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Orbiter to Map Moon, Looking for Ice and a Home for Astronauts

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By KENNETH CHANG Before NASA sends astronauts back to the Moon, it wants to scope out the territory it has largely ignored since the last time it sent astronauts there nearly 40 years ago.
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Orbiter to Map Moon, Looking for Ice and a Home for Astronauts

(topic overview)

CONTENTS:

- Soon two NASA spacecraft, a lunar spycraft and a kamikaze probe, will help answer the question by peering into the permanent darkness of craters at the moon's south pole. **(More...)**
- Although it could supply water for colonists to drink or grow food, more importantly, it could get split up to make hydrogen and oxygen for fuel for rockets. **(More...)**
- Some scientists oppose the new moon program, saying NASA should focus instead on research on Mars and other planets. **(More...)**
- The problem is that Lunar Prospector could only measure hydrogen, and not what matter the hydrogen was in. **(More...)**

- LCROSS was built using an Evolved Expendable Launch Vehicle (EELV) secondary payload adapter, or ESA ring, as the spacecraft structure, and costs were kept low by reusing existing hardware/hardware designs and commercial-off-the-shelf products. **(More...)**

SOURCES

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- **Information summarization a**

Soon two NASA spacecraft, a lunar spycraft and a kamikaze probe, will help answer the question by peering into the permanent darkness of craters at the moon's south pole. The new moon probes, the Lunar Reconnaissance Orbiter and the LCROSS impactor, are set to blast off this week on NASA's first mission to the moon in more than a decade. Any ice they discover could not only be used to quench an astronaut's thirst, but also to help fuel rockets for adventures beyond the moon. All moon rocks collected so far suggest that its surface is bone dry, with any water that might come from impacting comets baked off by the sun, except perhaps for a few water molecules trapped in volcanic glass beads. [1] 'We have much better maps of Mars than we have of our own moon's polar regions,' said Craig Tooley, project manager for the 504- million-dollar LRO mission. He told reporters that while the Apollo missions stayed near the moon's equator, the lunar poles are the likely landing targets for a potential manned spacecraft. The LRO will orbit the moon for about a year to develop the maps, before turning its attention to other scientific endeavours being proposed by scientists. 'LRO will bring new eyes to the moon and with these eyes we'll see new views of the moon,' said Rich Vondrack, a project scientist on the mission. Its eyes consist of seven instruments pointed at narrow sections of the moon which will gradually capture the entire surface. It will pay special attention to 100 regions of high interest. The LCROSS will focus on determining whether water could be hidden in the shadowy craters of the moon near its poles.[2]

Killer space radiation and meteorite impacts are just a few of the pleasures that await astronauts venturing onto the lunar surface as part of NASA's return to the moon, planned for the 2020s. According to a report in New Scientist, to map out these dangers and pinpoint resources like water-ice and metals in lunar rock and soil, NASA plans to launch its Lunar Reconnaissance Orbiter (LRO) on 17 June. It will hit orbit four days later.[3] Wednesday's launch will send two vehicles into space: the Lunar Reconnaissance Orbiter, or LRO, and the Lunar Crater Observation and Sensing Satellite, or LCROSS. The LRO's primary mission is straightforward: It will map and photograph the moon's surface.[4] NASA's Lunar CRater Observation and Sensing Satellite (LCROSS) and Lunar Reconnaissance Orbiter (LRO) spacecraft are the first steps in NASA's plan to return humans to the moon.[5]

Atop an Atlas 5 rocket at Cape Canaveral Air Force Station in Florida sits the first step in what will surely be a long and arduous task for NASA--returning humans to the moon. The Lunar Reconnaissance Orbiter, or LRO, set to lift off this week, will orbit the moon in search of potential landing sites and useful resources, such as water ice, that would facilitate a long-term human presence.[6] The unmanned $504 million Lunar Reconnaissance Orbiter, which launches Wednesday along with another satellite, is designed to take high-resolution photos to find safe future landing sites. Other instruments will examine radiation levels and identify natural resources on the moon, such as ice, for possible use by future human outposts.[7] Robinson, a professor in ASU's School of Earth and Space Exploration in the College of Liberal Arts and Sciences, is the principal investigator for the imaging system on the mission, known as LROC (short for Lunar Reconnaissance Orbiter

Camera). It's actually three cameras that will look at every piece of ground on the moon, under all kinds of illumination, from grazing light at local sunrise through local noon to grazing light from the opposite direction at sunset, with the goal of identifying safe landing sites for future voyages to Earth's satellite.[8] If all goes as planned over the next year, NASA's images of the moon will go high-resolution and wide-ranging as the Lunar Reconnaissance Orbiter snaps pictures to identify safe landing sites for future missions.[9]

The future of manned moon spaceflights remains unclear. Earlier this year, the president commissioned an independent review of NASA's manned space program, and the recommendations are expected later this year. Despite the uncertainty, Roland said, he thinks the lunar orbiter mission still makes "a certain amount of sense." Scientific instruments have advanced considerably since the Apollo days, he said, so it's likely to produce interesting findings. "But having said that, these two missions were designed to support a manned landing on the moon, and I'm not at all convinced we will end up doing that," he said.[7] NASA has announced that it intends to launch a manned moon mission by 2020. It would be the first U.S. return to Earth's satellite since the Apollo moon landings concluded in 1972. Whether NASA will meet its objective remains in doubt. President Barack Obama has continued and even boosted funding for the project, but this week's mission alone is expected to cost $500 million and cost cutting is sure to become a threat as record budget deficits loom. The Chinese are now six years into their manned space program, and have likewise spoken of reaching the moon by 2020, then pushing on to Mars.[4] MOUNTAIN VIEW, Calif. (KCBS) -- NASA is scheduled to launch a rocket this week that will return the space program to the Moon. Scientists at NASA Ames in Mountain View developed a satellite that will slam its payload into the lunar surface.[10]

LCROSS will provide scientists two chances to take a closer look. It will guide the top stage of its launch rocket in a huge orbit of the moon and Earth, picking up speed and then launching the spent booster toward the moon. The rocket will collide with the surface in a sun-shaded crater near the lunar south pole, gouging a 60-foot-wide, 9-foot-deep crater of its own and generating a plume of some 250 metric tons of lunar dust.[4] India has landed a probe on the moon and plans to send a motorized rover there within the next few years. A Japanese lunar survey mission concluded Thursday when its probe, like LCROSS, crash-landed on the moon's surface. The scientists involved in the moon launch remain confident that a new era of exploration is at hand, and of their place in it.[4]

Scientists and mission operators will remotely control the K10s from the NASA Lunar Science Institute (NLSI) at NASA Ames and collect scientific data using the K10's cameras and 3-D laser scanners. After the robots have completed their exploration, the mission team will use the images and 3-D terrain models taken by the K10s to plan a simulated astronaut mission in August. Media interested in interviewing the science and mission operations teams as they work at the NLSI should contact Rachel Prucey at rachel.l.prucey@nasa.gov or 650-604-0643 by Wednesday, June 24, 2009 to schedule interviews. "This field test is important for understanding how robots can help future astronauts be more productive on the moon," said Terry Fong, principal investigator of the robotic recon experiment and director of the Intelligent Robotics Group at NASA Ames.[11] NASA's return to the moon and the possibility of a manned spaceflight by 2020 could open the doors to even more research. That's welcome news to geologist Kip Hodges, director of ASU's School of Earth and Space Exploration. He is already working with NASA on plans to train astronauts in geology. "I love Mars, and we do a lot of work there, but we can't forget there's a tremendous amount of science that can still be done on the relatively accessible moon," he said. "We should do both."[9]

The LRO mission springs from NASA's Vision for Space Exploration, the Bush-era plan to return humans to the moon by 2020 on board Ares rockets currently in development to replace the space shuttle, which retires next year.[6] "NASA hopes that, from the LRO and the other missions. that we will have enough information to design the systems to return to the moon and pick the best places" to land, Vondrak said. Both spacecraft are poised at the Cape Canaveral Air Force Station for a 3:51 p.m. launch on Wednesday atop an Atlas V rocket.[12] Nearly 40 years after Neil Armstrong walked on the moon and uttered his famous words, NASA this week will launch the first in a series of missions designed to return astronauts to the moon by 2020.[7] Staffed launchpad could be start of missions to Mars. America's quest to return astronauts to the moon begins this week with the launch of an unmanned lunar orbiter and probe.[4]

Heading moonward is the Lunar Crater Observation and Sensing Satellite (LCROSS), which will slam into the Shackleton Crater on the south pole of the moon in a few months and kick up material that could have been in shadow for 2 billion years. Another probe will slam into the moon a few minutes later at a different location. It's all an effort to learn more about what the moon is made of, whether there is water ice in the crater, and therefore where to send U.S. astronauts in a planned return by 2020.[13] The craft will be equipped with a total of six instruments and will also measure the solar and cosmic radiation that humans working on the Moon in the future will be exposed to. It will be launched by the same rocket as LCROSS, or the Lunar Crater Observation and Sensing Spacecraft, from Cape Canaveral. LCROSS will fire a probe into the Moon at a point near its pole that never receives sunlight and analyze the resulting plume of debris.[14] The LCROSS spacecraft will shepherd the Earth departure upper stage of the Atlas V rocket, upon which it will be launched, to impact the moon to help confirm the presence of water ice in a permanently shadowed lunar crater and to characterize other regolith properties within the crater.[5] Dan Andrews, project director for the LCROSS mission, is excited about launching the spacecraft that will ultimately slam a rocket, and then itself into a lunar crater, at about 5,600 miles per hour. "We're going very tactically in to discover if there is indeed water ice, present in the bottom of those permanently shattered craters," Andrews said.[10]

After a year of low-altitude study, LRO will shift to a higher, more stable orbit for several more years of lunar studies. The second spacecraft, called Lunar CRater Observation and Sensing Satellite, will rocket off on a long, looping orbit around the Earth and moon.[12] A separate instrument, the $79 million Lunar Crater Observation and Sensing Satellite, is riding piggyback on the orbiter and is scheduled to slam into the moon about four months later, providing more insight into the moon's makeup.[9]

The Lunar Reconnaissance Orbiter will make the four-day crossing to the moon, settle into a circular orbit and begin a long period of study with six onboard instruments. LRO will measure the solar and cosmic radiation that long-term lunar explorers will encounter on the surface, and test its potential impact on human health.[12] NASA's Lunar Reconnaissance Orbiter (LRO), slated for launch this week, will map the moon's surface from orbit with unprecedented detail, capable even of imaging the tracks that lunar rovers left behind.[13]

ASU planetary scientist Mark Robinson talks about the value of returning humans to the moon and the scheduled June 17 launch of the Lunar Reconnaissance Orbiter with Arizona Republic reporter Anne Ryman. Her coverage of ASU's role in the next lunar mission begins on the front page of the June 14 Arizona Republic.[8] Frank Centinello, part of the mission operation team at ASU's Science Operations Center for the Lunar Reconnaissance Orbiter, is able to see the Lunar

Reconnaissance Orbiter and the moon from different angles on video panels.[9] LUNAR SCOUT: The Lunar Reconnaissance Orbiter, seen here being loaded into its protective casing last month along with its companion LCROSS spacecraft, will survey the moon in advance of planned U.S. manned missions.[6] The upcoming LCROSS will crash two probes into the moon. Its partner probe, the Lunar Reconnaissance Orbiter, will map the moon from orbit and work with other ground and space-based assets to scan the LCROSS impacts.[1]

NASA is also encouraging amateur astronomers to observe and photograph the plume. Though launched at the same time as LCROSS, the LRO will separate immediately from the booster and reach lunar orbit well in advance of its sister ship. In addition to mapping the moon and watching the LCROSS impacts, its role in preparing for a manned mission to the moon includes checking out possible landing sites and measuring radiation levels to determine whether long-term stays there will be possible.[4] The missions are NASA's first to orbit the moon since Lunar Prospector in 1999, and the first to reach the surface since the final Apollo landing in 1972.[12]

In 1998, NASA's Lunar Prospector also detected hints of water, this time at both poles. Its instruments analyzed neutrons absorbed by a variety of elements on the moon's surface, including hydrogen. With this device, Lunar Prospector discovered hydrogen concentrated at the moon's poles, which scientists conjectured might have come from water molecules, each of which contains two hydrogen atoms.[1] NASA scientists said that it is possible for frozen water to have remained in the moon's craters for billions of years, because the bottoms of the craters are never reached by sunlight and protect any ice from evaporation into the moon's thin lunar atmosphere.[2] One of the two will crash its rocket booster into a polar crater, then fly through the debris plume to scan for water ice. The second, conceived and built in Maryland, will orbit the moon for at least a year. Its goal is to find safe landing sites with the water and sunshine needed to help sustain a permanent manned base.[12] This NASA illustration depicts how water ice may lie hidden deep at the bottom of deep south pole craters that are in permanent shadow on the moon.[1] NASA thinks/hope that water is frozen in the perpetual darkness of craters near the moon's south pole.[15]

▲ BACK TO TOP

Although it could supply water for colonists to drink or grow food, more importantly, it could get split up to make hydrogen and oxygen for fuel for rockets. "It costs about $10,000 to $15,000 per pound to launch something in the space shuttle, and there are about 8 pounds of water to a gallon, so we're talking about $100,000 to bring a gallon of water to low Earth orbit," Colaprete said. "If we can use the lunar poles as a resource, we could use them as staging bases to go elsewhere on the moon, or beyond the moon, or beyond Mars or Europa or elsewhere we'd want to go. [1] After launch, the rocket will deliver the LRO into orbit around the moon, then take a long loop around the moon and earth still carrying the LCROSS satellite.[2]

Kring says that even given the uncertainties in the future of manned spaceflight in the U.S., the lunar orbiter is a mission whose time has come. "Not only is this the right time to launch LRO, the LRO spacecraft should be the first in a small fleet of missions that expand our horizons and, simultaneously, provide opportunities to enhance our nation's technological capabilities," he says.[6] It's a question that Arizona State University Professor Mark Robinson, who's overseeing the Lunar Reconnaissance Orbiter's cameras, hears often. He answers it with another question. "Why do we continue to go to Antarctica?" he asked a few weeks before the lunar orbiter was scheduled to launch. There are, of course, the intangible

social and political reasons, he says.[7] We don't expect to have any problems," said Richard R. Vondrak, project scientist for the Lunar Reconnaissance Orbiter, which was built at the NASA Goddard Space Flight Center in Greenbelt.[12] For starters, LRO will improve maps of the moon, says astrophysicist John Keller of the NASA Goddard Space Flight Center in Greenbelt, Md., deputy project scientist for the $500-million mission. "A point I like to make about LRO," he says, "is that when it comes to the shape of the moon, we actually know the shape of Mars much better than we do of the moon."[6] Craig Tooley, LRO mission manager for NASA, says the information it gathers will be the basis for a detailed atlas of the moon. It will collect that data with instruments that are far more sensitive than those used in the last American lunar surveyor, Clementine, in 1994.[4] Much remains mysterious about the moon, and NASA hopes to clear up some of the remaining questions with dual missions designed to set the course for the resumption of human lunar exploration.[2]

To simulate robots scouting on the lunar surface before a human space crew arrives, the "K10 Red" and "K10 Black" robots developed at NASA Ames Research Center, Moffett Field, Calif., will perform site surveys of the Black Point Lava Flow in Arizona June 14 - June 26, 2009.[11] The June field test is part of the 2009 Desert Research and Technology Studies (Desert RATS) project, which will send additional robots, human-operated rovers and lunar planners from NASA centers across the country to the Black Point Lava Flow in August and September.[11]

The LCROSS spacecraft was built and integrated by Northrop Grumman under contract to NASA Ames Research Center and was available for acceptance in 29 months.[5] The LCROSS payload was developed, integrated and tested by NASA Ames Research Center.[5]

▲ BACK TO TOP

Some scientists oppose the new moon program, saying NASA should focus instead on research on Mars and other planets. [7] The university has a history of involvement in space missions, ranging from Mars and Mercury to the Hubble Space Telescope and the Galileo Mission to Jupiter. That research has been overshadowed somewhat by the high-profile Phoenix Mars Mission, which landed a spacecraft on Mars last year to look for ice and is led by UA. ASU scientists continue to publish a steady stream of space research, and the university holds the distinction of having the only scientist, Phil Christensen, to have three science instruments operating on or around Mars.[9] The impact target will be the floor of a polar crater that seldom if ever sees the sun. Previous missions have detected hydrogen in such frigid craters, and some scientists believe that's evidence of subsurface water ice - a potential source of drinking water, hydrogen and oxygen for lunar bases.[12] LRO's cameras will scan the lunar surface for potential landing sites. It will also be on the lookout for new impact craters in areas previously only imaged with a resolution of 1 to 2 metres by the Apollo spacecraft four decades ago.[3] The LRO will orbit the moon, taking the most detailed images yet of the lunar surface, creating three-dimensional maps that are accurate to within one metre, showing details as small as boulder. It will measure radiation on the surface to scout for possible dangers to astronauts.[2] Nine square video screens display images of the moon's cratered surface. These same 30-inch screens will showcase the first photos from the lunar orbiter, which are expected by July 2.[9]

Engineers predict that during the first three years of human missions to the moon, humans will spend less than 10 percent of the time on the surface, while robots could be used more than 90 percent of the time.[11] "When we look back on what we did in LRO and we look at what followed, I think we'll see a profound impact," said Tooley, the LRO mission manager. "We'll see us as really being the small first

step where we have human beings permanently off this planet, moving out into the solar system, beginning with the moon." Sunday Nation-World Editor Bill Steiden compiled this article.[4]

CRaTER has cosmic-ray detectors separated by a material known as tissue-equivalent plastic. That plastic mimics how biological tissue absorbs radiation, and the LRO mission is the first time it will find use outside Earth's protective influence, Keller says. "By looking at the difference" between the radiation registered by the detectors, he explains, "you can say something about how much was deposited into that plastic."[6]

Lunar ice might have survived untouched for billions of years, so it could "serve as a fantastic time capsule into the past," Colaprete said. "This is ice that could date back just as the Earth and moon and inner solar system as a whole were evolving, what kind of organic molecules might have been delivered to Earth.[1] Washington - In the 40 years since the first man set foot on the moon, NASA has turned its attention away from Earth's nearest celestial neighbour to look ever deeper into space and build an orbiting space station.[2] The aerospace industry, which employs tens of thousands of people, is a powerful political lobby. Americans have a positive image of NASA, but they care little about space policy. "The general sentiment is NASA is a pretty good group of people, so give them money and let them do what they do," Roland said. President Obama faces difficult choices as the budget deficit widens and he pursues ambitious plans for reforming health care and education. During his campaign, he proposed delaying NASA's return to the moon by five years and redirecting the money toward education. He later backed off that statement during a speech in electorate-rich Florida, home to much of the space industry.[7] Some space experts doubt whether NASA's plans to return humans to the moon will ever happen.[7]

The space race once pitted the United States against the Soviet Union, and now China is emerging as the greatest competitor with plans to send humans to the moon.[7]

Supporters argue that manned moon spaceflights are essential if humans ever hope to travel to Mars and beyond. They say the moon is the best testing ground for how astronauts will handle extended stays in space.[7] The Nixon administration cut NASA's budget, and the last manned U.S. flight to the moon occurred in December 1972. The country began focusing on other efforts such as the Skylab space station.[7]

Five years in development, the two missions will cost a total of $580 million. The launches could be delayed if NASA officials decide to instead launch the Endeavour space shuttle, which is being repaired after a leak scuttled its launch Saturday.[12] The LCROSS mission was scheduled to launch Wednesday was postponed to allow the Space Shuttle more time to make last minute repairs.[10] The Atlas V rocket carrying the lunar craft is competing with the Endeavor space shuttle for launch time.[14]

ASU's role in the lunar orbiter mission is again focusing attention on the school's space research.[9] Providing mission planners a lunar "road map" can improve the quality and amount of science data collected on future missions to the moon. Scientists say this will help determine what lunar features might be of greatest scientific interest, as well as help identify resources and potential hazards.[11] Scientists want to know more about exactly how the moon formed. To do that, they need more samples from various areas. They need to send manned or robotic spacecraft to collect them. "This (mission) is helping plan where to go," Robinson

said.[7] In May, President Obama's administration ordered a review of NASA's current plan to end the space-shuttle program in 2010 and develop spacecraft to send astronauts to the moon.[7]

At the moon's poles, Keller explains, the fairly consistent low angle of the sun makes available essentially constant access to solar power and, potentially, stores of water frozen in permanently shadowed craters. (A companion spacecraft to LRO will seek out direct evidence of that water ice in October.)[6] "We want to do it in a better way." Other LRO instruments will measure changes in surface and subsurface temperatures and search for evidence of water ice and frost.[12]

Then it, too, will smash into the moon's surface, generating another plume that the LRO will analyze for the presence of water.[4]

The mission of LCROSS is even more intriguing. Its primary goal is to determine whether there is water, in frozen form, on the airless, lifeless moon.[4] In October it will swing back for a violent encounter with the moon's south pole. On its final approach, LCROSS will separate from its Centaur rocket booster.[12] Radar scans of the lunar surface reflected back the kind of signals at the south pole that one might expect of ice and other frozen compounds.[1] The booster, flying four minutes ahead of the satellite, will plunge to the lunar surface, sending up a plume of rock and dust on impact.[12]

The four month mission is dubbed the Lunar Crater Observation and Sensing Satellite (LCROSS).[15] "We're using the K10 robots to study how scouting can improve planning for human missions and improve lunar science."[11] The K10 robots are part of the Human Robotic Systems project under NASA's Exploration Technology Development Program (ETDP), which develops advanced technologies and capabilities for lunar exploration.[11]

MOFFETT FIELD, Calif. - NASA robots soon will begin exploring the dusty, rocky terrain of a barren desert on Earth much like the moon.[11] NASA moved the launch the two moon probes from Wednesday to no earlier than Thursday to allow the shuttle Endeavour to lift off on June 17.[1] London, June 15 (ANI): The Moon is all set to get its very own neighborhood watch, in the form of a scouting probe due to launch on June 17, which will make upcoming trips to the moon that little bit safer.[3]

Where is it? Controversial evidence for whether there is water on the moon began appearing in 1996 with the Clementine probe, a joint Pentagon-NASA project.[1] A previous lunar probe, 1998's Lunar Prospector, found spectrographic evidence of water potentially huge amounts of it at the lunar poles.[4] An earlier lunar satellite found high levels of hydrogen in the atmosphere near the poles, a hint that water could be present.[2]

After making the four-day trip, it will orbit the Earth'"s satellite at low altitude for about a year, making analyses to determine the presence of water.[14] There have been raging debates over the years as to whether there is frozen water on the moon or not.[1] Alex Roland, a NASA historian from 1973 to 1981 and now a history professor at Duke University, is among the skeptics. He calls the vision for returning to the moon by 2020 un- realistic because then-President George W. Bush appropriated little money for the venture when he proposed it. "It was brilliant politically," he said. "In an election year, he looks visionary, and none of the deliveries come until he leaves office. There's no risk in proposing this."[7] According to NASA calculations, the cost of sending a 12-ounce bottle of water to

the moon would be something in the neighborhood of $40,000.[4] NASA will fly a rocket booster into the moon, triggering a six-mile-high explosion.[15] If water already exists on the moon in the form of buried ice, it could be used not only for drinking, but to generate oxygen, manufacture rocket fuel and mix concrete for the shelters needed at a permanent base.[4] If there is water, it would greatly beneficial for astronauts to one day colonize the Moon.[10] Only four days' travel from Earth, the moon is a logical place for astronauts to train and prepare for longer missions.[7] Past moon missions collected rocks only around the moon's equator. "Imagine if you were Martians and you sent six missions to Earth, and they went to six places in Africa," Robinsons says.[7]

The reason for the renewed exploration is to lay the groundwork for resuming manned missions to the moon, a goal set by then-President George W. Bush in 2004.[4] During that experiment, Desert RATS will perform a simulated 14-day human mission to the moon.[11] Water on the Moon would make human habitation there logistically much easier.[14]

The probe will carry pieces of plastic designed to simulate the density and chemical proportions of human skin and muscle, as part of an experiment called CRaTER (Cosmic Ray Telescope for the Effects of Radiation). The LRO's particle detectors will measure how this plastic interacts with cosmic rays. A form of space radiation made up of particles such as protons that can lead to cancer by damaging DNA.[3] Images of the impact will also be captured by the orbiting LRO, as well as the Hubble Space Telescope and other telescopes on Earth.[2] More low-tech instruments will also be able to see the impact, which should be visible to amateur stargazers using standard telescopes. NASA also plans to stream the images live on its website.[2] The total event will last just 120 seconds, but scientists say the impact will provide valuable information to be collected on nine instruments, including five cameras that capture images in colour, thermal and near infrared images.[2]

Scientists and engineers will study the images and information the robots gather to help plan where humans should venture next.[11] As part of the two-week experiment, the K10 robots will navigate an area of Arizona scientists have chosen as a simulation of the Rupes Recta or "Straight Wall" fault seen on the moon.[11] Planetary scientist David Kring, a senior staff scientist at the Lunar and Planetary Institute in Houston, sounds a similar tone, noting that the orbiter "will be exploring regions of the moon that have been fuzzy or completely invisible to us in the past."[6] Black Point Lava Flow's wide variety of surface features, size (nearly 10 miles wide) and relative remoteness make it ideal for simulated lunar missions, according to project team scientists.[11] Scientists from five other universities and a private space company are also on the main science team, including the University of Arizona. Another dozen scientists from various institutions are participating, including the U.S. Geological Survey in Flagstaff. "Everyone feels a real sense of responsibility to get this right," said Tim Donnelly, who has a master's degree in geographic information systems and is part of the mission operations team.[9] Then there are the pure- science reasons for returning. Scientists such as Robinson view the moon as a way to study the early stages of planet evolution.[7]

Then LCROSS itself will crash into the Moon, producing debris for analysis by LRO.[14] The icy cold truth Any ice there might be on the moon could be key to the future of humanity in space.[1] Researchers speculated the moon's poles could hold as much as 3 billion metric tons of ice.[1]

The journey to the moon takes four days, and once there, the spacecraft will spend

at least a year circling the moon about 30 miles above surface and taking pictures.[9] On the moon, with little geological activity, rocks dating back 4.5 billion years lie right on the surface.[7]

China has set the same year as a target for it to place astronauts on the Moon as well.[14] Astronauts would return to the moon again five times, but the program slowly fell out of favor.[7]

The first manned moon landing was on July 20, 1969, and was a scientific and political triumph.[7]

▲ BACK TO TOP

The problem is that Lunar Prospector could only measure hydrogen, and not what matter the hydrogen was in. Instead of ice, the hydrogen might come from water bound up in clays, or protons from the solar wind, or the kind of carbon-laden molecules from comets that might have been part of the organic soup that life developed from on Earth, "or a mix of all those things," Colaprete said. [1] In all, about 25 people at ASU work on the lunar cameras, ranging from undergraduates to doctoral-level scientists.[9]

▲ BACK TO TOP

LCROSS was built using an Evolved Expendable Launch Vehicle (EELV) secondary payload adapter, or ESA ring, as the spacecraft structure, and costs were kept low by reusing existing hardware/hardware designs and commercial-off-the-shelf products. [5] Northrop Grumman is a leader in space exploration and has built many of NASA's smallest, and largest, spacecraft.[5]

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▲ BACK TO TOP

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