

Did physicists discover a previously unknown fifth force of nature?

By Amina Khan, Los Angeles Times on 08.24.16

Word Count **781**

Level **MAX**



Scientists at UC Irvine say they may have discovered a fifth fundamental force of nature. NASA/ESA/Hubble Heritage

A tiny, unseen force could potentially alter our basic understanding of the universe — if it really exists. Theoretical physicists at UC Irvine say they’ve found evidence for a fifth fundamental force of nature, carried by a particle that until now has gone totally unnoticed.

If supported by the independent work of other teams, the boson described in a paper in *Physical Review Letters* (and expanded upon in a study posted to arXiv) could move scientists to rewrite the standard model of particle physics.

“If this is true, it would be a really big guide as to what the future would hold as far as the ultimate theory of particle physics,” said study coauthor Timothy Tait, a UC Irvine theoretical particle physicist.

There are four known forces that govern the interactions of matter: gravitation, electromagnetism and the strong and weak nuclear forces. A force like gravitation sculpts the universe at the enormous scale of galaxy clusters; the strong and weak nuclear forces prevail in the tiny

interactions between subatomic particles. Together, those four forces govern the interactions between all the matter in the universe.

But researchers at UC Irvine say they've found evidence for a fifth force – one carried by a particle that they're calling "boson X." This force is a sort of analogue to electromagnetism — except where electromagnetism acts on electrons and protons (and ignores neutrons), this fifth force works between electrons and neutrons (and ignores protons).

The scientists first got the idea from a paper published by Hungarian researchers who were looking for a "dark photon" (a force carrier for dark matter) and found a strange signal in their data. Could it be a new particle? After analyzing the Hungarians' work and several other teams' experiments, the UC Irvine researchers ruled out the "dark photon" explanation but did conclude that the signal could have been caused by a heretofore undescribed boson.

The scientists described the particle in their first paper now appearing in *Physical Review Letters*. In the follow-up, they fleshed out the idea, showing how (with a small entourage of additional new particles) it could be stitched into the standard model.

"If it's real, it needs to be studied in gory detail," said David McKeen, a theoretical particle physicist at the University of Washington who was not involved in the study.

The standard model, often represented as an unassuming 17-square chart, describes the fundamental subatomic particles that are the building blocks of all matter. It describes humdrum particles like electrons and protons, and more exotic fare such as muon neutrinos, gluons and quarks, all in terms of three identifying characteristics: mass, charge and spin.

If scientists were to draft a metaphorical map of the known universe, the standard model would be the color-coded legend in the corner — the key that allows them to make sense of the physical world, from the smallest to the largest of scales.

And scientists have been doing their best to break it.

That's because, as neat as it looks, the standard model fails to describe everything in the universe; in fact, it can barely describe a tiny fraction. For example, it can't explain the existence of dark matter, which doesn't interact at all with normal matter but can sculpt the cosmic web of galaxy clusters with its massive gravitational influence. It doesn't explain why dark energy is causing the universe to expand at an increasingly faster rate.

Dark matter makes up nearly 27 percent of the universe's mass-energy density; dark energy makes up more than 68 percent. Normal matter — which can be described fairly accurately by the standard model — is less than 5 percent of that total.

Tait said that their discovery might be a doorway to eventually creating a model that more accurately describes the universe. It could also help demystify mysterious phenomena such as dark matter.

For example, while dark matter responds to gravity over large scales (just as normal matter does), scientists don't know the extent to which it might interact with itself over smaller scales. This new force-carrying boson could provide the answer.

"This could actually be the dark force," Tait said.

But McKeen was more cautious, adding that much more work needs to be done by other groups looking for this particle before any major conclusions can be drawn about whether this force exists, and what role it has in explaining such mysterious phenomena as dark matter.

“It’s not obvious that it helps us with any of these other outstanding problems,” he said. “It could have a connection, but it’s not obvious to me. But I think it needs to be studied — and then people will understand whether there is or not.”

Quiz

- 1 Which sentence below would belong in an objective summary of the article?
- (A) But researchers at UC Irvine say they've found evidence for a fifth force – one carried by a particle that they're calling "boson X."
 - (B) The scientists described the particle in their first paper now appearing in Physical Review Letters.
 - (C) The standard model, often represented as an unassuming 17-square chart, describes the fundamental subatomic particles that are the building blocks of all matter.
 - (D) For example, while dark matter responds to gravity over large scales (just as normal matter does), scientists don't know the extent to which it might interact with itself over smaller scales.

- 2 Which of the following questions is NOT thoroughly addressed in the article?
- (A) Why does the standard model of particle physics need to be rewritten?
 - (B) How did scientists first suspect the existence of dark matter and its relationship to gravity?
 - (C) What are the advantages of discovering a fifth force that governs the interactions of matter?
 - (D) Do all scientists agree with the findings of physicists at UC Irvine?

- 3 Read the following quote from physicist David McKeen.

"It's not obvious that it helps us with any of these other outstanding problems," he said. "It could have a connection, but it's not obvious to me..."

Which word BEST describes the tone created by the words "could" and "not obvious"?

- (A) serious
- (B) upbeat
- (C) anxious
- (D) skeptical

- 4 Read the following paragraph.

Tait said that their discovery might be a doorway to eventually creating a model that more accurately describes the universe. It could also help demystify mysterious phenomena such as dark matter.

Which answer choice would BEST replace the phrase "demystify mysterious phenomena"?

- (A) clarify the existence of mysterious entities
- (B) complicate mysterious and extraordinary events
- (C) explain the behavior of various mysterious forces
- (D) question the appearance of mysterious particles

Florida high schooler develops electrical generator that costs just \$12

By Marisa Endicott, Medill News Service on 04.25.16

Word Count **630**

Level **MAX**



Hannah Herbst, 15, from Boca Raton, Florida, presents her project BEACON, an ocean-energy probe prototype, at the White House Science Fair in Washington, D.C., April 13, 2016. Tong Wu/McClatchy/TNS

WASHINGTON — When Boca Raton, Fla., high school student Hannah Herbst found out her Ethiopian pen pal lived without electricity and running water, she knew she had to do something. So began her quest to build a small and affordable alternative energy source that could help generate power in developing countries.

“Everything that I’m fortunate to take for granted every day, she doesn’t have access to,” Hannah recalled in an interview.

On Wednesday, Hannah presented her prototype, BEACON (Bringing Electricity Access to Countries Through Ocean Energy), at the annual White House Science Fair, the sixth and final such event of President Barack Obama’s administration, where enthusiastic young exhibitors demonstrated a wide array of inventions from a less expensive test for Ebola to a more fire-resistant suit for firefighters.

BEACON uses what's known as a Pelton wheel system — a water turbine — connected to an AC generator to convert the energy produced by ocean currents into electricity. If scaled up, BEACON could power a desalinization pump or a 12-volt battery. For now, Hannah is focused on making many, smaller-scale units.

Unlike existing turbines that are often huge, expensive and operate on the ocean floor, Hannah's model is cheap and floatable, so anybody can use it. She made one iteration out of recyclable materials for only \$12.

Just 15 and a student at Florida Atlantic University High School, Hannah has come a long way since her initial idea almost three years ago. After presenting her project at county and state science fairs, she entered and won Discovery Education and 3M's Young Scientists Challenge, becoming "America's top young scientist" last fall.

Hannah sent \$3,000 of her \$25,000 winnings to Compassion International, the nonprofit that connected her with 9-year-old Ruth and her family in Dessie, Ethiopia. A couple of weeks ago, Hannah received pictures of the generator they bought with the money. The family also was able to pay some medical bills.

Until her parents, Joel and Julie Herbst, switched her from theater to engineering summer camp in the seventh grade, Hannah hadn't shown much interest in science. As a newcomer to the field and the only girl there, she felt intimidated at first. But she caught on quickly, and her team won the camp's weeklong competition.

"We've got to get more of our young women and minorities into science and technology, engineering and math, and computer science," Obama said Wednesday. "We're not going to succeed if we got half the team on the bench."

Hannah has since made it part of her mission to encourage other girls in science and math.

It's hard to be in such a male-dominated field, "but once you realize that you can make a difference regardless of gender or any of those other stereotypes, then you're fine," she said.

The young scientist is working to introduce elementary and middle school students to what's known as STEM — science, technology, engineering and mathematics — and help them develop kits of her first prototype.

Recently, Hannah teamed up with 3M, the conglomerate based outside St. Paul, Minn., to figure out how to bring BEACON to market. While she realizes that her dream is still a way off, she hopes one day to be able to give a version to Ruth and her family.

Over the summer, Hannah plans to work on her design to make it more powerful — before she starts full-time college classes at Florida Atlantic University in the fall. She wants to join the thespian society as well.

"No matter how difficult things seem or how much you think that you can't do it based off what other people say, you just have to keep going," Hannah said. "Never give up, because something could really impact someone's life in a way that you can't even imagine."

Quiz

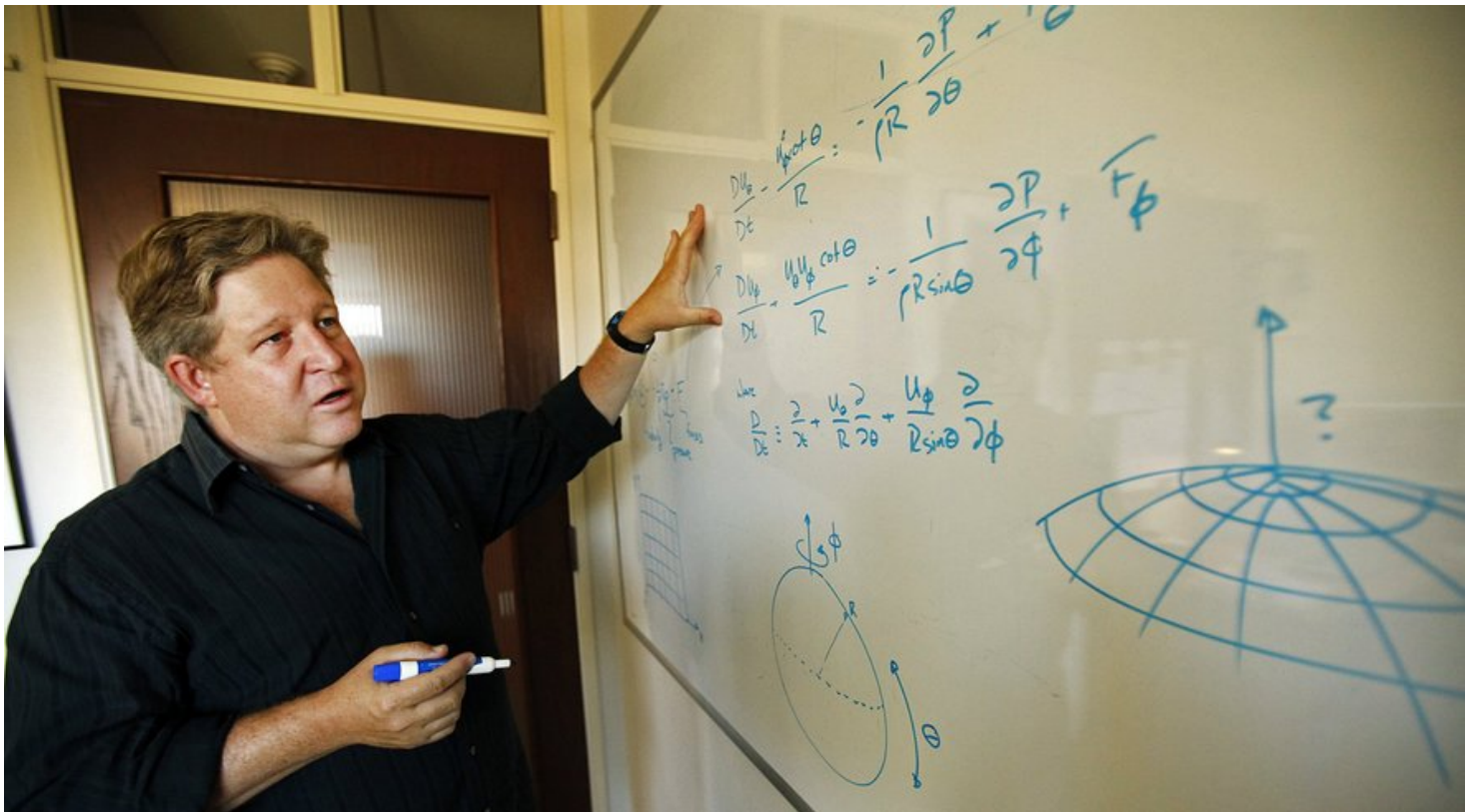
- 1 Which of the following sentences from the article shows Hannah's main goal?
- (A) After presenting her project at county and state science fairs, she entered and won Discovery Education and 3M's Young Scientists Challenge, becoming "America's top young scientist" last fall.
 - (B) Hannah sent \$3,000 of her \$25,000 winnings to Compassion International, the nonprofit that connected her with 9-year-old Ruth and her family in Dessie, Ethiopia.
 - (C) While she realizes that her dream is still a way off, she hopes one day to be able to give a version to Ruth and her family.
 - (D) "No matter how difficult things seem or how much you think that you can't do it based off what other people say, you just have to keep going," Hannah said.
- 2 Which of the following aspects of the article is NOT thoroughly discussed?
- (A) how Hannah's invention is designed and how it functions to generate power
 - (B) how Hannah fared in the competition at the White House
 - (C) why Hannah feels intimidated in the field of math, science and engineering
 - (D) the changes Hannah will make to her generator to make it better
- 3 Which paragraph below BEST reflects a major challenge in the STEM field?
- (A) Unlike existing turbines that are often huge, expensive and operate on the ocean floor, Hannah's model is cheap and floatable, so anybody can use it. She made one iteration out of recyclable materials for only \$12.
 - (B) Just 15 and a student at Florida Atlantic University High School, Hannah has come a long way since her initial idea almost three years ago. After presenting her project at county and state science fairs, she entered and won Discovery Education and 3M's Young Scientists Challenge, becoming "America's top young scientist" last fall.
 - (C) "We've got to get more of our young women and minorities into science and technology, engineering and math, and computer science," Obama said Wednesday. "We're not going to succeed if we got half the team on the bench."
 - (D) Until her parents, Joel and Julie Herbst, switched her from theater to engineering summer camp in the seventh grade, Hannah hadn't shown much interest in science. As a newcomer to the field and the only girl there, she felt intimidated at first. But she caught on quickly, and her team won the camp's weeklong competition.
- 4 What are the TWO CENTRAL ideas of the article?
- (A) A Florida high school student invented a cheap electrical generator she hopes will be more affordable for people living in Ethiopia. She hopes to improve the technology and bring more young women into the STEM field.
 - (B) Hannah won a competition at the White House to develop new generator technology. Hannah hopes to attend college in the fall at Florida Atlantic University.
 - (C) Hannah created an invention that uses a Pelton wheel system to generate electricity. She sent \$3,000 of her winnings to help a family in Ethiopia purchase a new generator.
 - (D) Hannah teamed up with the company 3M recently to see how she can bring her new generator to market. Over the summer, she plans to update the design and make it more powerful.

Physicists, others using science to help art of film animation

By Richard Verrier, Los Angeles Times on 08.06.14

Word Count 1,372

Level MAX



Ron Henderson, director of research and development at DreamWorks Animation, works on equations for the fluid dynamics behind a fluid simulation technology that gives animation artists the tools to work on the upcoming movie "Home" as they draw soap bubbles inhabited by diminutive aliens called the Boov. Al Seib/Los Angeles Times/MCT

In a small, utilitarian office in Glendale, California, Ron Henderson methodically jotted down equations for Isaac Newton's Three Laws of Motion on a whiteboard next to his desk.

The equations, the physicist explained, are the mathematical building blocks for constructing a three-dimensional, bubble-like sphere.

Henderson could easily have been preparing a lesson at Caltech, where he once was a faculty member. Instead, he was at DreamWorks Animation's Tuscany-style campus, doing his part to bridge the divide between art and science.

Henderson was explaining the math behind a fluid-simulation technology that would help artists working on the upcoming movie "Home" draw soap bubbles inhabited by a race of diminutive aliens called the Boov.

To give them visual references, Henderson and his team began by studying drawings and photos of soap films and bubbles last year. He invited a physicist colleague from San Jose State to give a lecture titled “Bubble Science.”

The physicist, Alejandro Garcia, took a low-tech approach. He arrived at the studio with boxes of liquid soap and party bubbles, using a plastic wand to fashion large bubbles for an audience of artists and technicians gathered at an outdoor amphitheater.

“He did cool things that we’re not doing, like what happens when you make a soap bubble out of hydrogen and set it on fire?” Henderson said, chuckling. “What does that look like?” The bubble made a loud boom and burst into a fireball when an assistant took a Tiki torch to it.

That’s the kind of thing that happens when the scientific set makes the move to the movies.

“What we’re doing here is creating tools for artists,” Henderson said. “I think it’s going to be a success.”

Henderson, 47, is part of an expanding cadre of high-level physicists, engineers and other scientists, including many former NASA employees, who have left careers in aerospace and academia to work in the movie business.

Demand for their services has grown as animated movies, once created by hand, push the boundaries of what can be created on a computer screen. Artists at DreamWorks, Disney-owned Pixar and other studios increasingly rely on the services of people such as Henderson to create complex algorithms to simulate realistic-looking water, fire, dust and other elements in movies packed with action and special effects.

“The physics behind what’s happening in these movies is incredibly complicated,” said Paul Debevec, a computer scientist and chief visual officer at the USC Institute for Creative Technologies. “You need real scientists to understand what’s going on. These are Ph.D.-level folks who could have been publishing papers in Physics Today. Instead, they are working on Hollywood blockbuster films.”

Scientists who leave academia for Hollywood risk losing some prestige among their peers. “My advisor at Caltech got some flak from Princeton, saying ‘How come you guys let him leave?’” Henderson said.

Although they typically get paid more in the film business, Henderson says money isn’t the main draw. He cites the excitement of working on movies and the challenge of finding solutions to technical problems.

DreamWorks has one of the largest contingents of scientists.

“We have sculptors and painters working side by side with software developers and particle physicists,” said Dan Satterthwaite, the studio’s human resources director.

The company’s research and development group has about 120 members with master’s and doctoral degrees in such fields as cognitive science, astrophysics, aeronautical engineering, chemistry, mathematics and computer science. Nearly a dozen of them are former employees of NASA’s Jet Propulsion Laboratory.

The studio has even hired biologists to advise animators on how to correctly illustrate the proper branch structure on a tree.

“This whole company is a very interesting mix of left brain and right brain,” said Jim Mainard, head of digital strategy and new business development for DreamWorks. “Often we end up at the same place, but from different directions.”

Mainard, himself a computer scientist, used to work for a NASA contractor involved in the Hubble Space Telescope. He also created film simulations for the Navy before DreamWorks hired him to help the studio build its own pipeline of computer-animated movies.

“When I came out of college, I never thought I would work in the entertainment business,” Mainard said. “For me, it was just a great time to make the transition. We were having our first child and I just liked the idea of making animated films. I thought that would align with having a family ... Making people laugh is a great legacy.”

Henderson’s office is cluttered with hints of his academic past. A bookshelf is lined with scientific texts with titles such as “Fluid Dynamics” and “Differential Equations.” On his desk is a manuscript for a book he co-wrote called “Multithreading for Visual Effects.”

Pinned on the front door is a congratulatory letter for a Technical Achievement Award he received in February from the Academy of Motion Picture Arts and Sciences.

Henderson, a director of the DreamWorks research and development team, received the award for developing a fluid-simulation system called Flux, which creates high-resolution effects 100 times faster than in the past.

“I was at home in Kentucky for the holidays when the announcement came out at midnight,” Henderson said. “I woke up my wife and kids ... It was a big honor.”

Henderson was born and raised in a small town near Nashville. A math whiz in high school, he dreamed of becoming a rocket scientist, studying aeronautical engineering at Purdue University. Later, he received a doctorate from Princeton in mechanical and aerospace engineering.

His groundbreaking research in the field of fluid dynamics landed him a job as a faculty member at Caltech, where he taught for five years before taking a leave to work for a commercial software company, ArsDigita.

When that company was sold in 2002, Henderson decided to make a permanent switch to the private sector. He joined DreamWorks, where a former Caltech colleague had worked.

“Science can be a very lonely activity,” he said. “I wanted to use my background in computational physics, but I wanted to have the experience of working with people and being able to see the results of what I did.”

Seeing “Shrek” also piqued his scientific curiosity about the new medium of computer-generated imagery, or CGI, that was changing how movies were made.

“What astonished me was how much detail and motion there was in every frame, the motion of the trees, the grass and all the other elements,” he said. “It intrigued me to the point that I didn’t think it was possible.”

Part of Henderson's role is to foster a culture of collaboration between workers from disparate backgrounds. Artists and engineers hold biweekly meetings and also work on the same floor to interact more easily.

Much of their focus is on what he calls improving the "scale of production." Because there are so many shots in a single movie — one film might have 700 scenes with fire, for example — Henderson and his team spend much of their time trying to devise more efficient ways of simulating effects through improved software and hardware.

Then there are specific technical challenges of creating something visually unique to the look of each film, such as the frost in "Rise of the Guardians," the stylized cannon fire in "Kung Fu Panda 2" or the ice-breathing dragon in "How to Train Your Dragon 2."

His latest challenge was creating the bubble-like spheres in "Home," which would provide the unique look to spaceships in the movie.

Turns out, creating a computer animation image of a bubble on a flat surface is one thing, but wrapping that image around a floating soccer-ball-like sphere is a much trickier problem of math and physics.

Using a variation on a numerical weather-prediction model, Henderson tapped into his knowledge of fluid dynamics to devise a new way to simulate flow on a sphere.

The fact that few moviegoers will appreciate the technical achievement doesn't bother him.

"I can go work for an oil company or I could go back to academia," he said, "but the personal gratification of doing something where you can clearly see the results of your work, and where you feel you are providing a unique benefit to the artists — that's what keeps me coming here every day."

Quiz

- 1 Which of the following BEST describes the main ideas in the article?
- (A) In order to help artists create realistic-looking 3-D environments quickly and easily, artists are using computer programs originally developed by DreamWorks to study physics, biology, and other branches of science.
 - (B) In order to help artists create realistic-looking 3-D environments quickly and easily, DreamWorks is hiring scientists to develop new computer programs and techniques based on physics, biology, and other branches of science.
 - (C) In order to help artists learn about Newton's Laws of Motion and other laws of physics and biology that describe the real world, artists are using computer programs originally developed by DreamWorks to study physics, biology, and other branches of science.
 - (D) In order to help artists learn about Newton's Laws of Motion and other laws of physics and biology that describe the real world, DreamWorks is hiring scientists to develop new computer programs and techniques based on physics, biology, and other branches of science.
- 2 If this article were to be rewritten to focus only on the science behind some of the work at animation studios, which of the following would be LEAST useful?
- (A) "The physics behind what's happening in these movies is incredibly complicated," said Paul Debevec, a computer scientist and chief visual officer at the USC Institute for Creative Technologies.
 - (B) Turns out, creating a computer animation image of a bubble on a flat surface is one thing, but wrapping that image around a floating soccer-ball-like sphere is a much trickier problem of math and physics.
 - (C) "We have sculptors and painters working side by side with software developers and particle physicists," said Dan Satterthwaite, the studio's human resources director.
 - (D) His groundbreaking research in the field of fluid dynamics landed him a job as a faculty member at Caltech, where he taught for five years before taking a leave to work for a commercial software company, ArsDigita.
- 3 Read the paragraph from the article.

"What astonished me was how much detail and motion there was in every frame, the motion of the trees, the grass and all the other elements," he said. "It intrigued me to the point that I didn't think it was possible."

Which of the following words BEST capture's Henderson's description of his reaction to "Shrek"?

- (A) malice
- (B) incredulity
- (C) rejuvenation
- (D) recrimination

Henderson, 47, is part of an expanding cadre of high-level physicists, engineers and other scientists, including many former NASA employees, who have left careers in aerospace and academia to work in the movie business.

Which of the following BEST replaces the word “cadre” in the sentence above?

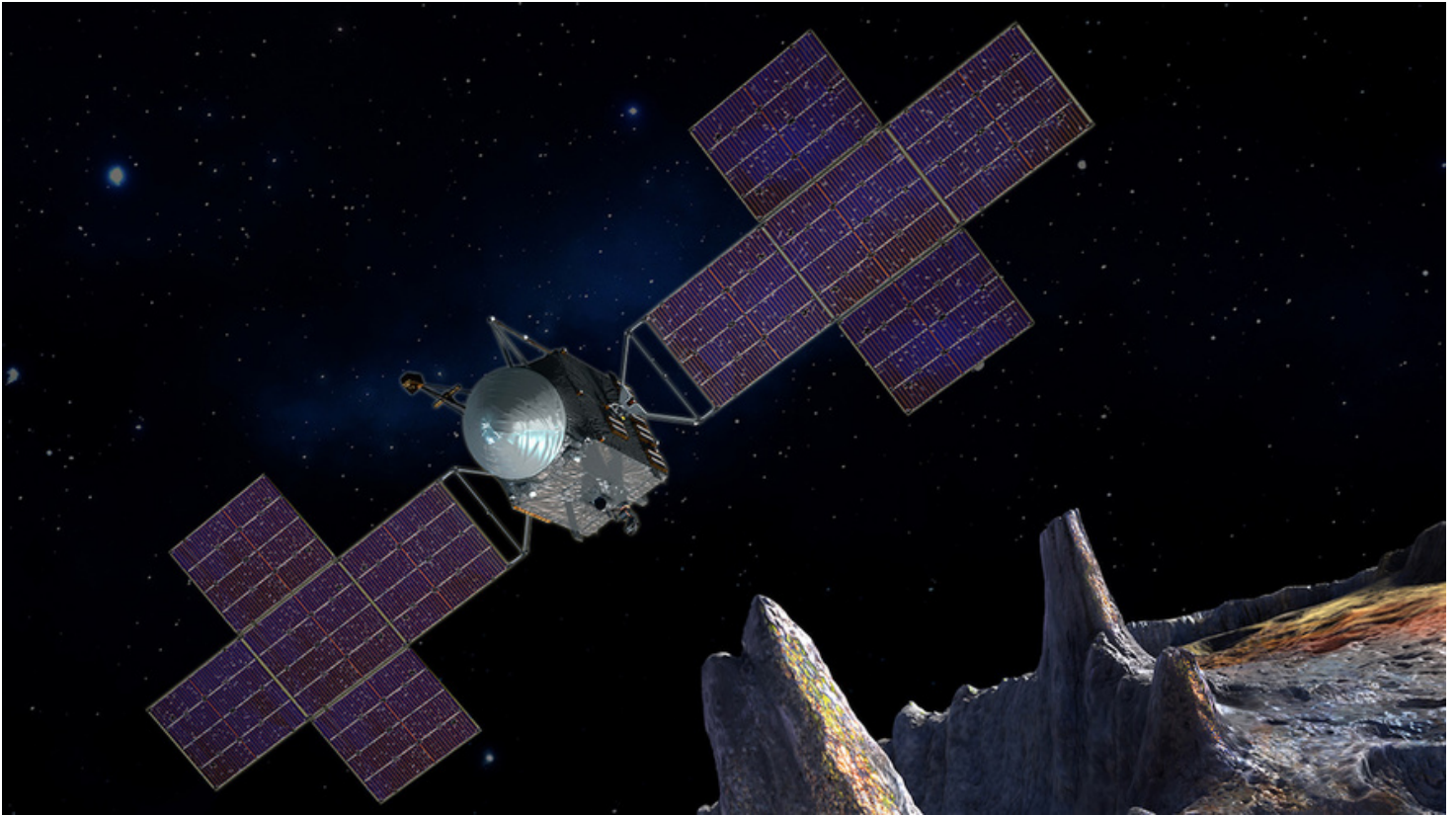
- (A) horde
- (B) herd
- (C) bevy
- (D) body

NASA plans to send high-definition video of Mars to Earth with lasers

By Julissa Treviño, Smithsonian.com on 04.26.18

Word Count **471**

Level **MAX**



NASA's Psyche mission to a distant metal asteroid that passes near Mars will carry a revolutionary Deep Space Optical Communications (DSOC) package. This artist's concept shows Psyche spacecraft with a five-panel array. Photo by: NASA

Pictures from space have allowed scientists to examine and search for clues about other planets and let space enthusiasts get a rare view beyond Earth.

Now, NASA wants to take that experience to a new level by transmitting high-definition video from places like Mars to Earth using laser beams.

As Joel Palca reports for NPR's "All Things Considered," the agency is planning to launch a probe that will allow data from future missions there to be transmitted via video.

Called Deep Space Optical Communications (DSOC), the technology that can beam high-def video to Earth from deep space as it travels aboard the Psyche mission, is set to launch in 2022.

Psyche won't go directly to Mars; rather, it will enter and leave the gravitational field of Mars on the way to the asteroid the mission is named after. Along the way, it will be able to "transmit the

clearest, quickest information ever obtained from an expedition into the solar system,” according to NASA.

On Earth, Alexander Graham Bell, the inventor of the telephone, also built a machine that used light from the sun to transmit sound, Palca writes, the precursor to today’s fiber-optic cables. In both cases, data is converted into pulses of light, then reconverted into data — photos, music or cat videos — on the receiving end. The DSOC works much the same way, but uses pulsed laser beams.

The probe won’t be the first time NASA uses laser light to beam data from space. In 2013, the agency did so as part of its Lunar Laser Communication Demonstration project. As Smithsonian.com reported, this proved it could transmit real-time data and 3-D high-definition video from space.

But doing so from Mars will be a new challenge. The red planet is much further away from Earth compared to the moon — about 140 million miles away, to be exact.

“The biggest challenges, by far, have to do with distance,” Kevin Kelly, CEO of LGS Innovations in Herndon, Virginia, which is helping build DSOC, tells Palca.

This makes pointing the laser and getting a signal that’s strong enough to transmit the video a problem, Kelly says.

As Palca explains, a laser beam might take 20 minutes to travel between Earth and Mars. By the time the beam reaches where Earth was, the planet has moved. Instead, scientists have to predict where the Earth will be when a signal arrives.

On Earth, the Hale telescope, a 200-inch telescope located at the Palomar Observatory in California, will capture the light, which will then go into a detector that can measure even the faintest of signals.

Elsewhere, scientists are also working on using laser communication closer to home. Palca reports MIT’s Lincoln Laboratory is building a mini optical system to send to low Earth orbit that will transmit data at 200 gigabits per second.

Quiz

- 1 Which matter is left uncertain in the article?
- (A) whether NASA has any prior experience using laser light to beam data from space
 - (B) whether the technology for beaming video to Earth from deep space is completely developed
 - (C) whether the NASA mission that is set to launch in 2022 is scheduled to go directly to Mars
 - (D) whether NASA can guarantee that video will be sent via laser beams from Earth to Mars
- 2 Which option accurately represents the relationship between two of the article's CENTRAL ideas?
- (A) NASA's Psyche mission will use DSOC to beam video to Earth from Mars; one challenge of the mission is receiving a signal from the video when it arrives on Earth.
 - (B) NASA's DSOC technology will send high-def video to Earth from Mars using laser beams; high-def video was invented years ago by Alexander Graham Bell.
 - (C) NASA plans to launch a probe that will allow data to be transmitted via video from Mars; this probe has been used successfully by NASA from deep space before.
 - (D) NASA is working on a mission to transmit data from Mars to Earth via video; NASA is simultaneously working on a mission to transmit data via video from Earth to Mars.
- 3 Which option would be MOST important to include in an objective and accurate summary of the article?
- (A) Because MIT is such a prestigious university, its plan to build a mini optical system that can transmit data at 200 gigabits per second is likely to succeed.
 - (B) The Hale telescope in California was selected to receive the laser beam from Mars because that telescope is widely recognized as the best in the world.
 - (C) Although 20 minutes might seem fast for a laser beam from Mars to travel to Earth, NASA scientists would tell you that it is not.
 - (D) The DSOC technology converts data into pulsed laser beams much as fiber-optic cables convert data into pulses of light.

- 4 Read the fourth paragraph below from the article.

Psyche won't go directly to Mars; rather, it will enter and leave the gravitational field of Mars on the way to the asteroid the mission is named after. Along the way, it will be able to "transmit the clearest, quickest information ever obtained from an expedition into the solar system," according to NASA.

Which conclusion is BEST supported by the paragraph?

- (A) On its way to Mars, Psyche will first transmit video from the asteroid the mission is named after.
- (B) It is usually too difficult for NASA expeditions into the solar system to obtain data on their missions.
- (C) Data transmitted from NASA expeditions into the solar system is not always clear.
- (D) The video sent by Psyche will be clear because Psyche will not go directly to Mars.

Rain or shine: new solar cell captures energy from raindrops

By Damian Carrington, The Guardian on 05.23.18

Word Count **502**

Level **MAX**



Researchers want to create a hybrid device that harvests kinetic energy from water as well as solar power from the sun. Photo by: Ramin Talaie/Corbis via Getty Images

A solar panel that can generate electricity from falling raindrops has been invented, enabling power to flow even when skies cloud over or the sun has set.

Solar power installation is soaring globally thanks to costs plunging 90 percent in the past decade, making it the cheapest electricity in many parts of the world. But the power output can plummet under gray skies, and researchers are working to squeeze even more electricity from panels.

The new device, demonstrated in a laboratory at Soochow University in China, places two transparent polymer layers on top of a solar photovoltaic (PV) cell. When raindrops fall onto the layers and then roll off, the friction generates a static electricity charge.

“Our device can always generate electricity in any daytime weather,” said Baoquan Sun, at Soochow University. “In addition, this device even provides electricity at night if there is rain.”

Other researchers have recently created similar devices on solar panels, known as triboelectric nanogenerators (Tengs), but the new design is significantly simpler and more efficient as one of the polymer layers acts as the electrode for both the Teng and the solar cell.

“Due to our unique device design, it becomes a lightweight device,” said Sun, whose team’s work is published in the journal ACS Nano. “In future, we are exploring integrating these into mobile and flexible devices, such as electronic clothes. However, the output power efficiency needs to be further improved before practical application.”

Sun said the field was developing fast and expects to produce a prototype product in three to five years. Other scientists in China have also used Tengs on solar cells to harvest some power from the wind, an approach Sun said could be added to his device. The top layer of the Teng is also grooved to help focus more light on the solar cell.

“The idea is interesting – a hybrid device that harvests kinetic energy from water without destroying the output of the solar cell during sunny times,” said Varun Sivaram, at the U.S. Council on Foreign Relations, and author of a new book on solar power. “There’s lots of nice engineering, like using one layer to do double duty as a component of the Teng as well as trap light for the solar cell.”

However, Varun said the power the device generates from falling rain needs to be significantly higher to start making an overall difference to a solar panel’s output. “It’s really not clear whether this is a big deal or not – I suspect it’s not.”

Professor Keith Barnham, at Imperial College London, said the hybrid device gave an important advantage in making it more compact and efficient. But he said: “Wind power is clearly the most effective and complementary power source to PV – and it works equally well in the rain!”

Other innovations in solar panel design include using the mineral perovskite as a flexible and efficient material, using so-called “quantum dots” and researching artificial photosynthesis, which uses sunlight to produce liquid and gas fuels.

Quiz

- 1 The following evidence was gathered to support the idea that the scientists who developed the solar panels featured in the article are attempting to make solar energy more efficient.

1. *A solar panel that can generate electricity from falling raindrops has been invented, enabling power to flow even when skies cloud over or the sun has set.*
2. *The new device, demonstrated in a laboratory at Soochow University in China, places two transparent polymer layers on top of a solar photovoltaic (PV) cell. When raindrops fall onto the layers and then roll off, the friction generates a static electricity charge.*
3. *“Our device can always generate electricity in any daytime weather,” said Baoquan Sun, at Soochow University. “In addition, this device even provides electricity at night if there is rain.*

What additional piece of evidence helps to create the MOST COMPLETE argument that the scientists who developed the solar panels featured in the article are attempting to make solar energy more efficient?

- (A) Solar power installation is soaring globally thanks to costs plunging 90 percent in the past decade, making it the cheapest electricity in many parts of the world.
- (B) “The idea is interesting – a hybrid device that harvests kinetic energy from water without destroying the output of the solar cell during sunny times,” said Varun Sivaram, at the U.S. Council on Foreign Relations, and author of a new book on solar power.
- (C) However, Varun said the power the device generates from falling rain needs to be significantly higher to start making an overall difference to a solar panel’s output.
- (D) “Wind power is clearly the most effective and complementary power source to PV – and it works equally well in the rain!”

- 2 Read the following paragraph from the article.

Sun said the field was developing fast and expects to produce a prototype product in three to five years. Other scientists in China have also used Tengs on solar cells to harvest some power from the wind, an approach Sun said could be added to his device. The top layer of the Teng is also grooved to help focus more light on the solar cell.

Which conclusion is BEST supported by the paragraph above?

- (A) Wind power is a better source of energy than solar power.
- (B) The Teng devices will likely advance more quickly than Sun's devices.
- (C) Significant time and energy is invested in developing more efficient solar power.
- (D) Sun and his team will primarily focus on adding more wind power capacity to their panels.

- 3 Read the following quote from Varun Sivaram.

“It’s really not clear whether this is a big deal or not – I suspect it’s not.”

Why did the author include this quote in the article?

- (A) to counterbalance the enthusiasm regarding the new solar panels
- (B) to clarify the view of most scientists regarding solar energy
- (C) to prove that harnessing rain for electricity is not effective
- (D) to highlight the need for more research and development around solar power

Which statement BEST reflects one of professor Keith Barnham's beliefs?

- (A) Developing smaller and more efficient solar panels will ensure that solar power is accessible to all.
- (B) The most important innovation in solar panel design is the pursuit of more flexible material.
- (C) Devices that can harness rain power should be made readily available.
- (D) It is essential to continue researching which alternative energy source is the most viable and powerful.