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00:00:00,310 --> 00:00:12,672

[Music]
Hello, and welcome to Open Science.

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00:00:12,672 --> 00:00:16,769

I'm Dr. Marshall Porterfield from NASA Headquarters
in Washington, DC, and joining me today is

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00:00:16,769 --> 00:00:20,269

Dr. Mark Weislogel from Portland State University.

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00:00:20,269 --> 00:00:21,720

Mark, you've been--.

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00:00:21,720 --> 00:00:22,720

--Howdy--.

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00:00:22,720 --> 00:00:25,770

--A principle investigator for our complex
fluids experiments for a number of years,

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00:00:25,770 --> 00:00:31,199

and we've all seen the videos of astronauts
playing with spheres of water in space.

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00:00:31,199 --> 00:00:32,279

This is your research area.

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00:00:32,279 --> 00:00:36,750

Can you explain the general phenomena and
then talk to us a little bit about what you've

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00:00:36,750 --> 00:00:40,600

discovered in your International Space Station
research?

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00:00:40,600 --> 00:00:44,730

People don't understand that the--a lot of
the forces that we see on the ground are the

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00:00:44,730 --> 00:00:45,730
same in space.

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00:00:45,730 --> 00:00:46,760
Those actually don't change.

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00:00:46,760 --> 00:00:49,150
But, what does change is the impact of gravity.

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00:00:49,150 --> 00:00:54,010
So, with a less--with less gravity, then we
start seeing small forces that we're not accustomed

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00:00:54,010 --> 00:00:55,910
to dominating the fluid process.

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00:00:55,910 --> 00:00:58,400
So, we see giant spheres of liquid.

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00:00:58,400 --> 00:00:59,860
We see giant bubbles.

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00:00:59,860 --> 00:01:03,150
We see liquid going to places where they're
not used to seeing.

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00:01:03,150 --> 00:01:07,740
They see this absence of an up or down kind
of thing, floating or sinking.

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00:01:07,740 --> 00:01:08,740
Those things all go away.

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00:01:08,740 --> 00:01:10,030
And so, that catches us by surprise.

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00:01:10,030 --> 00:01:12,789

And so, there's really a lot to learn to make systems work in space.

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00:01:12,789 --> 00:01:17,780
So, how has what you have learned in your research program contributed to the development

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00:01:17,780 --> 00:01:24,369
of a more reliable spacecraft and technologies that are needed to support humans in space?

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00:01:24,369 --> 00:01:25,369
Okay.

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00:01:25,369 --> 00:01:29,520
It's kind of--another thing is kind of odd, is that almost nothing, no fluid systems that

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00:01:29,520 --> 00:01:31,319
we have on Earth will just work.

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00:01:31,319 --> 00:01:33,509
You just take it to space, and it'll work.

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00:01:33,509 --> 00:01:37,639
Most of the systems will be corrupted by large bubbles plugging lines or liquids spilling

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00:01:37,639 --> 00:01:40,630
and going someplace they shouldn't be, that kind of a thing.

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00:01:40,630 --> 00:01:45,639
So, as soon as we learn how to position and make fluids do things on their using surface

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00:01:45,639 --> 00:01:51,389
tension and not, say, gravity, then we learn how to--we learn how to expect where the liquid

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00:01:51,389 --> 00:01:56,689
should be so that we can make refrigeration
systems work, make filter systems work, make

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00:01:56,689 --> 00:02:01,179
cooling systems work, make drinking systems
actually work, that kind of thing.

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00:02:01,179 --> 00:02:05,329
And so, all of our work, even though it tends
to be fundamental, has immediate application,

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00:02:05,329 --> 00:02:07,770
we find, to systems that are on spacecraft.

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00:02:07,770 --> 00:02:14,530
So, one of the most popular new things that
I've seen that's a result of your work is

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00:02:14,530 --> 00:02:21,650
the development of the coffee cup for the
astronauts to use in space.

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00:02:21,650 --> 00:02:23,110
And the shape is very interesting.

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00:02:23,110 --> 00:02:28,860
Can you tell me a little bit about the geometry
of the coffee, and, you know, very quickly

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00:02:28,860 --> 00:02:29,909
so that we can?

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00:02:29,909 --> 00:02:30,909
Yeah.

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00:02:30,909 --> 00:02:35,049
Well, the coffee cup actually use--utilizes
all we've learned about capillary stuff in

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00:02:35,049 --> 00:02:36,209

space.

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00:02:36,209 --> 00:02:39,250

And you can learn a lot of that stuff on the ground too, but in space, you see it on a

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00:02:39,250 --> 00:02:40,849

big scale.

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00:02:40,849 --> 00:02:46,310

In that--in--with that, we can make a cup large enough to still exploit capillary forces

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00:02:46,310 --> 00:02:51,240

so that when the astronaut brings it to his face, there's a gradient in the driving force

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00:02:51,240 --> 00:02:55,519

from surface tension to drive that liquid right into the mouth of the astronaut.

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00:02:55,519 --> 00:02:59,940

In a way, we've designed a cup so that the bottom of the cup is actually the lip of the

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00:02:59,940 --> 00:03:00,940

cup.

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00:03:00,940 --> 00:03:04,950

So, when an astronaut makes that connection, that serves as the bottom.

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00:03:04,950 --> 00:03:09,140

And it will drain the cup into his mouth at the rate that he or she takes it in.

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00:03:09,140 --> 00:03:15,360

Yeah, the video of seeing the astronauts use the coffee cups, and the drinking process

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00:03:15,360 --> 00:03:16,819

is very interesting.

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00:03:16,819 --> 00:03:20,760

I'm sure that the audience is really going to enjoy getting a chance to see those videos

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00:03:20,760 --> 00:03:21,760

also.

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00:03:21,760 --> 00:03:27,750

But, in addition to the coffee cup, your research has contributed to development or the modification

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00:03:27,750 --> 00:03:31,200

of other hardware systems that are very important on the International Space Station.

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00:03:31,200 --> 00:03:33,140

Can you give us some examples of that?

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00:03:33,140 --> 00:03:34,140

Right.

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00:03:34,140 --> 00:03:37,769

So, and the coffee cup actually has a lot of science in it, and engineering too.

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00:03:37,769 --> 00:03:42,650

So, if we can design a system, for instance, for processing urine, or processing waste

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00:03:42,650 --> 00:03:48,140

water other streams, or condensing streams of water by just having a simple--maybe it's

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00:03:48,140 --> 00:03:53,200

a complex shape, but a simple, non-moving part shape that make all the liquid go to

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00:03:53,200 --> 00:03:55,260

one place, then we can get it out.

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00:03:55,260 --> 00:03:56,260

We can get the bubbles out.

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00:03:56,260 --> 00:03:57,260

We can get the liquid out.

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00:03:57,260 --> 00:04:01,680

We can keep the system operating, and with no moving parts, with no electric power, just

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00:04:01,680 --> 00:04:06,489

the surface shape--just the shape of the container and the wetting properties and surface tension

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00:04:06,489 --> 00:04:07,489

of the liquid.

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00:04:07,489 --> 00:04:10,330

So, how long have you been involved with this type of research?

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00:04:10,330 --> 00:04:15,249

Well, I--when I was a Master's student, I saw some images of low-gravity fluid phenomena

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00:04:15,249 --> 00:04:17,170

and got absolutely hooked.

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00:04:17,170 --> 00:04:21,700

At--that drove me to look for a job at NASA, got one, and for the first decade of my career,

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00:04:21,700 --> 00:04:22,700

I worked at NASA.

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00:04:22,700 --> 00:04:24,570

So, this started--this was in my blood.

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00:04:24,570 --> 00:04:29,009

Then when I finally wound up at--in academia,
then I worked like crazy to try and continue

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00:04:29,009 --> 00:04:30,009

that research.

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00:04:30,009 --> 00:04:31,320

It's my favorite thing to do.

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00:04:31,320 --> 00:04:37,229

So, in addition to the work that's being done
on the Space Station and the application to

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00:04:37,229 --> 00:04:41,180

supporting astronauts right now on the Space
Station, how does your research benefit us

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00:04:41,180 --> 00:04:43,090

back on Earth?

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00:04:43,090 --> 00:04:49,669

We have a unique focus because we see gravity-less
processes, things that you don't see on Earth

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00:04:49,669 --> 00:04:51,699

very often because gravity masks everything.

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00:04:51,699 --> 00:04:54,950

But, for microscale systems, all this stuff
applies.

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00:04:54,950 --> 00:04:59,410

So, everything we learned in space is directly applicable to the ground systems so that when

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00:04:59,410 --> 00:05:04,620

we see all of these biological process small flows, wetting and spreading flows, we have

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00:05:04,620 --> 00:05:08,849

almost immediate tools to apply to those systems to make them work better.

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00:05:08,849 --> 00:05:13,030

And so, from lab on chip technology stuff to medical tubing, things like that, we can

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00:05:13,030 --> 00:05:14,460

have direct impact.

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00:05:14,460 --> 00:05:16,460

And we definitely want to go that direction.

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00:05:16,460 --> 00:05:18,520

And what about the journey to Mars?

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00:05:18,520 --> 00:05:24,310

Where do you see your research having the most impact and--in terms of the journey to

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00:05:24,310 --> 00:05:25,310

Mars?

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00:05:25,310 --> 00:05:27,530

In that one, we think that we can have a very significant impact.

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00:05:27,530 --> 00:05:31,430

Now, our stuff won't displace other methods that are being used.

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00:05:31,430 --> 00:05:37,830

But, we'll give--but, we might, and we definitely teach how to avoid catastrophe due to capillary

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00:05:37,830 --> 00:05:40,139

failure, like a bubble fouling the system.

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00:05:40,139 --> 00:05:44,390

And we definitely make systems that are far--that are more reliable, that free up astronaut

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00:05:44,390 --> 00:05:49,950

time to do other research, not just maintain the systems, that are passive with no power

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00:05:49,950 --> 00:05:56,080

requirements and things like that, or even are redundant, meaning are silent in the background,

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00:05:56,080 --> 00:05:59,379

continuing to function, even though a primary system may be at work.

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00:05:59,379 --> 00:06:01,970

So, it makes systems much more reliable.

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00:06:01,970 --> 00:06:06,340

There's definitely multiple systems, multiple technologies that are making the system function.

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00:06:06,340 --> 00:06:08,690

For life support, that would be a very nice thing to have.

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00:06:08,690 --> 00:06:12,810

Well, I think another area you need to think about too is the quality of life because crew

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00:06:12,810 --> 00:06:16,740

performance is tied to quality of life.

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00:06:16,740 --> 00:06:23,610

And just the coffee cup itself I think is really a major contribution because that's

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00:06:23,610 --> 00:06:26,229

something that people always do, and it reminds them of home.

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00:06:26,229 --> 00:06:27,229

Right.

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00:06:27,229 --> 00:06:30,560

In fact, the coffee cup, you know, it--their aromatic drinks, you know, would be much more

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00:06:30,560 --> 00:06:31,560

desirable in a cup.

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00:06:31,560 --> 00:06:34,920

Well, the astronauts might have to do the dishes every now and then, but that could

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00:06:34,920 --> 00:06:38,500

be a really--a real advantage too because, hey, there's tons of bags that are being thrown

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00:06:38,500 --> 00:06:39,930

away every time a drink is drunk.

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00:06:39,930 --> 00:06:44,410

So, you could actually have a significant savings if you use something like a cup.

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00:06:44,410 --> 00:06:49,840

And this last demonstration is, hey, you can have scalding drinks in open containers safely,

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00:06:49,840 --> 00:06:52,580

just like you do around your coffee--with
your coffee cup around your laptop in the

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00:06:52,580 --> 00:06:53,580

morning.

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00:06:53,580 --> 00:06:54,580

That is awesome.

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00:06:54,580 --> 00:06:56,729

Thank you, Mark.

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00:06:56,729 --> 00:07:00,449

Drinking coffee in a work environment is an
important part of life on Earth, and because