AirSpace Season 4, Episode 3

Water Me

Nick Partridge:

Welcome to AirSpace from the Smithsonian's National Air and Space Museum. I'm Nick.

Emily Martin:

I'm Emily.

Matt Shindell:

And I'm Matt. So many times, when you hear about scientists exploring our solar system, the news is about water -- finding water, hoping to find water, looking for water.

Nick Partridge:

But why do we care if there was once water on Mars, or if there are traces of water on the moon, or in icy bodies out there in our universe?

Emily Martin:

Water in space isn't always the kind that comes out of your tap or fills our oceans, but water is an essential building block to life and a crucial resource for future space travelers. So we're talking about where the water is and why we care, today on AirSpace.

Nick Partridge:

So a news cycle that made a big splash recently was that they discovered ... Yeah, right? Yeah, yeah, yeah. You like that one?

Emily Martin:

I do.

Nick Partridge:

It wasn't planned at all. They discovered water on the moon. Now, it seems like whenever a space story really hits, it's usually about finding water, or it's often about finding water. Am I alone in this?

Emily Martin:

No, I feel like anytime there's a press release, especially a press release about Mars, I feel like it's always a, “we found water on Mars” again.

Nick Partridge:

Water is not only at the center of soggy news stories about other places in the solar system, but it's at the center of missions. Perseverance is centered on an ancient lake bed, or what NASA thinks was an ancient lake bed. So clearly, all of the great minds spend some time thinking about water in outer space. So it's incumbent on us, I think, to ask the pertinent question, why do we care?

Emily Martin:

The low-hanging fruit answer to this question is astrobiology, the search for extraterrestrial life. And we don't necessarily mean intelligent life. I think at this stage in our solar system, we're talking exclusively about microbial life.

Matt Shindell:

Yeah, and that's a story that's changed a lot over time, from the early space age, when we thought that the first missions to Mars might discover some sort of basic life form, like lichens or something else living on the surface, not really knowing quite how dry and cold the surface of Mars really was, to now, where we're looking mainly for clues to sometime in the deep past where Mars might've been habitable and maybe, maybe some small pockets where life might still exist today.

Emily Martin:

Right. And the reason we care about water with respect to astrobiology is that, as far as we know it, water is a crucial ingredient to create life. And I don't just mean water to live in, or in our case, water to drink, it's that it's an essential building block of everything that makes up our bodies from all levels. And so, we assume that it's not just about having water for things to live in, but really having water available for things to build themselves out of. That's a weird way of saying it, but it's a building block.

Matt Shindell:

Yeah. And, I mean, another one of those things that's changed over time is where we think we might find liquid water in the solar system, right? I mean, that's why these stories are always so exciting for people, is that even though we know we discover water all the time in the solar system, the solar system still seems to be incredibly dry, at least the planets around us here in the inner solar system seem to be pretty dry. But as you look even further out, some of the planets that you're most interested in, Emily, in the icy moons, right, we didn't think of those as places where there might be life taking hold or life existing back in the early space age. But now, we think of those as some of the most promising places to find oceans underneath the ice or underneath the surface of those moons. Right?

Emily Martin:

Yeah. And this kind of goes to another reason we care about water. It's not just about finding astrobiological life or extraterrestrial life. It's really about, from a human perspective, where did we come from and how did we come out of that primordial soup? We think we understand what it takes for life to evolve, but so far, we only have one data point. We only have us here on Earth.

Emily Martin:

And so, like you said, Matt, now that we're thinking about life beyond places like Mars, and we're thinking about life maybe existing in places like the moons of Jupiter and the moons of Saturn, we're starting to talk about multiple different places where we could have had life evolving from nothing multiple times in just our solar system. And finding it even one more time in our solar system is a really important piece of the origins of life puzzle.

Matt Shindell:

Right. And even if we never found life anywhere else in the solar system, the story is still so important, right? Because we want to know why our planet took the path that it did, why we remained a wet planet in the habitable zone, or the so-called habitable zone, while the planets around us took very different paths, right? Mars and Venus both went down very different paths that make them very inhospitable to life. So why are we this warm, wet oasis here in the solar system?

Nick Partridge:

If we're thinking in terms of primordial soup, where did the water come from for our soup? Is that something that we're also learning about out in the solar system?

Matt Shindell:

I mean, that's a big question and Emily can speak to it better than I can, but I mean, it's one of the things that we're looking at with missions like Rosetta, where we're going off and looking at what the composition of comets are, and we're also looking at asteroids with other missions and trying to figure out where did the Earth's water supply actually come from? Because we have a ton of it. And one of the hypotheses is that it might've come from out there, from the asteroid belt or from comets bombarding the earth in its very early history.

Emily Martin:

Yeah. And this is one of the interesting, maybe even surprising results from the Rosetta mission, which was ... Me not being a chemist, I'm not even going to try and pretend like I know exactly what they measured, but they essentially tested the water on the comet and compared it to what we know about the water on the earth, because they think that maybe the water on the earth was primarily sourced from these icy comets. And the short answer is they don't match. And so, it doesn't actually look like we got all our ocean water from something like a comet. So it's still a very open question, where did Earth's water come from? Is it primordial? I don't know. I don't actually know the arguments for why our water couldn't be primordial, but it certainly didn't come from comets.

Nick Partridge:

Is there a practical matter at hand also? Thinking beyond primordial soup, we discovered water on the moon. Can astronauts make soup out of that water?

Emily Martin:

Maybe stone soup.

Nick Partridge:

Oh.

Emily Martin:

Seriously, though, water as a resource is important. And it's not just about being able to brush your teeth and flush the toilet and wash your hair once a week if you're an astronaut, and I actually don't know how many time astronauts wash their hair per week. But the point being that water as a resource for space exploration isn't just about hygiene. It's about energy and it's about growing food, potentially. And it's about producing a lot of resources for an astronaut, because water is expensive to move. You're not going to launch all the water an astronaut needs into space with that astronaut. It's too expensive. You need fuel to do it, and then you need fuel to launch the fuel. So you're not going to launch more water than you have to.

Emily Martin:

So, for example, astronauts who live on the Space Station, they recycle about 75 or 80% of their water. Some of it's collected from humidity coming out of the air. Some of it's recycled urine from space toilets. They're doing as much as they can to be sustainable, but it's still not a perfectly closed system. When you think about astronauts heading to Mars and living on Mars, they can't take all the water they need to survive with them. And even if they can find enough water on the surface of Mars to keep themselves alive, they can't bring all the food they need, right? So they need to think about things like growing food on Mars. But, what else? You can use water as a fuel, right?

Matt Shindell:

Yeah. You can make rocket fuel out of water if you have the means to do it, right, because one of the main things we burn to send rockets up into space is hydrogen. And, of course, there's hydrogen bound up in every water molecule.

Emily Martin:

Two, in fact.

Nick Partridge:

The constituent parts of it.

Matt Shindell:

Two. That's right.

Nick Partridge:

So pound for pound, it might be easier to send a rocket scientist to Mars who could make the fuel for the return trip out of found water on the surface or under the surface, in addition to being able to sustain the mission, just from the standpoint of water as a human resource.

Emily Martin:

They found some water on the moon, but not like in ice form. It's mixed up in the lunar soil or the lunar regolith. And it's really not a lot, right?

Nick Partridge:

Yeah. I read, basically, one water bottle dispersed among one whole cubic meter of soil, which-

Emily Martin:

That's not a lot.

Nick Partridge:

That's not a lot.

Matt Shindell:

Yeah, if you think about what that means, that's like individual water molecules separated over a great distance, not even making up one small droplet of water in any one spot, but just completely dispersed water molecules.

Nick Partridge:

So, we found water on the moon. That was the last big splashy story, a drop in the bucket of water in the universe.

Matt Shindell:

One more, Nick. One more.

Nick Partridge:

I'll try to hold one in reserve. I have a reserve tank of puns and I don't want it to run dry too early in the episode.

Emily Martin:

But they had to find this water somehow, right? How did they find this water bottle full of water in a cubic meter of soil on the moon?

Nick Partridge:

Right, that's not a lot of water. How did we spot it from down here?

Matt Shindell:

We didn't, actually. It was spotted from a telescope on a plane in the stratosphere. The telescope uses spectroscopy. Essentially, it was looking at the wavelengths of light that bounce off of the surface of the moon, and looking at those wavelengths for a signature wave forms that indicate the presence of different molecules. And one of the molecules that they were able to detect was water.

Emily Martin:

Well, and I think what's really great about the advancement of technology that we've had is you can do spectroscopy, like Matt was talking about, from ground-based telescopes. You can do spectroscopy from orbiting satellites, whether it's going around the moon or some other planetary system. You can do it from landers. You can do it from rovers. I mean, there's all different kinds of space robots that you can stick different kinds of spectrometers on. We can be more specific about where that water actually was being detected. And that's been really one of the things that's been really helpful to planetary science, as we've moved through all the technology and innovation that we've seen over the last decades.

Nick Partridge:

So we know there's water on Earth. We've talked about water on the moon. We've heard about water on Mars a lot. Where else is water in the solar system?

Matt Shindell:

Well, I mean the short answer is that the water is pretty much everywhere in the solar system. It's really difficult to think of a place where there isn't water, but there's very specific places that we're especially interested in, and also places where I think people would be really surprised to know that there's actually water, like on the surface of Mercury.

Emily Martin:

Right, and we're not talking liquid water here on the surface of Mercury. We're talking water in the form of water ice. And this is the kind of water you find on the moon oftentimes, and you see this kind of water on the surface of Mars. Water ice is actually really well distributed across the solar system.

Nick Partridge:

So we hear all about Mars. Are there more interesting places to discover water in the solar system than Mars, Emily?

Emily Martin:

Well, I don't want to start a fight about my personal preferences, but the moons of Jupiter or Saturn, maybe even Uranus, probably Neptune. All of those moons are made out of water ice for the most part. And then they have layers of salty water oceans that are in liquid forms underneath their ice shells. And so, these are places that have liquid oceans, and we've only really known about these liquid oceans for a few decades. And it's really changed our perspective on how we might distribute life across the solar system, because all of a sudden, we've got these liquid oceans. If it's a liquid ocean, it's what, zero degrees Celsius? It's not quite the freezing temperature of water, because it's still liquid. And all of a sudden, that increases the likelihood that we might be able to find extraterrestrial life.

Matt Shindell:

And one of the most fascinating things about some of those oceans out there is we've had an opportunity, and we might get some great opportunities in the future with future missions, to actually, as you've said, Emily, tastes those oceans, right? They actually are spouting out a plume of liquid into their vicinity and we've actually flown spacecraft through some of those plumes.

Emily Martin:

Right. The Cassini mission did a really excellent job exploring the Saturn system, but also as the mission went on, they started flying the spacecraft through the plume of Saturn's tiny moon Enceladus. And they started sampling and tasting the material that was coming out of the plume. And that's how we know there's a salty ocean, rather than just a fresh water reservoir underneath Enceladus's ice shell.

Emily Martin:

I think the scientific community has really expanded their definition of what constitutes habitable by not just thinking about liquid water at the surface and not just thinking about intelligent life, but really delving even deeper into the surfaces and into the interiors of these planets to look for habitable environments. And I think we've moved away from this hyper-focus on intelligent life and liquid water at surfaces, and really expanded that to start thinking about simply where can we produce a habitable environment, and how do we start searching for biosignatures that can tell us whether or not these hard to reach places are inhabited. And I think it's a shift in that focus.

Nick Partridge:

So it's less a drop in the bucket in terms of water exploration in the solar system and more the potentiality of drop by drop into potentially an ocean teaming with water out there in the universe, and therefore, hopefully, perhaps life.

Nick Partridge:

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