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Interview of Joan Feynman

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INTERVIEW
OF
JOAN FEYNMAN

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1 P R O C E E D I N G S

2 MS. FEYNMAN: Hello.

3 MR. CLINE: Hello, Joan. This is Troy
4 Cline. How are you?

5 MS. FEYNMAN: Okay. Well, pretty good. I'm
6 trying to beat a cold.

7 MR. CLINE: Oh, is that right?

8 MS. FEYNMAN: So I didn't go to work. Huh?

9 MR. CLINE: You're trying --

10 MS. FEYNMAN: Yeah.

11 MR. CLINE: -- beat the cold?

12 MS. FEYNMAN: Yeah, I'm -- I'm coming down
13 with a cold and I'm trying to --

14 MR. CLINE: Hope not.

15 MS. FEYNMAN: -- I didn't want to go outside
16 because it'll only get worse. Let me turn off my
17 iPad. Okay?

18 MR. CLINE: Okay.

19 MS. FEYNMAN: I'll be right back.

20 MR. CLINE: No problem.

21 Can you hear --

22 UNIDENTIFIED SPEAKER: Uh-huh.

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1 MR. CLINE: -- her?

2 (Off the record.)

3 MS. FEYNMAN: Okay.

4 MR. CLINE: Okay. Welcome back.

5 MS. FEYNMAN: I'm back. Yeah. Now, do we
6 want --

7 MR. CLINE: She's --

8 MS. FEYNMAN: Do we want to do an interview
9 now or what?

10 (Off the record.)

11 MR. CLINE: Yeah, we're working -- right now
12 we're working on just the sound. So as you were
13 talking, I was -- we're adjusting the volume. And --

14 MS. FEYNMAN: Okay.

15 MR. CLINE: And I think we're just about
16 ready. Yeah, we can absolutely do the interview right
17 now. And usually --

18 MS. FEYNMAN: Okay.

19 INTERVIEWER: -- how I open that up is in a
20 minute I'll just ask you to tell us, this is for the
21 audio person later on when he's doing the files, but I
22 usually ask the person to just say who they are and

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1 what they do or most recently have done and basically
2 your field. And then we start with the first
3 questions.

4 And then I won't speak as much, as I was
5 telling you before, so that they don't have to edit me
6 out. And we'll just start with the primary research
7 interest, what you like about it, and how you're
8 involved in space weather and some of the key events
9 and turning points. And then you can talk about
10 anything --

11 MS. FEYNMAN: You mean, you want me --

12 MR. CLINE: -- that sounds interesting.

13 MS. FEYNMAN: -- to just start talking and
14 you're --

15 MR. CLINE: Uh-huh.

16 MS. FEYNMAN: -- not going to ask me
17 anything?

18 MR. CLINE: I will -- actually, I will pop
19 in here and there as we go through the conversation.
20 I'll --

21 MS. FEYNMAN: Because --

22 MR. CLINE: -- make sure we stay on track

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1 with the right questions. And if we do get --

2 MS. FEYNMAN: Okay. So you --

3 MR. CLINE: -- into a conversation, that's
4 fine.

5 MS. FEYNMAN: I think it's a good idea to
6 you -- for you to ask me questions and I'll answer
7 them because --

8 MR. CLINE: Okay.

9 MS. FEYNMAN: You know, one by one, because
10 I don't see -- you know, I don't have a talk --

11 MR. CLINE: Uh-huh.

12 MS. FEYNMAN: -- ready to -- if -- to go on
13 for a few minutes. So it's --

14 MR. CLINE: Okay.

15 MS. FEYNMAN: -- not the way I normally
16 work. So --

17 MR. CLINE: Okay.

18 MS. FEYNMAN: -- if you're going to ask me
19 who I am and --

20 MR. CLINE: Uh-huh.

21 MS. FEYNMAN: -- what I do, please ask me
22 that, then you can edit it out.

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1 MR. CLINE: Okay. That's fine. That will
2 be fine. And if I do ask a question, if it makes
3 sense during the conversation, right after I ask the
4 question, you can just restate the question as you
5 talk.

6 Like, if I say, you know, what is your
7 primary area of research; you say, well, actually my
8 primary area of research is, you know, and you just.

9 That way it's easier to edit me out if we
10 need to. Sometimes they keep my voice in, just
11 depending on what I say. I never know what I'll be
12 saying either until the interview starts.

13 MS. FEYNMAN: Okay. This is slow to work
14 with, but I'll do my best.

15 MR. CLINE: Oh, you'll be just fine. And
16 actually, the way we're talking right now is exactly
17 the way to do it. And if there's --

18 MS. FEYNMAN: Okay.

19 MR. CLINE: -- any part that doesn't make
20 sense and you're like, oh, scratch that, let's -- let
21 me start that over, just say that and the --

22 MS. FEYNMAN: Yeah, okay.

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1 MR. CLINE: -- editor will know to do that.

2 MS. FEYNMAN: Interrupt me and tell me, you
3 know, if I go off but please --

4 MR. CLINE: Okay.

5 MS. FEYNMAN: -- lead me along, because --

6 MR. CLINE: I sure will.

7 MS. FEYNMAN: -- otherwise, I will be
8 babbling.

9 MR. CLINE: That's no problem. We'll take -
10 -

11 MS. FEYNMAN: Yeah.

12 MR. CLINE: -- care of that.

13 MS. FEYNMAN: Okay.

14 MR. CLINE: Well, we're -- I'm really --
15 we're real excited that you agreed to do this. And
16 it's -- I'm looking forward to talking with you right
17 now about space weather and -- and your influence and
18 what you've -- your part in the space weather research
19 that's been going on over the years.

20 EXAMINATION

21 BY MR. CLINE:

22 Q And why don't we start this interview, Joan,

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1 by just -- why don't you tell us who you are and a
2 little bit about what you do with space weather.

3 A Okay. My name is Joan Feynman. I work at
4 the Jet Propulsion Lab at this time. And space
5 weather is something I do from time to time.

6 But the solar terrestrial relationship is
7 what I do all the time. Space weather is a subset of
8 those because it consists of the sun doing something
9 to the solar wind that does something to the earth.
10 And it becomes space weather when it's dangerous to
11 something else, like people or power plants.

12 Q So in large, the greater picture of what
13 you've studied over the years, really has to do with
14 the effects of the sun on the entire solar system. Is
15 that correct?

16 A Well, it's really effects of the sun on the
17 earth

18 --

19 Q Okay.

20 A -- mostly and on the interplanetary medium
21 between the sun and the earth. And it's not just
22 effects of the sun. It's also understanding the sun

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1 itself. There are lots of problem with the sun; for
2 instance, how does it get its solar cycle and why is
3 the solar wind the way it is, and so on. And so I
4 cover all of those problems.

5 Some years ago, when I first came to JPL,
6 which must be like 30 years now, I was in a group
7 where my boss asked me to -- to make a model for the -
8 - the environment that the Magellan satellite would be
9 -- could be expecting as it flew.

10 And I looked at what had been done, and I
11 thought the person who had done it had done a very
12 good start at devising a method but that there were
13 certain things that needed improvement, so I improved
14 them.

15 One of the things was that it had been
16 considered that each solar energy particle event was
17 independent of another. And if you looked at the
18 data, that wasn't true. They came in groups.

19 And if you do a statistical analysis, which
20 is what I was doing, you have to take account that
21 there are groups, not just individual ones.

22 And that was my major contribution to that

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1 for quite a while. There are still arguments about
2 what are the groups. I think it's known but not
3 everybody agrees.

4 Q And when you say "groups," can you explain
5 to us a little bit more of what you mean --

6 A Yeah.

7 Q -- when you say that.

8 A Uh-huh. Yeah. When there's -- the way --
9 the most important thing in space weather, I would
10 say, is that there are events when in the solar wind
11 there are high energy particles accelerated by
12 disturbances in the solar wind.

13 These disturbances are due to phenomena
14 related to solar flares. A big glob of the solar
15 corona comes flying out at enormous velocities like
16 1,000 kilometers per second.

17 And solar wind, which is a -- which is
18 totally ionized, that is, it's a bunch of protons and
19 electrons and some helium doubly -- with charged
20 helium, so on, it acts like a fluid which was a big
21 surprise to the early people. They couldn't see how
22 it acted like a fluid.

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1 What it does is -- and the reason is unknown
2 but not for this -- anyway, the -- this big blob,
3 which is called a "coronal mass ejection," goes
4 through the solar wind and like a boat going through
5 an ocean it causes the shock -- a shock.

6 And this shock manages to accelerate
7 particles in the solar wind to very high energies.
8 And those particles come into the earth and can do all
9 sorts of damage to spacecraft, also spacecraft in
10 space.

11 And the whole coronal mass ejections cause
12 great geomagnetic storms. And there are big currents
13 in certain parts of the atmosphere. And those
14 currents cause currents in the flow in the power
15 plants in their, you know anyway, And the result of
16 that can be (inaudible).

17 Q Uh-huh.

18 A You know, like if you have a big surge of
19 current on the -- on your wire at home, you're liable
20 to blow up the toaster.

21 Well, here, there's a big surge of current
22 in the ionosphere, you blow out the power plants. And

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1 it's very expensive and very annoying.

2 And so that's one of the things people, if
3 you knew one of these very fast coronal mass ejections
4 was coming, then you could do something to shut down
5 the power plant for a couple of hours and then put it
6 back up again.

7 Q So --

8 A But.

9 Q Uh-huh.

10 A So this is of great importance to power
11 plant people and causes lots of money being lost.

12 Q Now, you mentioned Magellan, the Magellan
13 spacecraft. Can you tell us a little bit about what
14 that spacecraft was and the instrument aboard the
15 spacecraft that

16 --

17 A Of course.

18 Q -- that was connected to the work you did.

19 A No, I can't. Several reasons I can't do
20 that.

21 Q Okay.

22 A One is my -- the only question I was asked

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1 was what was the space environment that spacecraft had
2 to be able to operate in. And that does not include -
3 - I mean, I knew where it was going, I don't remember
4 anymore -- but that does not include the particular
5 instruments. It only includes what kind of particles.
6 They will have to be designed so they're not clobbered
7 --

8 Q Uh-huh.

9 A -- by the particles as they're expected. So
10 I don't have to know about the details of the project
11 that Magellan was on.

12 If you want to know, you can look it up.

13 Q Oh, sure.

14 A Actually.

15 Q And then --

16 A Yeah.

17 Q But what you found was very interesting.
18 And it was because of your research that you found out
19 that these particles operated in groups, if I'm
20 understanding properly, and that it --

21 A Yes, right, and so that the expectation, if
22 you got one you got several, was high. And that made

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1 a difference in the predictions as to what you may
2 get. That is, we knew there were -- in the time we
3 flew about ten big events, big coronal mass ejections.

4 It makes a big difference in predicting
5 whether those ten came in three groups of three and
6 one separate or was -- which would make -- you'd have
7 to predict four groups or ten separate groups. The
8 statistics are all together different.

9 And the -- that's -- and those models, the
10 models that the spacecraft designed to -- that is to
11 say, I calculate the probability that you couldn't get
12 an event with so -- and so many high energy particles
13 of such -- in such a -- well, the -- the flux --

14 Q Uh-huh.

15 A -- of the particles. And then the designers
16 of the spacecraft have to take that information and
17 say, okay, we have to design our spacecraft and the
18 instruments on it so that it can stand that much
19 radiation without collapsing. And that's what the
20 space environments needs.

21 Q Well, so up until that --

22 A Okay.

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1 Q -- point, they weren't -- the spacecraft --

2 A No.

3 Q -- really weren't prepared for that?

4 A No. What happened was that the model that
5 was invented had an error in it. And I corrected the
6 error and the error gave different results for the
7 space environment in the original prediction method.

8 Q Well, that's significant.

9 A And they were important different events.

10 In fact, when Magellan went up, suddenly it
11 -- I got a telephone call from the chief scientist
12 saying, my God, we've had all these sudden events on
13 the sun. He said could it kill us. I said, no, you
14 designed for it. And he was very much relieved.

15 Q I'll bet. I'll bet. Even today, can you
16 imagine people not paying attention to that --

17 A Well --

18 Q -- research.

19 A Huh?

20 Q I mean, even today, can you imagine if they
21 -- if anyone sent spacecraft up without that type of
22 protection or preparation, it wouldn't last that long,

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1 I would imagine.

2 A Well, it would be a waste of money, because,
3 I mean, you have to make certain decisions about how
4 to protect the spacecraft. And if you make decisions
5 that are way out of reality --

6 Q Uh-huh.

7 A -- it -- you waste money because you spent
8 too much time or too much money protecting it or it
9 wastes time because you haven't spent -- given it
10 enough protection and it gets clobbered.

11 So it's -- and -- in spacecraft design and
12 so on you have to worry about the possibilities that
13 things get broken or that things don't work. And it's
14 money either way, so it's --

15 Q That's right.

16 A -- a -- it's a give and take on that
17 project.

18 Q And it's also vital to human exploration. I
19 can imagine if we have humans exploring or living in
20 space and even in those days, I mean, we're -- I guess
21 this is --

22 A Well, the human stuff is very important. I

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1 mean, if you want to fly to Mars or something, you
2 have to know what the environment is.

3 And if you've got a human being in there,
4 then you have to decide what probability you want that
5 he will not be hurt, he or she will not be hurt by the
6 high energy particles (inaudible).

7 And my job was to predict the probabilities.
8 And the -- there are new models that have been
9 developed since mine, but they were -- all the models
10 were based on the same general principles.

11 And one of the problems is there's a lot of
12 question about the description of if you make
13 something -- if you want to know how many events are
14 going to have fluencies or fluxes above a certain
15 amount, it very much depends on -- when you do it, it
16 very much depends on what you know about coronal mass
17 ejections.

18 And so besides doing this space weather
19 part, I also do things like study what you know about
20 coronal mass ejections. And the sun has a solar
21 cycle, which every 11 years the sun gets more spots
22 and then it starts out for three or four years in the

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1 sun increasing the number of sunspots. You know about
2 sunspots?

3 Q Yes, and the sunspot cycle, uh-huh.

4 A Yeah, and then for seven years it decreases
5 the number of sunspots. And the number of events that
6 you expect depends partly on the sunspot number.

7 So it would be nice to be able to predict
8 the sunspot number. And it takes, say, ten, 15, 20
9 years to decide you're going to make a spacecraft, to
10 design the spacecraft, to get it all ready, and to
11 launch it. Okay.

12 Q Uh-huh.

13 A So you have to know what the sunspot cycle
14 is going to be like 20, 30 years from now. And we
15 don't know how to do that. And we don't know how to
16 make those predictions because we don't understand the
17 solar dynamo.

18 Q Uh-huh.

19 A Which is the dynamo is emulsions which cause
20 the sun to have the magnetic field that it does and
21 the sunspots that it does.

22 And so one of the things I do is study the

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1 solar cycle and the solar dynamo. And during the last
2 ten years, the sun has been doing something very
3 unexpected, that is to say, it has been much, much
4 calmer than was generally expected.

5 Q Huh.

6 A In my opinion, that's because it's another
7 cycle of the amplitude of the sunspot cycle which is
8 about 90 to 100 years.

9 And so what I'm doing at the moment is
10 seriously looking into that finding whatever I can
11 find out about this 80 to 90, 90 to 100 year cycle,
12 which I call the "Centennial Gleissberg Cycle," and
13 what's its cause on the sun and what's its effect on
14 earth.

15 Now, there's a lot of evidence that during
16 periods at the minimum of at least 88 or a hundred
17 year cycle, Centennial Gleissberg cycle, there's a
18 cooling effect. It's from ultraviolet radiation is
19 apparently -- we don't really know, but there's some
20 evidence that it changes, that it interacts with the
21 earth's atmosphere. This is not agreed to by
22 everybody but there's evidence for it.

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1 Q Uh-huh.

2 A That the changes in the solar output
3 interact with the earth's atmosphere to change the
4 climate.

5 Q Ah.

6 A So that when the sun is at the minimum of
7 the Centennial Gleissberg Cycle, it's a little cooler
8 on earth than it would otherwise be.

9 So my guess, because at this point only a
10 guess, is that one reason that the earth isn't hotter
11 than it is is because the sun has been cooling it
12 relatively. That is to say, heating from the sun has
13 been relatively small 2010 -- 20 -- yes.

14 Q Uh-huh.

15 A 2007 to 10 and -- but I don't know how much
16 smaller. And I don't even know if that's true. But
17 you asked me what I'm working on, so I am working to
18 find out if that's true.

19 Q Wow. So --

20 A So that's my present --

21 Q -- that's amazing.

22 A -- present. And if it is true, it would

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1 mean that the warming due to the carbon dioxide, which
2 I think people now believe in since it's true and
3 we've known it's true for 15 years or so, but anyway,
4 it would mean that the cooling from the carbon dioxide
5 is partially canceled by this -- I mean, the heating
6 from the carbon dioxide is partially canceled by the
7 cooling from the sun.

8 So that we are probably underestimating the
9 cooling that will happen in 15 years if you just say,
10 okay, it's going to continue whatever it's doing now.

11 Q Uh-huh.

12 A So it's important. I think that the most
13 important problem in the earth for all societies in
14 the earth world today society that we are paying no
15 attention, essentially no attention to the global
16 warming which is going to clobber us. And --

17 Q And -- that's right. And the impact that
18 the sun is having on that.

19 A The impact that the sun is having is minor.

20 Q Huh.

21 A But it is in the direction of currently
22 making the carbon dioxide high warming or looks

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1 smaller. If you think it's all due to carbon dioxide,
2 then you think that the warming of the earth is less
3 important than it really is.

4 Q Oh, I see.

5 A Because the -- yeah. So that what the
6 effect of the sun on the earth in this Centennial
7 Gleissberg Cycle is still not agreed to by everyone.

8 And the question you're asking me, what I'm
9 working on, I've got to be working on something that's
10 not agreed to by everybody. If it's agreed to, you
11 don't work on it anymore if you're a scientist.

12 Q That's right. And that's exciting --

13 A Yeah.

14 Q -- to hear you talking about this, because
15 there are many, many young scientists and people who'd
16 like to go into science that will be hearing this.

17 And this is really --

18 A Uh-huh.

19 Q -- an area I think that many people would
20 find interesting to explore.

21 A Well, look there, earth science is a
22 wonderful thing because when we know something, one of

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1 the side effects is that we realize there's something
2 else we don't understand. Like -- and then you go on
3 from there.

4 So there are always new subjects in science.
5 And for young people it's a good idea to work, if
6 they're interested, on the subject that they find
7 interesting or delightful and that's new. Because
8 it's easier when it's new.

9 What happens is all the easy things get done
10 at the beginning and then it gets harder and harder to
11 make new contributions and they're less and less
12 important.

13 So rather than looking at what's, you know,
14 a 15-year-old kid, boy or girl, who looks and sees
15 what's interesting now may find it, by the time
16 they're ready to get their Ph.D, something else is
17 more exciting and that's where they ought to be
18 studying.

19 But you got to study something that really
20 excites you. Otherwise, you know, it's a matter of
21 personality, what you like to do. But science is
22 something you have to do because you like to do it.

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1 Otherwise, it doesn't work.

2 Q Uh-huh. It's all about passion.

3 A So, yeah, you know, scientists are supposed
4 to be such dispassionate people. We're not at all.
5 We're very passionate people.

6 Q Uh-huh.

7 A We spend long hours working on things.
8 We're only paid for part of the time, more or less. I
9 mean, you don't leave the problem when you come home
10 from work. You work on it in your sleep. You know,
11 it's not a job like selling shoes where you may want
12 to forget about it when you come home and think of
13 something else.

14 Q Uh-huh.

15 A It's a passion.

16 Q It's a passion.

17 A For all of us.

18 Q It's a lifestyle.

19 A Huh?

20 Q Yeah, it sounds like science for people who
21 are passionate about it and really pursue it, it
22 becomes an entire lifestyle and a way of being.

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1 A Well, yes. And if you're not passionate
2 about it, you shouldn't try it because --

3 Q Uh-huh.

4 A -- it's very -- it's difficult. You have to
5 do a lot of learning and a lot of thinking. And if
6 you don't have a passion for it, you're not going to
7 make any nice -- you know, you're not going to enjoy
8 it. There's no point in going into it if you're not
9 passionate about it. And I've always been passionate
10 about it.

11 The reason I was interested in all of this
12 was because, you know, all of this geomagnetic
13 activity and solar influence on the earth, one of the
14 things that it produces is aurora. It's very
15 beautiful.

16 And when I was a kid, not a terrible lot was
17 known about them except that they came from --
18 something from the sun caused them.

19 And when I was about four years old, my
20 brother got permission from my mom -- it was nighttime
21 and I was in bed asleep -- my brother got permission
22 from my mom to wake me up and take me to see the

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1 aurora which was happening on Long Island at that
2 time.

3 And he walked me to a nearby golf course,
4 and I looked up and there were lights turning bluish
5 green -- though they may not have been green but there
6 were lights flashing in the sky and it was very
7 beautiful. And I got hooked. So that's what I've
8 been studying the rest of my life.

9 Q Well, that's amazing.

10 A Things to do with those aurora. Huh?

11 Q I love those stories of what it was that
12 actually ignited the interest or the passion to pursue
13 a particular career.

14 Some people have talked about stories of
15 seeing the aurora. Others have talked about looking
16 up and seeing a comet or shooting stars or the moon
17 and it just totally ignited this entire path in their
18 life from that point on.

19 A Yeah. Well, of course, all my family was
20 very interested in science -- my father, my brother.
21 My mother was interested in the beauty of nature.

22 Q Uh-huh.

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1 A But, you know, there I was a little kid and
2 my brother got permission to break all of the rules so
3 that he could show me the aurora. So my mother and
4 father were behind this also. So it was very exciting
5 for a little kid. And it's been fun.

6 Q It's been fun.

7 A That's why I'm still working at this
8 insanely a long time.

9 Q And still making -- and still exploring new
10 territory. That's what's -- that's really awesome.
11 That's amazing.

12 A Yeah. Well, you know, I still -- quite
13 awhile back I thought I might retire, so I tried it
14 for two weeks. And I decided I didn't like it, so I
15 came back.

16 Q Well, my dad's a minister, and I can totally
17 understand that that certain people --

18 A Yeah.

19 Q -- in certain careers that are passionate
20 about their careers, they --

21 A That's right.

22 Q -- never stop.

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1 A You never stop unless somebody forces to you
2 stop but -- and they can't really, because you can
3 always do it at home especially now with the computers
4 where all the data is available and so on.

5 So it's been great fun for my life. And I
6 started at a time when it was not considered
7 reasonable for women to do this, but now it is.

8 And so I think, you know, anybody who finds
9 something, you know, in science or somewhere else that
10 interests them, should choose to do it, you know.

11 Q That's right.

12 A I was told it was impossible. It turned out
13 that was wrong.

14 Q Wow, what a --

15 A Thank goodness.

16 Q -- different time.

17 A Yes. Yes. Yes. That's right. Women
18 didn't make a living when I was a child. And women
19 weren't supposed to be mathematicians and scientists.
20 There was a prejudice against it.

21 But it doesn't make any difference. You
22 just do it anyway. You don't have to get permission

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1 from the entire world to decide what you're going to
2 do.

3 Q They will eventually catch up.

4 A Oh, yeah. But I, you know, just think
5 passion takes you a long way.

6 Q It sure does. And you know in the
7 interviews that we've been conducting for Space
8 Weather Living History, it seems that many of the
9 scientists and people being interviewed always come
10 back to that word, that that is really --

11 A Passion.

12 Q Passion, that that really is the torch --

13 A Yes.

14 Q -- that kept them involved.

15 A That is. That is. That is the torch for
16 scientists. And it always strikes me as strange that
17 laymen think we're very serious, very, you know,
18 unpassionate people.

19 Q Uh-huh.

20 A We're not. We're not. So you want more
21 information?

22 Q I -- this has been already, believe it or

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1 not, we've been talking for 33 minutes.

2 A Oh, my. That's a long time.

3 Q Yeah, these interviews go very well
4 especially when people start talking about what it is
5 that they're excited about and what they do. It just
6 happens. And it's such a pleasure --

7 A Yeah.

8 Q -- on my end to be able to hear that and to
9 listen to it.

10 A Yeah.

11 Q I think it's a very unique experience for me
12 as well.

13 A Yeah, well, I'm glad you enjoy it. And I
14 hope people really warm up to the idea that science is
15 not a chore, it's a pleasure.

16 Q Well, we'll probably take that statement and
17 make that one of the main statements in your interview
18 that you just said. I'll make sure --

19 A Okay.

20 Q Yeah, that would be wonderful.

21 A Okay.

22 Q Yeah.

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1 A Okay. Fine.

2 Q Well, thank you so much.

3 A Okay.

4 Q And do you have anything else that you think
5 you would like to add or are you good with --

6 A No. I think my -- yeah, my main dream has
7 been really to get this preserved.

8 Q And it was very good.

9 A My main idea is that you should find
10 something you're passionate about and do it whether
11 people tell you can or not. And that it's -- that's
12 the message, not the particular thing that you're
13 passionate about, that'll be part of your life
14 somehow.

15 Q Wow.

16 A Yeah.

17 Q Well, thank you --

18 A Okay.

19 Q -- so much, Joan, for your time.

20 And what we'll do from this point on is,
21 Carolyn and Barbara Thompson will take a look --
22 they'll listen to the sound, they'll have it

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1 transcribed, and then they will go through and edit
2 out the parts that they know that we don't need or
3 that my voice or whatever it is that they edit out.
4 And then they'll send that final transcript to you and
5 you can take a look --

6 A Okay, great.

7 Q -- at the actual transcript and give input
8 to it. So if there are parts that you'd rather be
9 moved around or changed, that's no problem.

10 A Fine. Fine.

11 Q And then we'll put it up online on Sun-Earth
12 Day and in the Space Weather Living History Project at
13 some point. And we'll let you know when that happens,
14 so.

15 A Okay, fine.

16 Q Well, thank you so much.

17 A It's been nice talking to you.

18 Q I'm glad we finally were able to --

19 A Beautiful --

20 Q -- make it happen.

21 A -- really. Okay.

22 Q All right. You have a wonderful day.

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1 A Bye.

2 Q Good-bye.

3 A You, too.

4 (Whereupon, the interview of JOAN
5 FEYNMAN, was concluded.)

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1 CERTIFICATE OF TRANSCRIBER

2

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