Four Georgia science teams share one mission: Getting us to Mars

Behind the scenes with the Georgia Tech researchers who discovered flowing water on Mars, the county vying to become a commercial spaceport, and two companies working on methods to transport and house astronauts

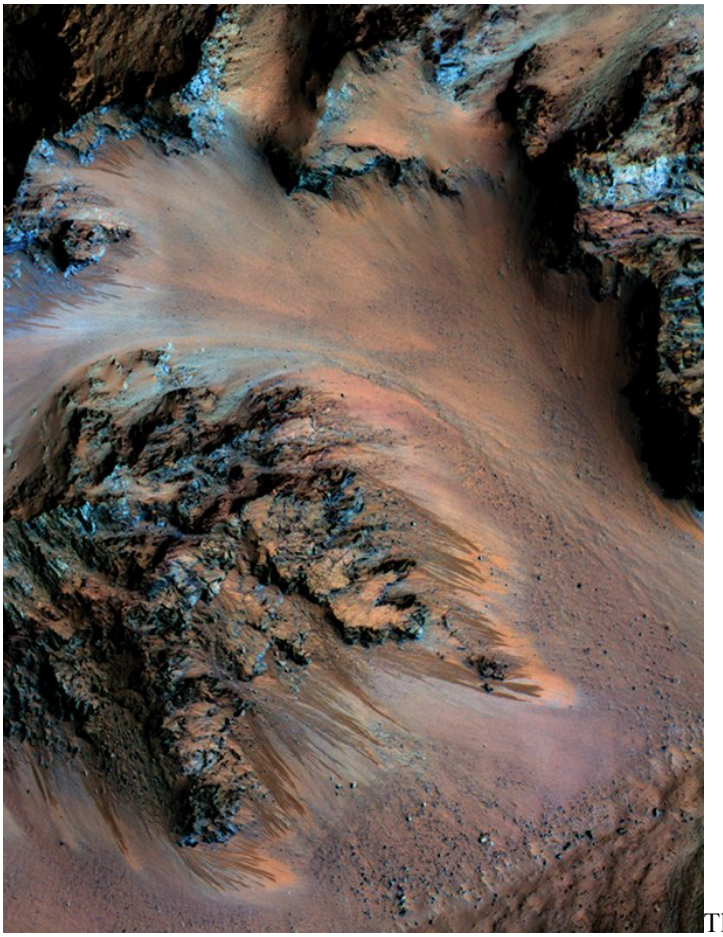
February 16, 2016Candice Dyer0 Comments


Photograph courtesy of NASA/JPL-CalTech

When Lujendra “Luju” Ojha was growing up in Nepal, he didn’t own a telescope, frequent a planetarium, or devour science fiction. He did, however, gaze up at the stars and ponder big questions. “I had this sense of wonderment,” he says, “and wasn’t content with the theological answers I was getting about where we come from.”

About two years after relocating to the United States, he found himself at the University of Arizona, studying under Alfred McEwen. The professor is also the principal investigator of HiRISE, the powerful camera attached to the Mars Reconnaissance Orbiter, which circles and spies on the Red Planet. Together the scientists pored over photographs of the surface of Mars, and in 2010 Ojha noticed a curious feature: dark streaks on a crater that seemed to ebb and then intensify with the warmth of the seasons. The images are beautifully desolate. Other research had determined that Mars was once sopping wet with seas and rivers, and it still has polar ice caps, but the temperature—zero degrees Fahrenheit on a hot day—was thought to be much too cold for pure water, much less liquid that would trickle downhill. So the mutability of these markings stood out.

“Honestly, I didn’t know what in the hell those streaks were,” he says. “We weren’t looking for them.”

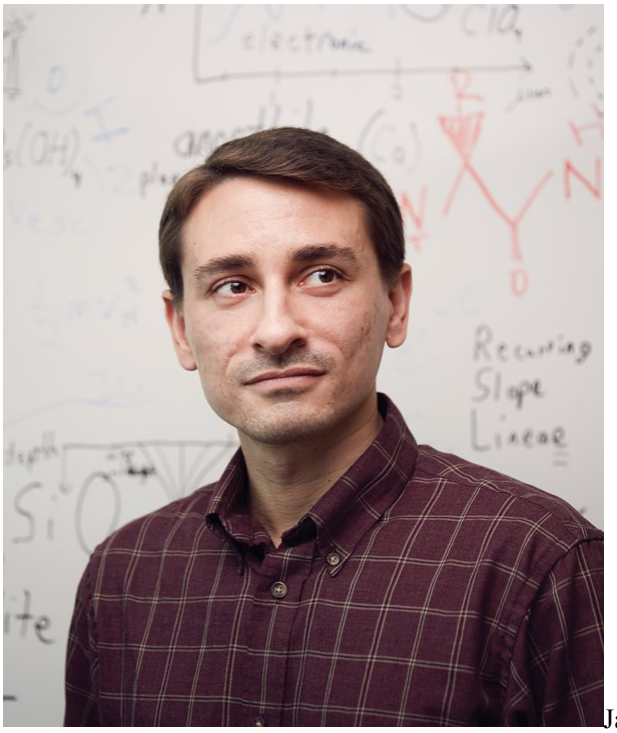

The dark streaks, seen stretching down from this rocky Mars summit, are caused by flowing, salty water.

Photograph by NASA/JPL/University of Arizona

Ojha resumed other projects related to geophysics and seismology before enrolling in grad school at Georgia Tech, which boasts one of the largest aerospace engineering programs in the country. In the meantime, the enigmatic streaks—referred to as “recurring slope lineae”—were scanned by the Compact Reconnaissance Imaging Spectrometer for Mars, or CRISM, an instrument on the Mars orbiter that analyzes the chemicals on the planet’s surface by studying the different bands of reflected colors. In 2012 NASA also announced that the rover *Opportunity* (at one point, there were no fewer than seven functioning spacecraft orbiting or on Mars) had found clay deposits that typically form in wet environments favorable for life, and HiRISE found evidence of ancient hot springs. Some of the light-toned Martian rocks, too, have been associated with hydrated minerals like sulfates and clay. In fact, much of the surface of Mars is covered by a thick mantle of ice and

dust. So many factors were pointing to the presence of water, but a high-powered and more conclusive divining rod was needed to detect a current, active rivulet.

Water is the fundamental component of life as we know it. If liquid water were found to be on Mars, there could be life underground. And, when it comes to the prospect of a manned mission to Mars, water would mean humans could, conceivably, live off the land there.


James Wray

Photograph by Gregory Miller

Enter Georgia Tech with its own spectrometer; at seven pounds, it fits into a backpack for fieldwork. Last January, Dr. James Wray, an assistant professor and planetary scientist, was looking to test the new device. Ojha and three other doctoral candidates brought in random materials to sample against readings from CRISM images. Wray himself brought pieces from a meteorite and some rocks from out West, where the formations are believed to be similar in composition to those on other worlds. One student specializing in volcanology brought igneous rocks. Another, Mary Beth Wilhelm, who also works for NASA, remembered that the *Curiosity* rover had found perchlorate—a kind of salt containing chlorine—on Mars, so she brought some samples. The scientists wondered if the salts were the residue left behind by evaporating or freezing water. "The randomness of our sampling on that particular day was due to the fact that the spectrometer had just arrived, so we weren't really trying to do any formal hypothesis tests yet," Wray says. "Mainly I just wanted to figure out how to use the software, and check that everything worked."

Spectrometer

Photograph by Gregory Miller

The spectrometer has a feature that looks somewhat like a pistol—you point and pull the trigger, and the resulting graph parses the colors of the rainbow reflected from the target in a graph form. For sampling purposes, the researchers pointed their instrument at pure water, which caused the oxygen molecule to do a jiggly "dance." It was similar, but not identical to the CRISM photo from Mars, so Wilhelm hypothesized that maybe the Martian water was mixed with perchlorate. When they tested that with their spectrometer, they couldn't believe their eyes—it matched the Martian reading. Nobody yelled "Eureka!," but everyone in the small lab was thinking it.

Using all of this "spectral evidence," which Wray likens to a "fingerprint, signature, or a criminal's calling card," the researchers discovered something sure to usher in a momentous new Space Age: flowing water on Mars. The perchlorate was keeping it from freezing, acting like salt on an icy sidewalk. Mars apparently was weeping salty tears, some a meter wide. You might be able to make mud pies in them, but you wouldn't want to drink from those brooks, at least not in their current saline form. Moreover, perchlorate has another useful and fateful-sounding feature: It can function as rocket propellant. Says Wray, "I honestly don't know if this is good news or bad news for the idea of supporting life, but it was certainly news."

Wray had to be certain about what he was seeing. That night he stayed up until 3 a.m., analyzing squiggly graphs and other out-of-this-world images to rule out other possible explanations for the striations of Martian canyons in at least four places. None seemed to fit. "It's the holy grail that everyone has been looking for," Wilhelm says. "Water is the key ingredient of life. The next step will be to look for biosignatures of organic compounds, of the building blocks of life."

Still, nobody knows exactly where the water is coming from, or if it does indeed support some thirsty microorganisms. You might think NASA would immediately send its rover to gather more samples. But no: Any authoritative research on Martian life first will have to rule out our own contamination; believe it or not, even our space vehicles pick up certain cellular hitchhikers hardy enough to survive the radiation of outer space. What are we tracking in to Mars, and how do we shake it off enough to do meaningful research?


Lujendra Ojha at a TedX talk in Mumbai last year

Photograph courtesy of Georgia Tech

“I think the atmosphere must play a role in redistributing the water over extensive slopes, but where it comes from before going into the air is still a mystery,” says McEwen, the HiRISE operator working with Ojha. “An important question is whether these features indicate habitable environments near Mars’s surface, important to future explorations to prevent contamination by Earth microbes. An even more important question is where is there life near the surface of Mars today, which we really need to know before sending people to the surface. If there is extant life, that means we can actually understand an alien biology.”
The discovery, in other words, effectively raised more questions than it answered.

The resulting article in *Nature Geoscience*, with Ojha as lead writer, made international news. “When we saw the headlines about how a Mars mystery had been ‘solved,’ we all cringed a little,” Wray says, “because we still have so many questions. There are places that are wet on Mars, but where is it coming from? How is the perchlorate being made on Mars? We still don’t know.”

In a case of fortuitous timing, the movie *The Martian*, which celebrates the cagey survival skills of an astronaut stranded on the Red Planet, opened that same week. The film’s publicity team tweeted a video of its star, Matt Damon, toasting the researchers’ discovery with a glass of life-sustaining water. Suddenly, for the first time since NASA’s budget started shrinking and since the two space shuttle disasters muted the public’s enthusiasm for space travel, everyone was talking giddily about Mars as the next go-to destination.

“Future astronauts might not have to bring water with them,” Ojha says. “We will eventually figure out a way to drink this water we’ve found.” Sensing the moment, NASA issued one of its rare invitations for astronaut applications.

“It’s an exciting time for all of us who have this interest because we’re getting ready to do space exploration again, for real,” says Wray, 32. “That’s only the second time in my lifetime that NASA has put out the call for astronauts. I didn’t apply the last time because I didn’t think there was a chance of going to Mars then. Now, though, it’s different. I could go to Mars in my early 50s.”

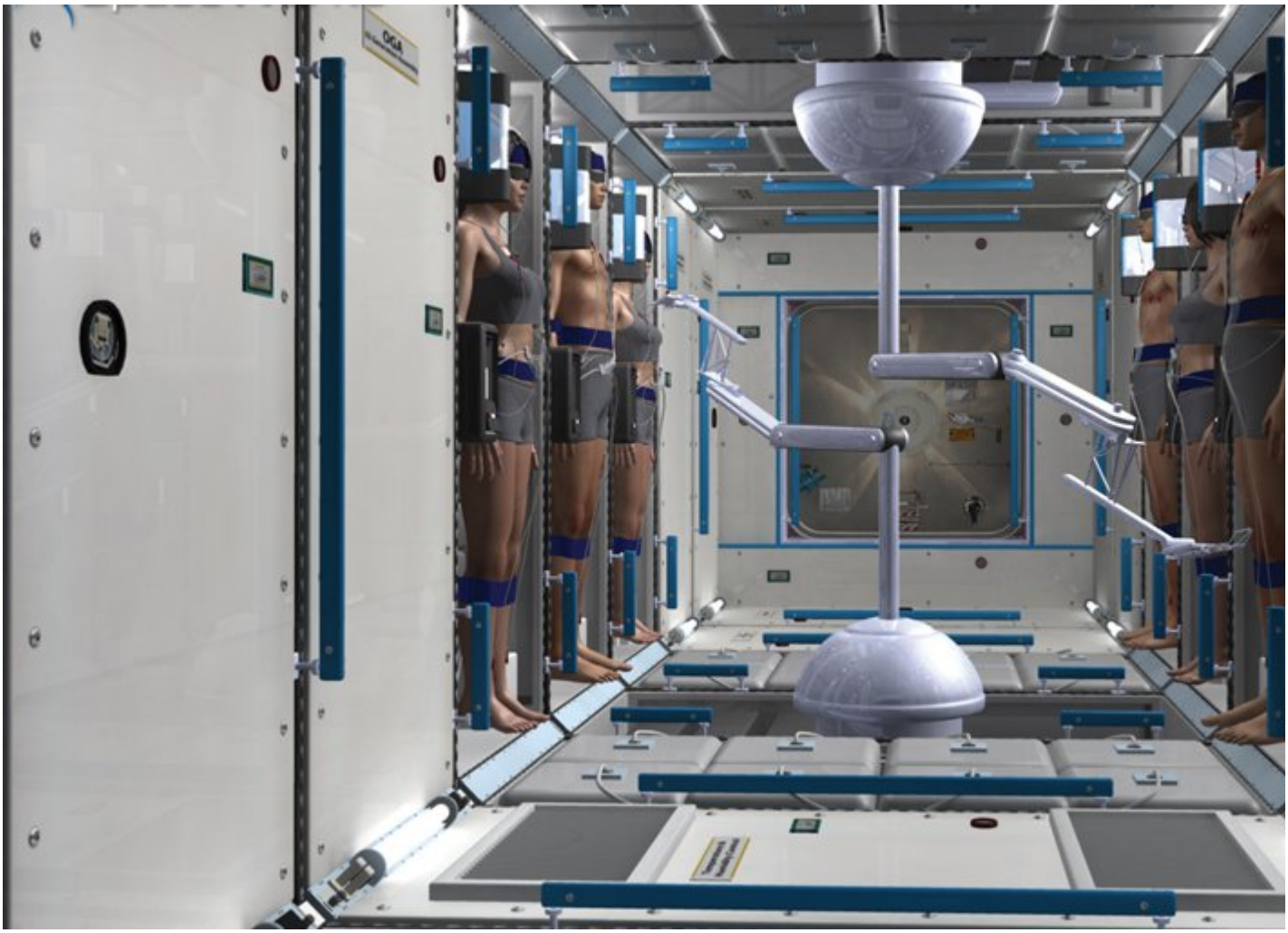
Georgia is no stranger to space exploration. The southeastern part of the state was NASA’s second choice for a launch facility, but the agency went with Cape Canaveral instead. Still, an isolated stretch of pineywoods near the Georgia coast in Camden County figures in aerospace history. During the mid-1960s, the world’s most powerful rocket motor—3.25 million pounds of thrust—was fired from a facility there. The rocket was manufactured by Thiokol Chemical Corporation, which built solid-propellant rocket motors and a booster for the Apollo program. Eventually the property changed hands and functioned as an industrial site for chemicals and munitions; then it sat empty. In 2006, though, state economic boosters started noticing the growth in the commercial space exploration market. Andrew Nelson, an executive in the space industry and an engineer who has worked with satellites and the first GPS receivers, spotted the old airstrip on a map while helping Georgia explore its options. Now Camden County is attempting to become a commercial spaceport—sort of a garage for rockets.

“What makes Camden County work is that it’s close enough to the equator,” Nelson says. “When you’re launching a payload from the equator, you get some help from the spin of the earth—it gives you a little bump—so the latitude is good there. It’s also an area low in population.”

The Federal Aviation Administration is currently commissioning an environmental impact statement for the site, examining its suitability for liquid-fueled, medium-lift-class, orbital and suborbital vertical launch vehicles—including, maybe, in the distant future, a craft bound for Mars. The study is expected to be completed next year, and the county likely will apply for a license with the FAA. If all goes as planned, the site should be operational within four or five years.

“A spaceport would attract other high-tech industries for research and development and manufacturing, which would help generate jobs,” Nelson notes. “Even at this preliminary stage, the county is getting calls from businesses in Germany and other outfits that are interested in setting up shop near the spaceport. This would really diversify South Georgia’s economy.”

What excites Nelson most, though, is the wow factor among children. “I speak to a lot of groups of children, mostly middle schoolers,” he says, “and if you can hook ’em on science in sixth grade, you have them for life. A Camden County spaceport would inspire kids from Glynn County to Atlanta. It would have an immeasurable impact on their curiosity.”



Astronauts might spend part of the voyage to Mars in stasis.

Photograph courtesy of Spaceworks

A one-way manned voyage to Mars would take at least six months. What would astronauts do all that time? An Atlanta company, which is working closely with NASA, has one possible answer: Sleep.

SpaceWorks Enterprises is developing the technology for the Torpor Habitat Project. The initiative would induce a coma-like stasis using "therapeutic hypothermia" that would enable astronauts to hibernate like bears for all or parts of the voyage. Think Sigourney Weaver in Alien.

By inhaling cold air, the astronauts in their radiation-shielded capsules would have their bodies cooled down by 10 degrees, slowing metabolism and reducing the need for oxygen by 50 to 70 percent, says Dr. John E. Bradford, president and COO of SpaceWorks. Besides making the journey seem to go by quicker, the technology would also mean less food would be necessary for the voyage, which, in turn, would mean a ship with less mass—an inescapable mandate for any manned mission to Mars.

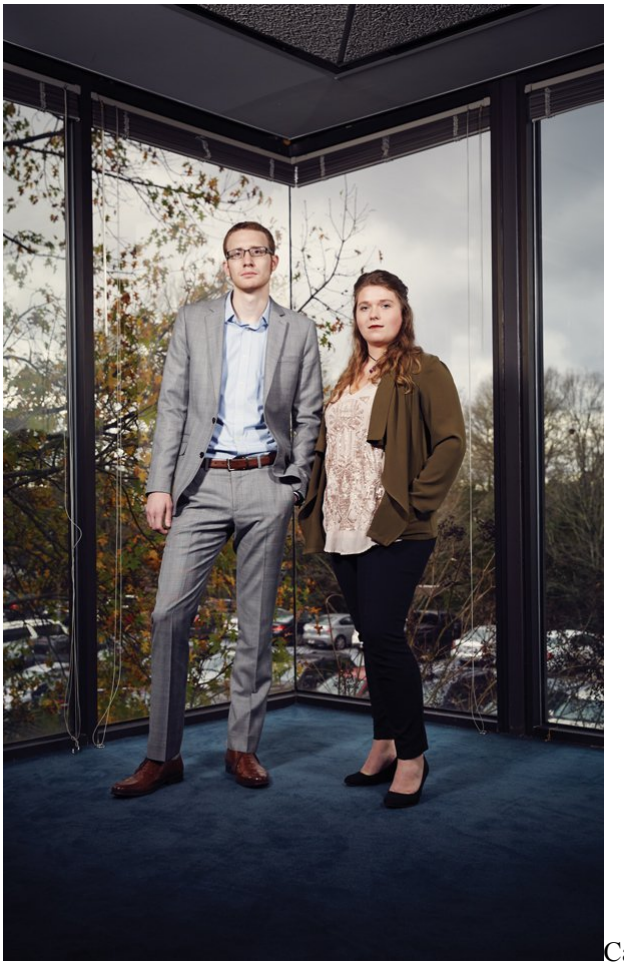
Would the astronauts snooze for the entire six months? Maybe, but not likely. They probably would have to take turns. "Ideally and to maximize the system impact," Bradford says, "we would like to place the crew in stasis for the entire duration of the mission, but if we can't achieve that medically, we have looked at an approach to cycle through the crew members undergoing stasis periods of 10 to 14 days followed by two days

of being awake and active." One member would be awake while others slept, and that active crew member would be responsible for waking the others before he or she settled into torpor.

Bradford concedes that the procedure "sounds science fiction-y," but it already is used by the medical community in cases of traumatic brain injury.

"Current medical protocols call for administration of therapeutic hypothermia, or TH, for 24 to 72 hours," Bradford says. In China, though, patients have been induced to sleep for two weeks.

How would such a procedure be tested beforehand? "Pigs make a fairly good surrogate for humans," Bradford says, "but I get emails from people all the time volunteering for an experiment. We are working on obtaining private as well as government funding to initiate some near-term experimental work."


Caleb Williams and colleague Claire Cole

Photograph by Gregory Miller

In 2005, NASA initiated "Centennial Challenges," which use cash prizes to solicit new technology development from the private sector, not supported by government funding. One of these bold blueprints—in competition for a $2.25 million prize—originates from the Westside. Project manager Caleb Williams, a local technology consultant and space enthusiast, is part of a seven-member team that is developing a 3-D printer that would melt Martian sand, which astronauts could use to construct a shelter once they've arrived and planted their flag. The outfit is called Solar Crafting.

“Mankind has long survived in hostile environments as long as the right tools were at hand,” Williams says, “so we thought: What if there’s a way to send a device that will build a house from the materials there, rather than trying to ship a whole house through space?”

In this project, a robot processor would crush Martian sand into a fine powder and then transfer it to a kind of 3-D “balloon” printer.

An example of how Solar Crafting’s technology could work.

Rendering by Charlie Wood

The inflatable balloon, which features a powerful lens, acts as a solar concentrator, focusing sunlight down to a small point to generate temperatures in excess of 2,000 degrees Celsius—hot enough to melt most metals. “We’ll be able to melt the powder as it is being extruded into a form of resin, which is then deposited layer by layer to create our habitat exterior,” Williams says.

The vision for the resulting shelter sounds more like a centerfold from *Architectural Digest* than an adobe hut.

How living on Mars could one day look.

Rendering by Leah Fett

“The idea is for it to be a soothing retreat with separate areas for living and work,” Williams says, “with large light fixtures, rounded walls and rounded edges everywhere, and a palette of colors reminiscent of Earth because the astronauts will be forced to see so much red dust all the time. It’s designed to ward off that feeling of psychological isolation.”

When it is not in use as an apparatus of interplanetary imperialism, the printer could help erect housing for refugees in the developing world here on Earth, Williams says. “We’re about transforming this world and the next.”

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- See more at: http://www.atlantamagazine.com/great-reads/four-georgia-science-teams-share-one-mission-getting-us-to-mars/#sthash.WUhZ3eqi.dpuf