DISCOVERY 30TH ANNIVERSARY ORAL HISTORY PROJECT
EDITED ORAL HISTORY TRANSCRIPT

INTERVIEWEE HAROLD F. LEVISON
INTERVIEWED BY SANDRA JOHNSON
BOULDER, COLORADO — AUGUST 2, 2023

JOHNSON: Today is August 2, 2023. This interview with Dr. Hal Levison is being conducted for the Discovery 30th Anniversary Oral History Project. The interviewer is Sandra Johnson. Dr. Levison is in Boulder, Colorado and talking to me today over Microsoft Teams. I appreciate you talking to me again today for our second interview.

You made a statement last time when we were talking about the Nice model. You said that you were amazed that this model has held up as long as it has. Is there a specific reason why that's unusual for this type of model? Why would it not hold up?

LEVISON: Well, I think it's just typically what happens in these kinds of models is that you come up with these ideas. That one was particularly out of the box and different. The expectation is people will continue working on it and exercising it, and eventually it fades away and something that hopefully it contributes to. That's the way science is done. I think it's sort of surprising that—well, let me take a step back. There are a lot of ideas floating around in the literature that compete to explain certain observational facts. Most of them, if not all of them, end up being wrong in the long run. Again, that's how science is done. To stumble onto an idea that is actually robust and lasts for 20 years is unusual.

JOHNSON: Okay. I was just curious about that. I wasn't sure when people come up with ideas how long it takes for people to put holes in them.

LEVISON: It depends on how good the idea is.

JOHNSON: Well, hopefully with Lucy the idea will be strengthened instead of discounted.

LEVISON: I don't care either way. A lot of people in this field base their self-worth on their ideas. I think that's very bad for science because it means that they try to hold onto their ideas for a long period of time. The way I've dealt with that is I assign self-worth on having ideas. If you're pushing the envelope, a good fraction of them will be wrong. That certainly has happened to me. But to actually judge how you value yourself and whether your ideas are right is a dangerous thing. If the basic ideas underneath the Nice model are wrong, somebody will figure it out eventually. That's how science is done.

JOHNSON: Lucy is a long duration mission; the things that you want to accomplish or the places planned that Lucy will visit is going to be at least 12 years from the time it launched. That's a long time to be a PI on a mission. I know a lot of the Discovery missions, the people I've talked to, they're more a couple of years, three or four years. They're shorter duration missions. Or else once things start off, they go on and do other things. Are you planning to be focusing on this mission the whole time?

LEVISON: Yes. If I have time to do other things, I'll do other things. I'm a little unusual for a PI [principal investigator] because I'm older and had a successful scientific career even before I got involved in the mission. If I had stopped and retired—I was a little young for that when we started

Lucy—I would've walked away saying that I had a very successful scientific career and have influenced the field in fundamental ways. Because of that, I don't mind concentrating on Lucy and having this be sort of a cap to an end of a successful career. I think that gives me advantages as a PI that I'm not worried about my legacy scientifically and the success of Lucy. Although I'm doing everything that I can to make it a success, it's not directly tied to my legacy in my mind. A lot of younger PIs have come up through the ranks and that's what they wanted to do. They've been involved in missions their whole career building up to being a PI. In a way, they really do view their legacy as being directly tied to the mission. I'm not like that, and so I decided it would be an excellent way of ending my career and set it up so that I will be able to do that.

JOHNSON: I hadn't thought about that, but I guess a lot of younger PIs, if they're going to be doing this, a lot is tied up into those initial successful missions and getting that behind them so that they can move on and do others. That makes sense.

LEVISON: Right. I'm unusual that way.

JOHNSON: When I talked to Keith [S.] Noll, because he's older and he was talking about how he hopes to be there at the end too. And he did mention that people are older on Lucy so it may be the last thing, so I thought that was kind of interesting.

We talked about the plaque that you did, or that you came up with the idea. I think that was such a good idea. And I know there were some other types of public outreach that were done. They had the Lucy Soundscapes; the patch, the contest for the kids, Lucy in Space; the time capsules. I thought that it was interesting, that type of outreach. Some of these missions are more

high profile than others. Also, Keith shared the posters, the very 1960s psychedelic posters that were designed.

LEVISON: He and I did that together, and we've had fun doing that.

JOHNSON: Yes, that's what I was wondering if you just want to talk about that for a little bit and where those ideas came from. Do you think that excitement is being generated with younger kids about Lucy?

LEVISON: We're doing the best that we can. One of the challenges that we're faced with is that we're not going to have the critical science for a long time, and so we're being as creative as we can to keep the interest there. I tend to think that NASA generates a little too much noise, and so I don't want to be making a lot of noise when nothing really is happening. We're working on this balance of making sure people remember that we're there and that we're doing things versus not discovering water on Mars every two or three years. I have an excellent team. Katherine Kretke is, on our side, our main outreach person. She, I think, has a similar concern as mine but is doing an excellent job at finding that balance.

Now, some of the things, like the posters, are not directly related to outreach. We're using them for outreach. We did that for the team. This is all intended to be internal stuff to keep the team interested over these long periods of time and just to have some fun, and so that's really what led to those posters.

JOHNSON: Yes, I just thought they were so neat. Of course, it goes back to the generation I grew up in so I enjoy them.

LEVISON: Me too, and Lucy the fossil. We chose that time period—I don't know if we covered this before. Lucy the mission is named after Lucy the fossil. Lucy the fossil is named after the Beatles song, "Lucy in the Sky with Diamonds." We're trying to make that cultural connection because all that stuff was happening during this period of time.

JOHNSON: Yes, and I think it makes that connection really clear. I enjoyed looking at them because of that. I can see where that would be appealing to your team as well.

The Soundscapes were interesting. I went out and listened to some of them and some of the music that people came up with. I think those kinds of things are appealing to artists and people in the public and kids in school.

LEVISON: Are you interviewing Tom [Thomas] Statler, who's a project scientist?

JOHNSON: He's on my list, but I haven't contacted him.

LEVISON: That was his idea. He's an amateur composer. He's actually written a symphony about Lucy during the pandemic.

JOHNSON: I'm going to move on to the mission itself. Some of the details about how the information is going to be gathered once you start visiting the asteroids. This November will be the first one, right, for Dinkinesh?

LEVISON: Yes. It's not a science target but it's to test everything to make sure—

JOHNSON: So the information you'll be getting back there is more to see if the instruments working?

LEVISON: It's not even the instruments that we're mainly concerned with, although we're going to be testing them somewhat. We have an innovative system onboard that actually is observing the target as we go by and making sure that the instrument's field of view are always pointing at the target. If you go back, for example, to New Horizons encounter, they took a significant fraction of data of blank sky because they didn't know where Pluto was accurately enough to be able to point their instruments. As a result, they just covered that uncertainty, and only a certain fraction of the images actually had Pluto in it. We made the spacecraft smart enough that it should keep the instruments pointing at the target the entire time. That is a system that, although there is heritage, really has not been flown before, the exact system we're using.

It turns out as we started putting this together, we realized that we are in a position where we are stressing that algorithm—it's a computer algorithm—in a way that it will struggle to work accurately enough. It has to do with the geometry of the approach, which we're coming from the side. If this is the Sun, right here is the target, we're flying this way almost at 90 degrees. That means there are a lot of shadows and things like that during approach. The shapes of these things,

because they're small, could be challenging. And so as we were doing more and more work to make sure this algorithm's going to work, we realized that we better test it a couple times to make sure it's going to work in space. That's why we're doing Dinki.

JOHNSON: Okay. You'll have another gravity assist in 2024, and then 2025 will be DonaldJohanson?

LEVISON: Yes. And that's, again, another test.

JOHNSON: Will it be similar to what's going on with Dinkinesh?

LEVISON: We added Dinki because, remember when I was describing this, one of the things we're concerned about is the geometry that we're approaching at 90 degrees. It turns out we can do that with Dinkinesh but we can't do it with DonaldJohanson. From DonaldJohanson's point of view, we're coming out of the Sun and so we're not going to be challenging this algorithm as much with that. Because since we're looking at it face-on, there won't be many shadows. It's going to be a useful test for other reasons, but we decided we really needed to have something at high phase angle. That's that angle. The other issue is that there's a philosophy when you're building instruments like this or spacecraft like this called fail faster. If something's not going to work, you want enough time to be able to fix it. Doing it on encounter in 2023 rather than 2025 gives us a lot more time if we find something wrong for 2027 encounter with a Trojan. Also, if we find something wrong and need to fix it, we'll get another chance to test it before we get to the Trojans. All of that sort of made sense to us to put those resources into doing this.

JOHNSON: That makes sense. It's interesting because people think you just fly up and do something and it's no big deal, but you have to have that time built in to make adjustments.

LEVISON: Again, I'm going to compare us to New Horizons because in a way we're very similar to New Horizons when it comes to our concepts of operations at least. The spacecraft's very different. They had one encounter, and they had 10 years to plan that encounter basically. We have 4 encounters in 15 months. What that means is that we have to have all the science sequences, everything we want to do planned early enough that we're basically going to program the spacecraft and let it go. That's a challenge. I'm worried about getting it all done in time actually, even though 2027 feels like a long way away.

JOHNSON: Yes, it does seem like a long way away, but I guess it's really not. When you get to the first Trojan in 2027, when you start getting that information coming in, you mentioned you have to wait a long time for the results. What comes in first? Will you be seeing the photos or will it be data? How is that going to work?

LEVISON: Well, the photos are the data. If you think about it, even the near-infrared spectra are all really focused. Yes, we set priorities for different things. We have a list of first light, we call it, observations. Those will come down fairly quickly so that we can have a press release and show data and stuff like that. And then we set the priority of which is coming next. We haven't gotten that yet. It'll take a while to get it all.

JOHNSON: That's what I was wondering how quickly you would be talking to the press about what you're seeing.

LEVISON: Some of the really rich stuff, like the really close approach images, will come down first so that we can start talking to the press about what we've done. That's pretty typical.

JOHNSON: Yes, that'll be fun. It's going to be interesting when those first images start to come out to the public.

LEVISON: Well, again, it doesn't seem that far away.

JOHNSON: What do you think are some of the lessons learned with your experience with Lucy and with this Discovery class mission in the way that these missions are run.

LEVISON: I think the Discovery mission is unique of the missions that I know about, except for maybe the really small missions, where the community has the ability to propose anything that they want. Even other PI-led programs, New Frontiers[1] for example, NASA actually puts in the AO [announcement of opportunity], "This is what we want to do." When it comes to Discovery, it's open to basically anything in the solar system. I think that allows for a level of creativity. I think our sister mission Psyche[2] is a perfect example of that, where you go through a referee

[1] The New Frontiers Program is designed to accomplish focused planetary science investigations, using innovative and efficient management approaches. The Program's prime objective is to answer unique science questions in the exploration of the Solar System.
[2] The Psyche spacecraft is traveling to a unique metal-rich asteroid with the same name, orbiting the Sun between Mars and Jupiter.

process to determine what science is the best bang for the buck. Even New Frontiers, for example, they take a list of topics from the Decadal Survey[3]. That is basically a list developed through consensus, and there really isn't a competition like Discovery for deciding which science is the best to do. Discovery is unique in that way.

Now, it turns out Lucy—one of the New Frontiers' targets, before we were selected, was studying Trojans. We actually didn't really do something different than what NASA was asking to do. We're doing it differently than they wanted it done, so I'm not sure we could've gotten away with proposing something like this to New Frontiers because there are aspects of the science, I would argue, that didn't make it through that consensus building step. What New Frontiers had when we were competing was to basically orbit a Trojan and do a detailed study of one object.

What we argued successfully with Lucy is this idea—I think I mentioned it last time we talked—that these objects are very different from one another, and it's the diversity that's interesting. You couldn't, in my view, really successfully do what New Frontiers wanted done because you didn't know which one would be interesting. The first thing we should do was a reconnaissance. Find out what that diversity means and then maybe do an orbiter later on once we understand which objects are interesting and why they're interesting, or which type of objects are interesting to look at. Again, that probably wouldn't have been able to work in New Frontiers because of the way the New Frontiers call was written. But since Discovery's open to anything, that allowed us to make that argument. Is that clear?

[3] NASA relies on the science community to identify and prioritize leading-edge scientific questions and the observations required to answer them. One principal means by which NASA's Science Mission Directorate engages the science community in this task is through the National Research Council (NRC). The NRC conducts studies that provide a science community consensus on key questions posed by NASA and other U.S. government agencies. The broadest of these studies in NASA's areas of research are decadal surveys. As the name implies, NASA and its partners ask the NRC once each decade to look out 10 or more years into the future and prioritize research areas, observations, and notional missions to make those observations.

JOHNSON: Yes, it is clear. I was going to ask you about your thoughts about the relevance or the importance of the Discovery type missions for planetary science and for exploration, so I think you answered that there. That it's because of that freedom that they allow science, which is unique, as you said. Is there any decisions that were made for Lucy that you might not make again if you did it over again?

LEVISON: The only thing that I can think of is use a different type of solar array. We're in a good place except for the solar array, and hopefully that won't be a big deal. Being in a good place, it's hard to go back and say this was a wrong decision, and so no. Except for the solar array, I think we have done everything about as good as we could do it.

JOHNSON: I have a couple of questions, but I was wondering, is there anything we haven't talked about with Lucy that you wanted to mention? I know we've kind of skipped around a lot today especially, but if there was anything that we didn't mention last time.

LEVISON: I'd have to go back and actually remember what we talked about. I can't think of anything except for emphasizing the importance that the team—having the right people in the right places, how important that is to the success of anything that big. And how, particularly the people you're going to talk to from Donya [Douglas-Bradshaw] to Keith to Jessica [A. Lounsbury], all those people were the right people in the right time. That's why we're being successful.

JOHNSON: Is there anything that you would say you're most proud of? I know the mission's not over yet so it may be kind of hard to pick now, but is there anything, thinking about your role with Lucy, that you think you're most proud of at this point?

LEVISON: Yes. There are two things I can think of. The first is—and I think we mentioned this the last time—related to this idea of teamwork. This is one thing I think a PI has a lot of influence on is the culture of the team. No one blames anybody. Everybody's always looking forward. No finger pointing. No anger. I've never heard anybody angry in a meeting. People have gotten angry, including myself, and I'll call the person. But calling people on to the carpet in meetings is just not done. I wouldn't tolerate it if it were and the team knows that. One thing is fostering a culture that leads to success and people being happy. That's probably the thing I'm most proud of. I think also being involved—is not quite the right word—in the CONOPS [concept of operations] and being able to do the science planning and understanding how the spacecraft is actually going to be flown in an intuitive way, and being involved with all that at a level that I'm told is not typical for a PI is something I also take pride in.

JOHNSON: So being involved with the engineers and the people building it and that sort of thing?

LEVISON: Yes. Well, it's more the people that are going to fly it, but really being involved in this terminal tracking system, which is what I was talking about earlier. And realizing that the assumptions being made by the engineers were too simplistic, and that kind of thing forcing them to go back and reevaluate some of the decisions they made in order to make sure it's going to work, understanding it well enough to do that, writing some of the original codes that model the

encounter itself. That kind of thing I take pride in. A lot of how we're doing the details of the science planning, convincing ourselves that the science sequences are going to be successful, that initial design I was totally involved in.

JOHNSON: From some of the other missions I know the roles are more specifically defined and it sounds like you were involved with a lot of things beyond just the science as far as communication, as we talked about, and that teamwork.

LEVISON: Yes.

JOHNSON: I asked Keith about this a little bit, and I thought I'd like to get your experience with it. He was the project scientist and the NASA scientist and then you're the PI, talk about that relationship and how that worked between the two of you.

LEVISON: I've known Keith for 35, 40 years. It's really been that long. We've respected each other scientifically for a long time before either one of us got involved in mission, although a lot of his work was with Hubble [Space Telescope]. I would say he runs the day-to-day management of the science team. He does the meetings. He distributes tasks to the science team and things like that. Besides that on an overall arching management of the mission, I tend to think there's a group of three of us that are sort of badgeless. We talk to each other all the time. Everybody has equal say. The decisions are always mine but that's because somebody has to make the decision, but it's pretty open flowing discussion. Why, what did he say?

JOHNSON: Pretty much the same. He gave you a lot of credit for being a good leader and instilling that in the team.

LEVISON: It's the way I think teams should work. Everybody has their responsibilities. But it's sort of a flat structure from my point of view, at least at the leadership level.

JOHNSON: I would think a lot of communications, especially with engineers, scientists, technical people, managers. All the different people you work with but everybody has to understand the same language at some point and get along.

LEVISON: It's true. He's involved probably at a lower level than typical project scientists are. He attends all the meetings. Basically any meeting that I do he attends, so does Simone Marchi who is my deputy. We're all sort of equally involved. Keith and I would tend to do good cop, bad cop dynamics when we're at meetings that we're not happy with. We'd be texting in the background. That's one advantage of actually doing Zoom and Webex meetings rather than being in the room. One of us would get upset at something and I would say, "You do that. You bring that up," because you have to be careful. The PI has a special place of leadership that if you wanted to complain about something, it's taken much more serious if anybody but you does it. Quite often, if there's an issue, I'll have him do it, bring it up or push on it, and then I can mediate the answer. That's the dynamic we've used a lot.

JOHNSON: That's interesting. Teams does allow that background communication going on. I would assume that the worst thing you've had to deal with, or the thing that you've found was

difficult, was probably having to deal with the solar arrays. Is there anything else that was especially difficult getting up to the point of launch?

LEVISON: COVID wasn't easy. We were lucky, and I think we discussed this the last time about where we were in the development of Lucy that allowed the impact to be small. It stressed the team, particularly the folks at Lockheed, beyond—they certainly couldn't work like that continuously for years, year in and year out. We had some turnover that was unexpected that was stressful for me. But, again, the institutions as teammates always stepped forward to make sure that we got the people to replace the people that left.

Even the solar arrays were interesting. It was a bad time, but it was a joy to watch the engineers figure out what happened and very quickly actually. Within a month they knew what happened and figured out what to do. It was really an impressive piece of work. That was fun if you call it that. It was scary for a while. It's still a little scary.

JOHNSON: Yes, I think I'd read that they think it's 98 percent deployed, just not latched.

LEVISON: Yes, but the not latched is the important part. We're certainly getting enough power. But the structural integrity—these things are made out of cloth. If you think about it like a clothesline, or a better idea is a guitar string. The strength is due to tension, and we don't have all the tension that we need. So I'm more worried about the structural integrity and behavior, the spacecraft vibrating too much than I am about power. Power we're fine.

JOHNSON: Yes, well, hopefully it'll hold and it won't cause any problems. If there's anything else you can think of or even later when we get the transcript back if you feel like we didn't cover something enough, feel free to add that or we can talk again and you can talk about it, either way. I appreciate you talking to me again and finishing up a few of those questions. I'm going to go ahead and stop the recording.

[End of interview]