INTERVIEW

OF

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P R O C E E D I N G S

INTERVIEWER: Okay. If you can just tell us who you are.

DR. SCHRIJVER: My name is Karel Schrijver, and I work for the Lockheed Martin Advanced Technology Center, where I am an astrophysicist, a researcher.

INTERVIEWER: Perfect. Our first question is, what is your primary research interest? And we'll follow that up with, what is it that you actually personally like about that?

DR. SCHRIJVER: You know, the interesting thing is that my primary research interest has been shifting an awful lot. It goes from year to year in different directions. Right now, what I am really interested in is two things.

One is understanding the sun's magnetism and the variability that drives all of the space weather, but the other, really, is, how much can we actually understand, quantify, follow the impact of space weather into society directly, not merely our technological infrastructure, but actually understanding the impact on our daily lives.

INTERVIEWER: Okay. Perfect. And the next question I will ask is, with what and when were you involved in space weather research throughout your career?

DR. SCHRIJVER: I became involved in space weather research, really into what is called space weather, after coming to the United States -- I was trained and educated in The Netherlands, I came here 17 years ago now -- and eventually found myself on advisory committees of NASA where I started to really talk to colleagues from different fields that were not solar, but they were working in the heliosphere, they were working on the environment of the Earth. And increasingly I found myself involved in the research of space weather.

Right now, my main involvement is in the fact that we have the Solar Dynamics Observatory looking at the sun, the cause of all of space weather. We have incredible amounts of data coming down, beautiful imagery coming down, and of course it's interesting to then ask the question, well, what does all of that do? How do we follow that through the space between the sun

and the Earth, and how does it drive space weather?

INTERVIEWER: Okay. Very good.

DR. SCHRIJVER: My interest in astronomy really started when I was sitting late at night, in the middle of the night, because that was the way it was broadcast in The Netherlands, the Apollo landings. I was 11 at the time, and I remember just sitting up through the entire night looking at this black and white screen, looking at the Dutch commentary over what was happening on the moon.

And that was at the time that I was deciding, well, what kind of school type do I go to, because in The Netherlands you differentiate that way. And, well, I really am interested in technical things. I'm actually interested in physics. So I started studying physics, realized after a while that there is much more new ground to cover in astrophysics, so I drifted into astrophysics. But I was trained as a stellar astronomer.

And the main frustration of a stellar astronomer is you can look at stars of different ages, of different rotation rates, you can vary all sorts of

things, but everything is a point. And you can never understand what happens on the point until you look at one in great detail. So I, even during my graduate years, turned my attention to the sun and looked at all of those beautiful images that then were taken, which now look so simple, and of poor quality.

But that really triggered it, and from then on I got increasingly interested to understand what was happening and how we could expand from what we could see at the sun into the space that we can't actually see, into the heliosphere where everything is measured locally, but you can't make images anymore.

INTERVIEWER: Question now, what are some of the key events and turning points in space weather research that you can share with us?

DR. SCHRIJVER: I think there are two points that to me really changed things. One had to do with the fact that at some point just a few years ago we suddenly saw the sun from all sides, and we could actually see the connections of events going off on the sun. Until then, I think most researchers had the idea that some explosion happened in some location. And,

therefore, if you wanted to understand the explosion, you studied what happened at that location.

But increasingly, we have become aware that the magnetic field that pervades all of the solar atmosphere, that is the driver of everything that happens in there, is really a field that you sense over long distances. So sometimes we see things happen on one side of the sun, and literally we can see the atmosphere being distorted, pulled apart, and something on the other side of the sun happens.

And then we are talking about 500,000 miles away. That is a long distance. And, still, we send -- we can directly see that space weather is in many cases a much larger phenomenon, and that comes out of this wonderful ability of looking at the sun all the time with great instruments, and now from three different angles.

Another really interesting event was when, in the middle of the summer of 2011, we actually saw the very first comet go into the solar atmosphere. Until then, we had seen several thousand approach the sun, but none of the made it into the atmosphere proper.

And seeing that relatively tiny object light up and disappear as it was subjected to this intense heat of the solar atmosphere is interesting, but it did something else, particularly when the second one came along just half a year later, because what then we realized was happening was we had a little point source that was throwing out material, as the comet was evaporating, into the solar corona.

And by tracing what that material was doing, we could actually learn the conditions of the solar corona. We can measure the direction of the field. We can indeed have an idea of the direction of the field. We can measure indirectly, but we could derive the density and the temperature, and all of that in a domain that doesn't light up. So if the comet hadn't been there, there would have been no signal coming from there.

So it was the very first time, in a sense, that we had a probe going through the solar corona, of which we can now analyze the signal. And this is one of the things that NASA is looking forward to in the near future -- sending a probe too close to the sun.

It can't get as close as the comets can, but it will sample another domain. But we have had the first flavor, all of these lessons we can learn from that thing going in there. It was a great experience.

INTERVIEWER: And if you could give us a few parting comments, closing comments, that are in your mind right now.

DR. SCHRIJVER: Well, I think one thing to realize is that we know the sun as an object in our sky, and the sun is only one of an incredible number of stars just like it out there in the galaxy.

So if we would like to understand what happens on the sun, what drives space weather, this mysterious process that happens in its interior that we call the dynamo, that we don't really know very well, we are beginning to get a grip on it, that we can get it into a computer, but we can't yet forecast.

And in the moment that someone says, "Here is an idea by which I can now forecast what the sun will do 11 years from now, or 22 years from now," we would say, "We would love to test that." But to test it is going to take a century or two centuries before you are

happy with it, unless you can look at many other stars. If you look at many stars, and much faster can you say, "Yeah, this is a good model" or "this is a bad model."

It's very similar to a physician looking at a patient. He doesn't learn necessarily from one patient, but from many patients you can infer lots of lessons.

So I think space weather is something that, in general, we should think about as happening throughout the universe. And there are lessons in the universe at large that we should apply to our own sun.

(Whereupon, the interview of DR. KAREL SCHRIJVER was concluded.)

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