accepted.

So I went to UCLA without really knowing what I was getting myself into. My interests really were more in remote sensing of the Earth, but as it turned out, I liked it once I started studying it; space physics, that is, which had to do basically with plasmas and electric and magnetic fields and the various regimes that are in and around the Sun and planets and Earth, the moon.

And I just found it very interesting. I like my physics on a big scale; kilometers, not nanometers. I thought it was very interesting, and

all the courses that I took were good. And then I got a job at Los Alamos National Lab and kept working in that field.

MR. CLINE: And then what's really interesting is that you are involved in, you know, some of the beginnings, really, of what we are calling space weather research today. And that actually led towards your career as an astronaut?

DR. PHILLIPS: Well, first off, we've been studying space physics since the International Geophysical Year in 1957-58, and so I wasn't in on the ground floor. I started in that business in the 1980s. But nevertheless, I got to -- I got involved in some fairly groundbreaking spacecraft missions, particularly the Ulysses mission over the poles of the Sun.

Whether or not it helped me get -- to start a career as an astronaut, I will probably never know. The fact that I was working on NASA-based programs probably worked in my favor when I applied to be an astronaut. But nevertheless, it took me a long time. I took the scenic route to the launch pad. I put in

my first application in 1976 and finally got hired in 1996.

MR. CLINE: Now, what -- during that time that you were -- you were working with space weather -- and you were talking -- let me get the right terminology here. It was plasma physics, correct, space plasma physics?

DR. PHILLIPS: That's correct.

MR. CLINE: What were some of the key events or turning points during your time in that type of research that you think were pretty significant?

DR. PHILLIPS: The biggest turning point for me was the launch and the flight of the spacecraft Ulysses. Ulysses was a -- actually a European spacecraft launched on the U.S. space shuttle and containing instruments from both the United States and Europe, launched in 1990, and first went out to Jupiter and went over the poles and then used the gravity deflection to turn south and then went over the poles and continued operating, basically, for about another -- well, nearly 20 years, and it went over the poles of the Sun -- well, it was on its third

lap over the poles of the Sun when they finally turned it off.

And I was fortunate enough to be on the launch and initial data return from that mission, and eventually, when the original principal investigator of our instruments retired, I became the principal investigator. I didn't help build the instruments. I came in a little later.

But what was very nice about it was every time I would get a new week's worth of data -- we would get data a week at a time, and I would see observations that no one had ever seen before in a place where no one had ever taken measurements before. And that was very exciting. It's a form of exploration, that even though I'm just sitting in my office, looking at new results, for me, it was every bit as exciting as something where I was doing it physically, like going on the South Pole or going to space.

MR. CLINE: So this is -- this is research that's being done -- and you said this earlier -- Sun and solar wind research far, far away from Earth, but

yet it clearly has a direct connection with what we know about space weather and how -- the impacts on Earth.

DR. PHILLIPS: That's correct. What was unique about Ulysses was that it went over the poles of the Sun, so we were able to measure the -- not only the solar wind, but energetic particles and electromagnetic fields with a solar origin, basically, in the complete environment surrounding the Sun, and not real close, but not just from the vantage point of Earth, which is where every other spacecraft had measured these phenomena.

So we were able to kind of make a global map of how the Sun produces the plasma and electromagnetic field environment that we are enveloped in, but we -- but we were able to produce this global map that helped us understand the entire process.

MR. CLINE: That sounds amazing. I mean, what an addition to add to all the research -- the ongoing research that's been going on with space weather. And do you think in the future, as we venture further into space, if we do additional

exploration, can you imagine that -- I'm also answering my own question, but the type of research and data that we can get from those remote regions far away from Earth that -- the type of impact that might have on our understanding of the solar system and space weather. I mean, I can imagine that there are questions out there that remain unanswered that students today and people who are listening to this will be able to be part of one day.

DR. PHILLIPS: Absolutely. Every new spacecraft or every new observatory produces observations that have -- that are unique, whether it's because a spacecraft's in a different place or because it has a better instrument than the -- than the last spacecraft. And there are still major questions about the Sun.

I mean, for example, one of the real fundamental questions about space weather is how does a solar corona that's a region distant from the surface of the Sun, how does it get heated, because it's actually much hotter than the surface of the Sun? So it would be like if you put a pan of cold water on

a barely warm hotplate, and then the water started boiling. It doesn't make any sense from a -- from a thermodynamic standpoint, so you have to understand it from the standpoint of conversion of electromagnetic energy.

And as we -- every time we launch a new solar observatory or a new spacecraft into the inner (ph) solar system, we learn more and more about that really fundamental process.

MR. CLINE: Now, earlier, you also talked about your experience in space as an astronaut. Can you tell us a little bit about that? Because you mentioned earlier that, you know, you were there for quite a prolonged period of time at one point, so your dosage rates would have been high. Can you walk us through some of your experience?

DR. PHILLIPS: Sure. Sure. Well, my second space flight, my second of three, was in 2005. We launched and landed on a Russian Soyuz spacecraft, and there were only two of us, myself and a Russian fellow, and we were aboard the International Space Station for six months.

Now, this was -- to put it into context of space weather, we were, during the declining part of the sunspot cycle, almost as sunspot minimum. Sunspot activity was very, very low. And this is a period under which you don't get much radiation from impulsive solar events, but your background radiation from cosmic rays is actually high.

And in six months on space -- in space, I didn't worry about space weather at all. I did, in fact, have a place on the space station where I could take shelter, where it was lined with polyethylene bricks, but we never had to do that. I did have a personal dosimeter, and there was also sort of a -- a spacecraft-wide dosimeter with an alarm capability that was installed aboard the ISS. It never alarmed while we were -- while we were on board.

But after I got back in October 2005, I found out my radiation dose, and it turned out that in six months, I had absorbed a radiation dose of 8 REMs. REM is a Roentgen Equivalent Man. Eight REMs. Now, this was -- compare this with the OSHA dose of 5 REMs per year for a person who, say, works at a nuclear

power plant or works in some sort of radiation environment. I had 8 REMs. The OSHA limit was 5 REMs. So if I had been a nuclear plant worker, they would have had to send me home.

MR. CLINE: Oh, wow.

DR. PHILLIPS: But the NASA limit, in fact, is considerably higher than the OSHA limit. It's 50 REMs per year, plus they have an additional lifetime limit based on an enhanced cancer risk. So I was over the OSHA limit in six months, but well under the NASA limit. And I found that out after I got back.

But so it is what it is. I can't worry about it too much. And it's also interesting that in my 11 -- excuse me, my 15-year career as an astronaut, about half of my radiation dose came from space flight. The other half came from medical procedures and experiments.

MR. CLINE: Oh, okay. That makes -- that's amazing to hear that. Wow.

DR. PHILLIPS: Yeah. And a couple other aspects of space weather when I was in space was looking at the aurora, for one thing. And because I

was personally interested in space weather, much more so than typical astronauts -- or much more -- every astronaut has their own interest, and most of them are not space physicists. I am, and so I was interested in the subject.

So I had mission control, every day when I was in space, send me up the NOAA space weather report for that day. And so I was kind of aware of what was going on in terms of solar flares and sunspots, which were -- and there wasn't much of that during our time.

And I was particularly interested in it because it would help me pick out times to look at the aurora borealis and aurora australis, or the northern and southern lights. Now, we were in space in Northern Hemisphere summer, so it was hard to see the northern lights. It was just too bright in the Northern Hemisphere.

So most of the time what we would see is the aurora australis, or southern lights, typically down around Tasmania or New Zealand. And we took some pictures, and we got to -- got to look at it a lot. And in the -- in the International Space Station,

you're generally going over, or sometimes through, the aurora.

MR. CLINE: No kidding.

DR. PHILLIPS: And it was really, really -- it was really spectacular.

MR. CLINE: So as you were traveling through, your perspective, you're literally -- as you look out your viewing window or port, you're able to actually see the aurora just all around you?

DR. PHILLIPS: Yes, you can, occasionally. More often than not, we're above it, but sometimes we're sort of in it, and once you're in it, it appears very, very diffuse. The lights are not really bright, whereas from a distance, you can see structure. Once you get really close to it, what you're seeing is sort of a vague feeling that you're going through areas that are slightly illuminated in either blue or green.

But we would see that quite often. And my crewmate, Sergei Krikalev, who was a very good photographer, took a lot of very nice pictures of the aurora australis, which is hard to do with a handheld camera, because you need like a two-second exposure to

get a good image, and you're just holding the camera with your hand. And after getting some pictures that were not so good, I finally gave up and just said, "I'm just going to enjoy this. I'm just going to watch it go by and not even -- and not spoil the experience by trying to get a picture."

MR. CLINE: Now, I have seen some footage of the aurora australis from -- on YouTube and different places and through some NASA videos that have been released. Those were, I think, you know, taken from the space station. Were you part of that, some of the release of some of the video footage in any way?

DR. PHILLIPS: No, I wasn't, and I think -- I was on the station in 2005, and those images were taken a little bit later, when they had, one, better video cameras on board, and, two, better windows. It would have been very difficult for us to have taken that kind of image. But I've watched them, and they can be really spectacular as you see the cities go by and occasional thunderstorms flashing, and then in the background, you can see a faint aurora. I think they're really spectacular.

MR. CLINE: I just can't even imagine the change that you would experience in your life after being part of something like that and witnessing something like that.

DR. PHILLIPS: Sure.

MR. CLINE: You also mentioned something about various things that you saw and witnessed while you were in space, one being clearly, you know, the aurora. What were some of the other things that you noticed and witnessed while you were there?

DR. PHILLIPS: Well, the other things that I -- that I witnessed while I was there that involved space weather were primarily noctilucent clouds. Noctilucent means, basically, they'll glow at night. And these are thin -- very thin, very high-altitude clouds that mostly appear over the polar areas. And we -- I can actually look at -- the spacecraft -- the International Space Station doesn't go over the poles, but we've got a couple windows that look out on the horizon, so when we're near our peak northern and southern latitude, which is 51.6 degrees, we can look out one of those windows and see further toward the

poles. And quite often, I would see these noctilucent clouds, which are extremely high-altitude clouds, that are part of the -- sort of the lowest altitude part of the space weather, if you will. and I found it kind of interesting, because I've never seen it from the ground.

And let me tell you one other experience I had which involves yet another part of space weather, and this has to do with ozone. As you probably know, ozone in the upper atmosphere screens out much of the ultraviolet radiation that would otherwise hit Earth.

And all the windows on the International Space Station are coated with an ultraviolet protective layer except one particular window on the Russian segment. And most of the time, we were flying with that window facing Earth, not facing the Sun, so I wasn't worried about ultraviolet light, and I got a little complacent.

And then one day, I opened the shutter on this big window in the Russian segment, not realizing that the spacecraft had maneuvered, and that window was actually facing somewhat toward the Sun. And I

opened the shutter, and I got a big blast of sunlight on one side of my face. And I closed the shutter. And I estimate that I had sunlight on my face for about four seconds. And the next day, half of my face was red, so I got sunburned in four seconds --

MR. CLINE: That's amazing.

DR. PHILLIPS: -- by opening the shutter on this window that didn't have an ultraviolet coating. And --

MR. CLINE: Wow.

DR. PHILLIPS: I -- yeah. And I'd never been very much any kind of an expert on atmospheric chemistry or the way the ozone layer works, but I had a computer-based encyclopedia on board, so I looked it up that night, and it turned out that the ozone layer screens out something like all but one part in several thousands of the flux of ultraviolet light in certain wavelengths to the Earth. So my four seconds of exposure was like several -- perhaps like four hours on the surface of the Earth.

MR. CLINE: Well --

DR. PHILLIPS: Anyway, I managed to get

sunburned in four seconds.

MR. CLINE: That really makes you appreciate our atmosphere that much more, and the ozone layer in particular, yeah.

DR. PHILLIPS: Absolutely, and it sort of made me appreciate the shutter on that window too, and it made me much more careful about it for the rest of the flight.

MR. CLINE: Whoa.

DR. PHILLIPS: Fortunately, I did -- I did not actually look at the Sun. I just got sunlight --

MR. CLINE: Yeah.

DR. PHILLIPS: -- on my face.

MR. CLINE: Well, plus it would be a great way to cook a steak in no time flat, I would assume.

DR. PHILLIPS: Yeah, I'm not so sure about that.

MR. CLINE: Maybe it wouldn't be edible, but it could burn it.

DR. PHILLIPS: Yeah.

MR. CLINE: Now, you had mentioned a little -- and I'm sure this is something that you were often

aware of -- would be debris in space. And could you tell us a little bit more about your experience with that?

DR. PHILLIPS: Yeah. There are natural objects in space in orbits similar to the space station orbit, and then there are manmade objects from spacecraft launches and from collisions of spacecraft and deliberate shoot-downs of spacecraft, which have been done by China and by the United States.

And, actually, I was in space a little before those events, but there was still natural and manmade debris in space, and it's tracked, basically, by the U.S. Air Force, who sends out alerts when something -- when we're in danger of hitting a piece of debris.

And NASA evaluates it and then decides what are the odds that we're going to -- we're going to strike this piece of debris? And if they -- if the odds go above a certain threshold, then they maneuver the spacecraft.

Now, during my six-month flight, we maneuvered the International Space Station one time

for debris avoidance, and it's done very, very gently. The crew hardly even notices it. Small rocket engines are fired by command from the ground, and if they hadn't have told us we were going to maneuver, Sergei and I, my crewmate and I, probably wouldn't have even known it, because it's a very gentle acceleration. But they -- we changed orbits once in six months.

By the way, Phase 2 of this -- what the crew does in response to -- in response to a debris alert is that they can go to their Russian Soyuz capsule, which is basically their lifeboat, and so they'll hunker down there and wait for the debris to pass. We never had to do that. In fact, I think it's only been done once or twice in the whole life of the space station, but we did maneuver one time.

MR. CLINE: Now, out of all of the experiences that you had in -- particularly in space, the launch, your stay in space for an extraordinary amount of time, and then return, reentry, and all of that, what do you think was the most either exciting or part of it that made your -- maybe the most memorable part or part that made your heart nearly

pound out of your chest? What would that be, what part of your experience?

DR. PHILLIPS: For me, the most exciting part was landing in a Russian Soyuz capsule. This is very different from landing on a shuttle. On a shuttle, you only pull about one and a half G's, and then you end up rolling out on a -- on a runway. Landing on a Russian Soyuz capsule, you parachute in in a grassland of Kazakhstan. You pull something like 5 G's on the way in. And parts of it are pretty intense, like, in particular, when the parachute first opens.

I don't know exactly what it looks like from outside. I've never seen film of it. But what it feels like from inside -- and remember that I've been in zero G. I've been in weightless -- weightless for six months, so my body's used to weightlessness, and suddenly, the forces that come on -- but after we get through the upper part of the atmosphere and the spacecraft slows a bit, then a parachute opens, and when the parachute opens, it feels like you're spinning down a drain. That's what it feels like for

about three or four seconds.

If I hadn't been warned about it, if I didn't know it was a pretty violent few seconds, it would have been really scary. But my -- basically, my vision blacked out, and I felt like I was spinning down a drain for a few seconds.

MR. CLINE: And, of course --

DR. PHILLIPS: And then --

MR. CLINE: -- was it spinning actually, or was that just a sensation?

DR. PHILLIPS: No, actually -- I don't think so. I think -- and I -- as I mentioned, I've never seen video of this event. I don't know what it looks like from outside, and I don't think anyone has ever taken video of it. But from inside, it feels like you're spinning down a drain.

MR. CLINE: Uh-huh.

DR. PHILLIPS: I think what it really is is the spacecraft is just shaking really violently, and because your body's sensors are used to being weightless and haven't had to work very hard for six months, basically, it confuses your body's attitude

receptors.

MR. CLINE: Sure. Sort of like a sense of vertigo.

DR. PHILLIPS: Yeah, it's -- but it goes way beyond vertigo. I mean, it's really extreme.

MR. CLINE: Well, that's amazing. Wow. Do you have anything else? We've gone over the -- several of the notes that we talked about earlier, and you've hit every single point.

DR. PHILLIPS: Oh, okay.

MR. CLINE: And you've done a great job with that, and I'm wondering is there anything else that you'd like to add to this that we could include or --

DR. PHILLIPS: Well --

MR. CLINE: -- anything you'd like to maybe say to the people listening?

DR. PHILLIPS: Well, first off, one of the little events that happened when I was up there -- two -- can I mention two other little events?

MR. CLINE: Sure.

DR. PHILLIPS: First off -- first off, I got -- I got word that there was going to be a solar

eclipse. And I asked the people on the ground to send me up information about the solar eclipse while I was up there. And it turned out we were going to fly through the shadow of the moon. And, yeah, I got the exact --

MR. CLINE: Which eclipse was this?

DR. PHILLIPS: -- time and everything. Yeah. And as it turned out, we flew through the shadow of the moon while we were over the Indian Ocean, and I thought it was going to be very, very dramatic, like it's suddenly going to go from bright to dark, and, actually, it was rather subdued.

I could barely tell that we were in the shadow of the moon. We didn't go from, you know, bright sky to the -- well, the sky is always black in space, but we didn't go from bright sunlight to darkness. We went from bright sunlight to slightly less bright sunlight. So but we did fly through at least a piece of the -- of the solar eclipse, of the shadow of the moon.

And then one other thing that happened while I was up there was there was a comet, and I wish I

could remember the name of the comet, but I can't. It was predicted to impact Jupiter. And so I managed to find a place on the spacecraft where I could see Jupiter, and I positioned myself right when the comet impact was going to happen, and just in case something really spectacular happened, like a big exposure on Jupiter -- but, no, Jupiter's a very big planet. The comet's not very big. Comet crashed into Jupiter, and I didn't see a thing. I tried.

MR. CLINE: Which year was the eclipse? Was it, by any chance, the 2006?

DR. PHILLIPS: No, it was 2005.

MR. CLINE: 2005.

DR. PHILLIPS: If I remember right, it was fairly late in the mission. It was --

MR. CLINE: Okay.

DR. PHILLIPS: -- perhaps -- I'm taking a guess now -- August of 2006 -- 2005, excuse me. It was August 2005, and it -- we went through it over the Indian Ocean. I remember that part.

MR. CLINE: And were there, by any chance, any types of cameras or recording equipment that were

pointed towards the Sun to capture the eclipse as seen from space that you remember?

DR. PHILLIPS: No, there were not. And --

MR. CLINE: Okay.

DR. PHILLIPS: And, quite frankly, I was a little bit surprised that nobody but me seemed very interested in it when I called mission control about it. I had gotten an email from a friend on the ground saying, "Are you going to see the solar eclipse tomorrow?" And that was the first I'd heard of it. And I called down to mission control, and they didn't really -- I mean, they sent me the information, but I didn't get the feeling they were even very aware of it, so --

MR. CLINE: That's amazing, isn't it?

DR. PHILLIPS: You know, it seemed -- well, first off, they don't really want to point their cameras at the Sun. I can understand --

MR. CLINE: Right. It would have to be bright without --

DR. PHILLIPS: Yeah. They're --

MR. CLINE: -- a H-alpha --

DR. PHILLIPS: They're --

MR. CLINE: -- or some sort of filter.

DR. PHILLIPS: I mean, these are external cameras that have to last, basically, the life of the space station, or at least many years. And they can point them just about any direction, but they really don't want to point them at the Sun, so I can understand why they weren't too interested in taking images of it. And I didn't look at the Sun either. I didn't --

MR. CLINE: Right.

DR. PHILLIPS: -- have any instrument with a solar filter. I was looking at the surface of the Earth to see if the shadow of the moon would be really distinct when they flew through it, and it was less distinct than I thought.

MR. CLINE: But it was noticeable? You could actually see the difference?

DR. PHILLIPS: Yes. Yes, it was noticeable.

MR. CLINE: Now, have you ever witnessed a total solar eclipse from the ground?

DR. PHILLIPS: Yes, I have. Just -- not in

any professional capacity.

MR. CLINE: Uh-huh.

DR. PHILLIPS: I've been in places where people would set up a couple of amateur telescopes with Sun filters. And once I watched it on a pinhole camera.

MR. CLINE: Uh-huh.

DR. PHILLIPS: But, yeah, I've seen several solar eclipses in my lifetime.

MR. CLINE: I was going to say it would be really funny, in some way, had -- if the only place you'd actually witnessed a total solar eclipse had been in space, which is the most --

DR. PHILLIPS: Oh, no.

MR. CLINE: -- unique experience you can imagine.

DR. PHILLIPS: Yeah. No, I've seen better ones on Earth than I have in space.

MR. CLINE: I remember we had the opportunity to be in Side, Turkey with a crew of people filming the 2006 total solar eclipse, and I think one of the -- apart from the temperature change

and the temperature shift, that -- we had a whole crew of students from Side who were monitoring the temperature shifts and wind and all of that.

I thought what was really fascinating was when you would hold up a colander or anything that had holes in it or crisscross your fingers and let the sunlight shoot through your fingers, and then all you would -- you would just see hundreds of solar eclipses all over the ground or under trees. We just all found that incredibly fascinating.

DR. PHILLIPS: I actually never thought about looking at it with a -- through a colander. That sounds like a good idea. I've done a pinhole camera, which is -- and I guess a colander's like a hundred pinhole -- or a thousand pinhole cameras.

MR. CLINE: It really creates an amazing effect. And I know we have an eclipse coming across the United States in 2017, so we'll have our colanders out then. And we also noticed under trees, you know, with the Sun that came through the trees, the way the light was bending, refracting, you saw just thousands of images of the -- of the solar eclipse as it was

going on.

DR. PHILLIPS: Yeah. Well, Troy, you asked me if I had anything else I wanted to tell people, and it's just that space weather is real, it affects not only life in space, but life on Earth, and I think it's really important that we continue our efforts to understand it, to produce warning capability for destructive events. And as we become more and more of a high-tech society, we are becoming more and more vulnerable to space weather. So we really have to understand it as well as we understand weather on Earth.

MR. CLINE: Well, John, this has been an amazing interview. Thank you so much for your time. And I think the very next part of this process will be they will edit the interview down and then create a transcript, and then that transcript will be edited somewhat, and then we'll send that transcript -- Carolyn Ng will likely send that to you, and then you can read through it, strike anything, make any edits, suggest any -- if you need us to move something around, we can --

DR. PHILLIPS: Okay.

MR. CLINE: -- certainly do that. And then after that, we'll have it in the queue and ready to go up on the Space Weather Living History tool that we're creating. And then we'll let you know --

DR. PHILLIPS: Very good.

MR. CLINE: -- when that's happening. All right?

DR. PHILLIPS: Okay. Well, I look forward to the next step and to the finished product, and it was a pleasure talking to you today.

MR. CLINE: Thank you very much. And you have a -- have a great -- have a great afternoon.

DR. PHILLIPS: Okay. Thanks very much.

MR. CLINE: Uh-huh.

DR. PHILLIPS: Bye-bye.

MR. CLINE: Bye.

(Whereupon, the interview of Dr. John Phillips was concluded.)

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CERTIFICATE OF TRANSCRIPTION

I, MARY E. YOUNG, hereby certify that I am not the Court Reporter who reported the following proceeding and that I have typed the transcript of this proceeding using the Court Reporter's notes and recordings. The foregoing/attached transcript is a true, correct, and complete transcription of said proceeding.

_____ _____

Date Mary E. Young

Transcriptionist