September 2012

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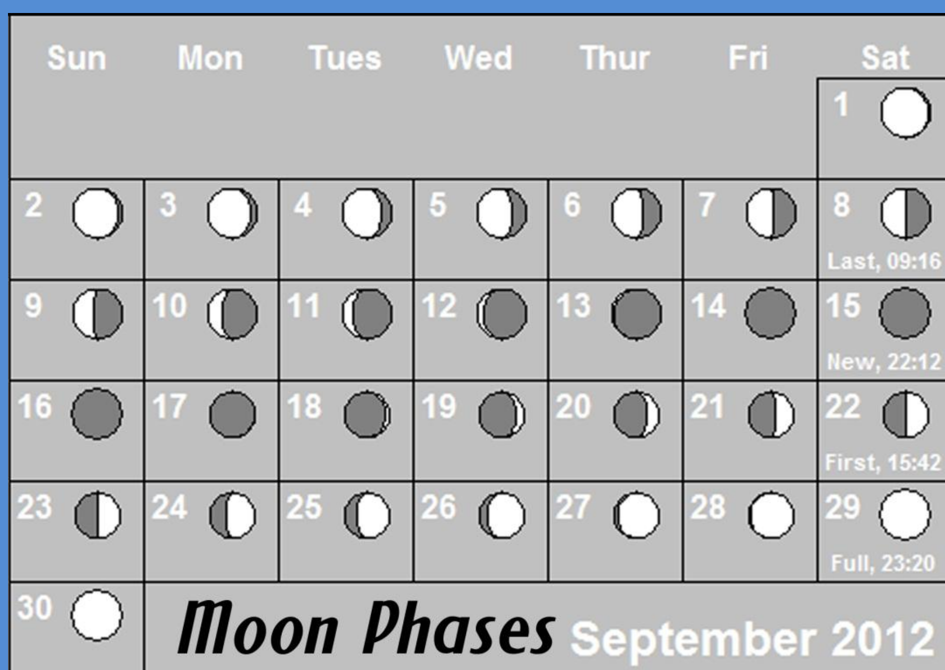
September Meeting

The next meeting of S*T*A*R will be at 8pm on Thursday, September 6th, 2012. Our guest speaker will be Robert Vanderbei, a professor in the department of Operations Research and Financial Engineering at Princeton University, as well as an accomplished astro-imager. Professor Vanderbei will give a brief tour of his recent book, "Sizing Up The Universe", which was published in 2010 by National Geographic. The meeting is at the Monmouth Museum at 8 p.m.

Calendar

- September 6th, 2012 – Robert Vanderbei
- September 8th, 2012 – Annual STAR Picnic at Buck Mills Recreation Area from 3-11PM



Are you a S*T*A*R Member?

S*T*A*R, The Society of Telescopy, Astronomy, and Radio, has promoted amateur astronomy since 1957 when it was organized by an energetic group of observers who participated in Project Moonwatch, a program in which a worldwide network of observers tracked the path of Sputnik among the stars of the night sky to obtain information on how the earth's atmosphere affects satellite orbits. This group soon evolved into an amateur astronomy club which was incorporated under its present name in 1969.

Today, S*T*A*R is the focal point for amateur astronomy in Monmouth County, NJ, attracting members of all ages, occupations and educational backgrounds. Its objectives are to promote the enjoyment of astronomy, and to increase the level of astronomical knowledge among its members and the public. The club achieves these goals through its regular meetings, observing nights, field trips, cooperation and exchange of information with other clubs, and special activities such as assisting Bayonet Farm in Holmdel and other park systems in conducting public astronomy programs.

S*T*A*R meetings are held on the first Thursday of the month from September to June, at 8 pm at the Monmouth Museum on the campus of Brookdale Community College, Lincroft, NJ. Programs generally consist of lectures and discussions by members or guest speakers on a variety of interesting topics on astronomy. Refreshments are served during the meeting and, weather permitting, a short observing session may occur afterwards.

The club owns 8" f/8, 13" f/4.5 and 25" f/5 Dobsonian telescopes which are available for use by members. Because of its large size use of the 25" requires the supervision of two qualified operators. To borrow a telescope or become a qualified operator of the 25", please contact the Vice President.

The current officers of S*T*A*R are:

President	Rob Nunn
Vice President	Kevin Gallagher
Secretary	Steve Fedor
Treasurer	Arturo Cisneros
Member at Large	Dave Britz

S*T*A*R is a member of United Astronomy Clubs of New Jersey (UACNJ), the Astronomical League (AL), and the International Dark Sky Association (IDA).

Memberships:
( ) Individual....$35
( ) Family...$45
( ) Student… $15

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Make checks payable to: S*T*A*R Astronomy Society, Inc. and mail to P.O. Box 863, Red Bank, NJ 07701

Seeing the birth of the universe in an atom of hydrogen

(Phys.org) -- Windows to the past, stars can unveil the history of our universe, currently estimated to be 14 billion years old. The farther away the star, the older it is—and the oldest stars are the most difficult to detect. Current telescopes can only see galaxies about 700 million years old, and only when the galaxy is unusually large or as the result of a big event like a stellar explosion.

Now, an international team of scientists led by researchers at Tel Aviv University have developed a method for detecting galaxies of stars that formed when the universe was in its infancy, during the first 180 million years of its existence. "The method is able to observe stars that were previously believed too old to find," says Prof. Rennan Barkana of TAU's School of Physics and Astronomy.

Published in the journal Nature, the researchers' method uses radio telescopes to seek out radio waves emitted by hydrogen atoms, which were abundant in the early days of the universe. Emitting waves measuring about eight inches (21 centimeters) long, the atoms reflect the radiation of the stars, making their emission detectable by radio telescopes, explains Prof. Barkana. This development opens the way to learning more about the universe's oldest galaxies.

Reading signals from the past

According to Prof. Barkana, these waves show a specific pattern in the sky, a clear signature of the early galaxies, which were one-millionth the size of galaxies today. Differences in the motion of dark matter and gas from the early period of the universe, which affect the formation of stars, produce a specific fluctuation pattern that makes it much easier to distinguish these early waves from bright local radio emissions.

The intensity of waves from this early era depends on the temperature of the gas, allowing researchers to begin to piece together a rough map of the galaxies in an area of the sky. If the gas is very hot, it means that there are many stars there; if cooler, there are fewer stars, explains Prof. Barkana.

These initial steps into the mysterious origins of the universe will allow radio astronomers to reconstruct for the first time what the early universe looked like, specifically in terms of the distribution of stars and galaxies across the sky, he believes.

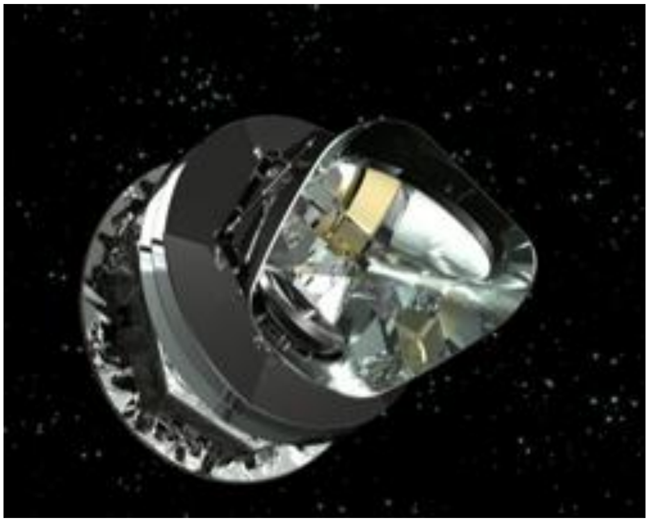
A new era

This field of astronomical research, now being called "21-centimeter cosmology," is just getting underway. Five different international collaborations are building radio telescopes to detect these types of emissions, currently focusing on the era around 500 million years after the Big Bang. Equipment can also be specifically designed for detecting signals from the earlier eras, says Prof. Barkana. He hopes that this area of research will illuminate the enigmatic period between the birth of the universe and modern times, and allow for the opportunity to test predictions about the early days of the universe.

"We know a lot about the pristine universe, and we know a lot about the universe today. There is an unknown era in between when there was hot gas and the first formation of stars. Now, we are going into this era and into the unknown," says Prof. Barkana. He expects surprises along the way, for example involving the properties of early stars, and that observations will reveal a more complicated cosmological reality than was predicted by their models.

Mystery of dark matter may be near to being deciphered

(Phys.org)—The universe is comprised of a large amount of invisible matter, dark matter. It fills the space between the galaxies and between the stars in the galaxies. Since the prediction of the existence of dark matter more than 70 years ago, all sorts of researchers – astronomers, cosmologists and particle physicists have been looking for answers to what it could be. With the latest observations from the Planck satellite, researchers from the Niels Bohr Institute, among others, may be closer than ever to a solution to the origin of the mysterious dark matter.



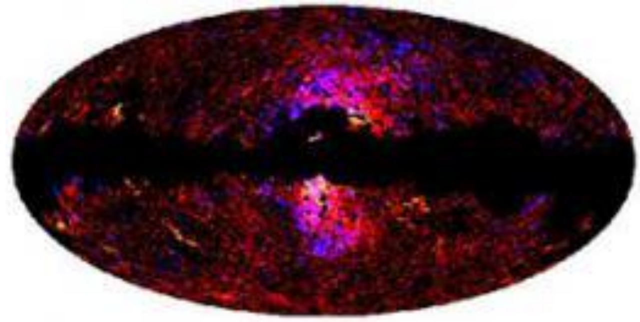
The ESA satellite Planck was launched on the 14th of May 2009. The satellite does not just remain still in space, but changes direction every hour as well as rotates once a minute on its own axis. These movements mean that it scans the entire surrounding Universe in the course of six months.

The Planck satellite, which was launched in 2009, has extremely sensitive instruments that can map microwave radiation in the entire sky with great precision. The latest data from the Planck mission reveals unusual radiation from our own galaxy, which open a new direction in understanding the most fundamental properties of the space, time and matter in the Universe.

Radiation from dark matter

"We have observed a very unique emission of radio radiation from the centre of our galaxy, the Milky Way. By using different methods to separate the signal for very broad range of wavelengths, we have been able to determine the spectrum of the radiation. The radiation originates from synchrotron emission, i.e. electrons and positrons circulating at high energies around the lines of the Magnetic Field in the centre of the galaxy, and there are quite strong indications that it could come from dark matter," explains Pavel Naselsky, professor of cosmology at the Discovery Center at the Niels Bohr Institute at the University of Copenhagen.

Pavel Naselsky explains that leading scientists like Niels Bohr professor Subir Sarkar have predicted, using calculations, that dark matter may consist of very heavy particles that are around 10 times as heavy as the Higgs particle, that is to say, 1,000 times heavier than a proton. But they have very unique properties and do not interact with 'normal' matter particles. Dark matter particles are also usually very scattered and do not interact with each other.



The image shows emission from the centre of the Milky Way, detected by PLANCK satellite. The black zone mask is emission from the galactic disk, the blue-red-white zone in the centre of the map is the new abnormal radiation.

"But we know from theoretical predictions that the concentration of dark matter particles around the centre of galaxies is very high and we have a strong argument they can collide there and in the collision electrons and positrons are formed. These electrons and positrons start to rotate around the magnetic field at the centre of the galaxy and in doing so produce this very unusual synchrotron radiation.

It has simply not been possible to observe this radiation in such detail before, as previous instruments have not been sensitive enough. But with Planck, this unusual radiation is seen very clearly.

"The radiation cannot be explained by the structural mechanisms in the galaxy and it cannot be radiation from supernova explosions. We believe that this could be proof of dark matter. Otherwise, we have discovered absolutely new (and unknown for physics) mechanism of acceleration of particles in the Galactic centre", says Pavel Naselsky, and he expects exciting new results already within the next few months.

The results have been published in ArXiv:1208.5483 and submitted to the scientific journal, Astronomy and Astrophysics.

The Kuiper Belt at 20

Planetary science is celebrating the 20th anniversary of the discovery of the Kuiper Belt. That came in 1992, when the first Kuiper Belt Object (KBO) was discovered.

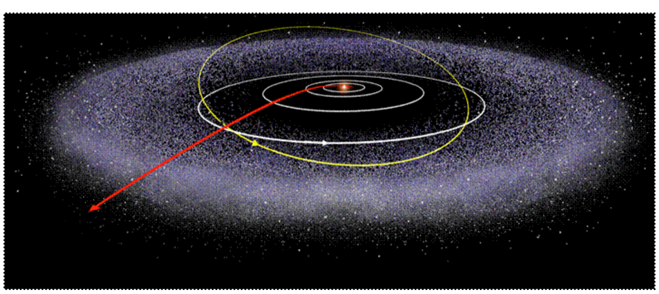
Actually, of course, the first object in the Kuiper Belt was discovered in 1930—Pluto itself; and the second such object, Pluto's giant moon Charon, was discovered in 1978. The Kuiper Belt was first postulated—most famously by Gerard Kuiper—by planetary scientists back in the 1930s, '40s and '50s. But it took until 1992 for technology to mature sufficiently enough to find another object (outside the Pluto system) orbiting the Sun beyond Neptune.

Some planets of the Kuiper Belt; note that since this diagram was made, we've learned that Eris is actually smaller than Pluto. Credit: sollunaterra.webs.com

Since 1992, more than 1,000 KBOs have been discovered. But only a tiny fraction of the sky has been surveyed for KBOs. It is estimated that more than 100,000 KBOs exist with diameters of 100 kilometers or larger, along with billions of smaller objects down to the size of cometary nuclei, just a kilometer or two across. (By comparison, Pluto is huge—its diameter is almost 2,400 kilometers, making a drive around its equator as far as from Manhattan to Moscow!)

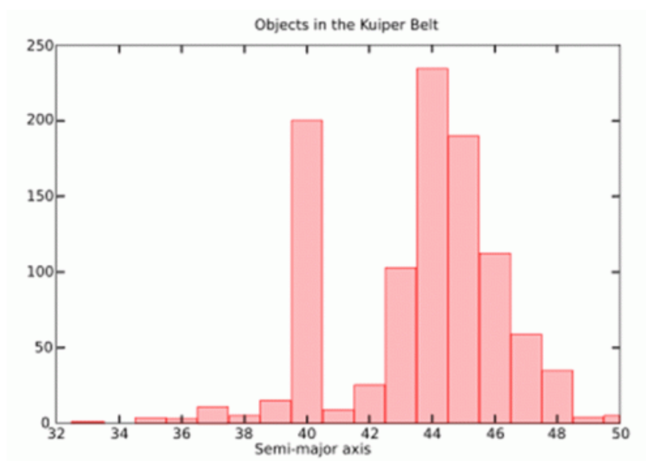
Most of the known KBOs are just 100 to 300 kilometers across, about one-tenth of Pluto's diameter. But some are smaller than 100 kilometers across, and some are larger than 300 kilometers across. In fact, there is great diversity among KBOs:

- Some are red and some are gray
- The surfaces of some are covered in water ice, but others (like Pluto) have exotic volatile ices like methane and nitrogen
- Many have moons, though none with more known moons than Pluto
- Some are highly reflective (like Pluto), others have much darker surfaces
- Some have much lower densities than Pluto, meaning they are primarily made of ice. Pluto's density is so high that we know its interior is about 70% rock in its interior; a few known KBOs are more dense than Pluto, and even rockier!


New Horizons hopes to explore beyond Pluto, into the ancient and unexplored Kuiper Belt. Credit: NASA

But I don't consider this surprising assortment of KBOs to be the most important contribution to our knowledge of the Solar System that has come from telescope exploration of the Kuiper Belt. In my opinion, the three greatest solar system lessons we've learned from the Kuiper Belt are:

- That our planetary system is much larger than we used to think. In fact, we were largely unaware of the Kuiper Belt—the largest structure in our solar system—until it was discovered 20 years ago. It's akin to not having maps of the Earth that included the Pacific Ocean as recently as 1992!
- That the locations and orbital eccentricities and inclinations of the planets in our solar system (and other solar systems as well) can change with time. This even creates whole flocks of migration of planets in some cases. We have firm evidence that many KBOs (including some large ones like Pluto), were born much closer to the Sun, in the region where the giant planets now orbit.
- And, perhaps most surprisingly, that our solar system, and very likely very many others, was very good at making small planets, which dominate the planetary population! Today we know of more than a dozen dwarf planets in the Solar System, and those dwarfs already outnumber the number of gas giants and terrestrial planets combined. But it is estimated that the ultimate number of dwarf planets we will discover in the Kuiper Belt and beyond may well exceed 10,000. Who knew? (And which class of planet is the misfit now?)



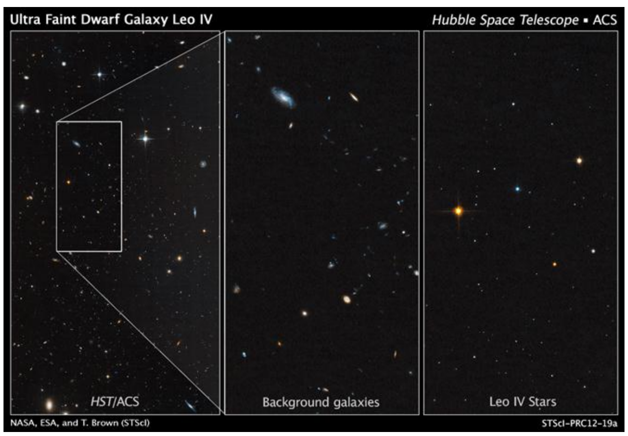
This plot shows one aspect of Kuiper Belt structure: Different numbers of bodies orbit at different distances. This graph includes just the known bodies, which make up a tiny fraction of the grand total. Credit: Wikipedia

What an amazing set of paradigm shifts in our knowledge the Kuiper Belt has brought so far. Our quaint 1990s and earlier view of the Solar System missed its largest structure! It didn't know about the existence of dwarf planets, the most populous class of planet in our solar system —and very likely the galaxy. It didn't even contemplate that dwarf planets would have such a wide range of colors, reflectivities, orbits and surface compositions. And it didn't realize that the locations of most planets in our solar system today—even including some of the very largest planets—are different from where they were born.

Just imagine—when the New Horizons spacecraft has its close flybys of the Pluto system and smaller KBOs, combined with new giant telescopes coming on line to probe the sky—what we will learn about the Kuiper Belt in the next 20 years. It's an exciting time, and its sometimes hard for me to believe after working on this since 1989, that our 2015 exploration of Pluto and its many moons is almost upon us—but it is!

New information about the Solar System is important to astrobiologists who are trying to determine how our system evolved to support the only habitable planet yet known - Earth. This knowledge is useful in determining where else in the Universe habitable planets might exist.

Hubble Unmasks Ghost Galaxies

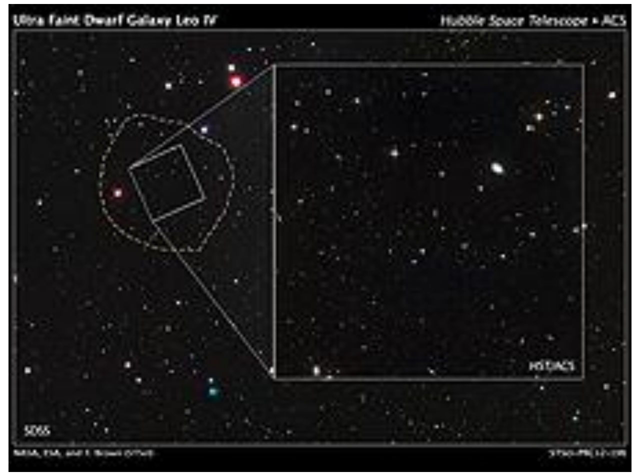


These Hubble images show the dim, star-starved dwarf galaxy Leo IV. The image at left shows part of the galaxy, outlined by the white rectangular box. The box measures 83 light-years wide by 163 light-years long. The few stars in Leo IV are lost amid neighboring stars and distant galaxies. A close-up view of the background galaxies within the box is shown in the middle image. The image at right shows only the stars in Leo IV. The galaxy, which contains several thousand stars, is composed of sun-like stars, fainter, red dwarf stars, and some red giant stars brighter than the sun. Credit: NASA, ESA, and T. Brown (STScI)

Astronomers have puzzled over why some puny, extremely faint dwarf galaxies spotted in our Milky Way galaxy's back yard contain so few stars.

These ghost-like galaxies are thought to be some of the tiniest, oldest, and most pristine galaxies in the universe. They have been discovered over the past decade by astronomers using automated computer techniques to search through the images of the Sloan Digital Sky Survey. But astronomers needed NASA's Hubble Space Telescope to help solve the mystery of these star-starved galaxies.

Hubble views of three of the small-fry galaxies reveal that their stars share the same birth date. The galaxies all started forming stars more than 13 billion years ago – and then abruptly stopped – all in the first billion years after the universe was born in the big bang.

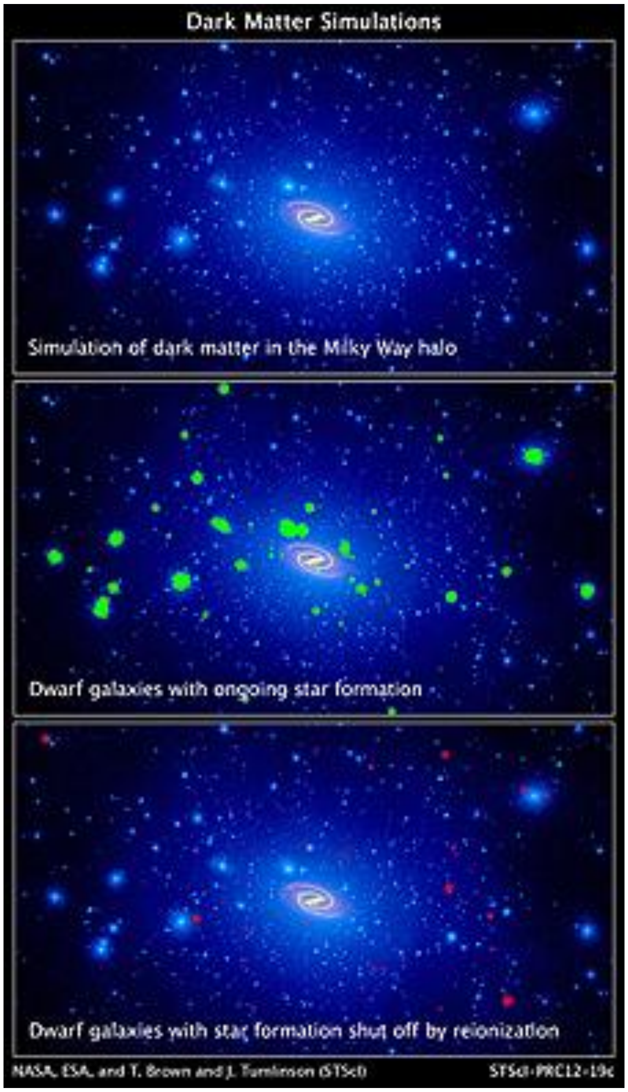


The small and faint star-starved dwarf galaxy, Leo IV, is one of more than a dozen ultra-faint dwarf galaxies found lurking around the Milky Way. These galaxies are dominated by dark matter, an invisible substance that makes up the bulk of the universe's mass. The wide image, taken by the Sloan Digital Sky Survey, is a view of Leo IV and the surrounding neighborhood. The galaxy resides 500,000 light-years from Earth. The dotted line marks the galaxy's boundaries, measuring about 1,100 light-years wide. The small white box outlines the Hubble Space Telescope's view. Credit: NASA, ESA, and T. Brown (STScI)

"These galaxies are all ancient and they're all the same age, so you know something came down like a guillotine and turned off the star formation at the same time in these galaxies," said Tom Brown of the Space Telescope Science Institute in Baltimore, Md., the study's leader. "The most likely explanation is reionization."

The reionization of the universe began in the first billion years after the big bang. During this epoch, radiation from the first stars knocked electrons off primeval hydrogen atoms, ionizing the cool hydrogen gas. This process allowed the hydrogen gas to become transparent to ultraviolet light.

Ironically, the same radiation that sparked universal reionization appears to have squelched star-making activities in dwarf galaxies, such as those in Brown's study. The small irregular galaxies were born about 100 million years before reionization began and had just started to churn out stars. Roughly 2,000 light-years wide, the galaxies are the smaller cousins of the more luminous star-making dwarf galaxies near our Milky Way. Unlike their larger relatives, the puny galaxies were not massive enough to shield themselves from the harsh ultraviolet light. What little gas they had was stripped away as the flood of ultraviolet light rushed through them. Their gas supply depleted, the galaxies could not make new stars.



These computer simulations show a swarm of dark matter clumps around our Milky Way galaxy. Some of the dark-matter concentrations are massive enough to spark star formation. Thousands of clumps of dark matter coexist with our Milky Way galaxy, shown in the center of the top panel. The green blobs in the middle panel are those dark-matter chunks massive enough to obtain gas from the intergalactic medium and trigger ongoing star formation, eventually creating dwarf galaxies. In the bottom panel, the red blobs are ultra-faint dwarf galaxies that stopped forming stars long ago. Credit: NASA, ESA, and T. Brown and J. Tumlinson (STScI) The relic galaxies are evidence for a transitional phase in the early universe that shut down star-making factories in tiny galaxies. During this time, the first stars burned off a fog of cold hydrogen in a process called reionization.

The discovery could help explain the so-called "missing satellite problem," where only a few dozen dwarf galaxies have been observed around the Milky Way while computer simulations predict that thousands should exist. One possible explanation is that there has been very little, or even no star formation in the smallest of these dwarf galaxies, making them difficult to detect.

The Sloan survey recently uncovered more than a dozen of these star-starved galaxies in our Milky Way's neighborhood while scanning just a quarter of the sky. Astronomers think the rest of the sky should contain dozens more of these objects, dubbed ultra-faint dwarf galaxies. The evidence for squelched star formation in some of the smallest of these dwarfs suggests that there may be thousands more where essentially no stars formed at all.

"By measuring the star formation histories of the observed dwarfs, Hubble has confirmed earlier theoretical predictions that star formation in the smallest clumps would be shut down by reionization," said Jason Tumlinson of the Space Telescope Science Institute, a member of the research team.

Brown's results appeared in the July 1 issue of The Astrophysical Journal Letters.

"These are the fossils of the earliest galaxies in the universe," Brown said. "They haven't changed in billions of years. These galaxies are unlike most nearby galaxies, which have long star-formation histories."

The stellar populations in these fossil galaxies range from a few hundred to a few thousand stars both fainter and brighter than our sun. The galaxies may be star-deprived, but they have an abundance of dark matter, the underlying scaffolding upon which galaxies are built.

Normal dwarf galaxies near the Milky Way contain 10 times more dark matter than the ordinary matter that makes up gas and stars. In ultra-faint dwarf galaxies, dark matter outweighs ordinary matter by at least a factor of 100. "The small galaxies in our study are made up mostly of dark matter because their hydrogen gas was ionized and the stars got turned off," Brown explained.

These mostly dark-matter islands coexisted unseen with our Milky Way for billions of years, until astronomers began finding them in the Sloan survey.

When these galaxies were uncovered, astronomers began proposing many reasons for their shortage of stars. Some believed that internal dynamics, such as a supernova blast, blew out the gas needed to create more stars. Others suggested that the galaxies simply used up what little gas they had. And a few thought that the galaxies were born during the early universe and reionization had turned off their star formation.

Then, ground-based observations of two of the newly discovered galaxies revealed tantalizing evidence that the stars were indeed ancient. So Brown decided to use Hubble's Advanced Camera for Surveys to look deep inside six of the galaxies to study the population of stars and determine when they were born. So far, Brown and his team have finished analyzing the Hubble data of three of the galaxies, named

Hercules, Leo IV, and Ursa Major. The galaxies' distance from Earth ranges from 330,000 light-years to 490,000 light-years.

"Astronomers have said before that certain galaxies should be ancient, and then someone studies them hard enough and finds younger stars," Brown said. "Some of us expected to uncover younger stars and prove that the galaxies are not relics from the early universe. We were surprised to find that all the stars were ancient."

Brown measured the stars' ages by analyzing their brightness and colors. For reference, Brown compared the galaxies' stars with the stars in the ancient globular cluster M92, located 26,000 light-years away. M92 is more than 13 billion years old, one of the oldest objects in the universe. The analysis revealed that the galaxies' stars are as old as those in M92.

"The stars in the ultra-faint dwarf galaxies are very sparse," Brown said. "This is one reason why no one went after them with Hubble. However, we thought they were good targets for Hubble, given Hubble's ability to measure precise ages. You look at the Hubble images and there are almost no stars, but the ones we have are enough to give us the ages of these galaxies."

The Hubble Space Telescope is a project of international cooperation between NASA and the European Space Agency. NASA's Goddard Space Flight Center in Greenbelt, Md., manages the telescope. The Space Telescope Science Institute (STScI) in Baltimore, Md., conducts Hubble science operations. STScI is operated by the Association of Universities for Research in Astronomy, Inc., in Washington, D.C.

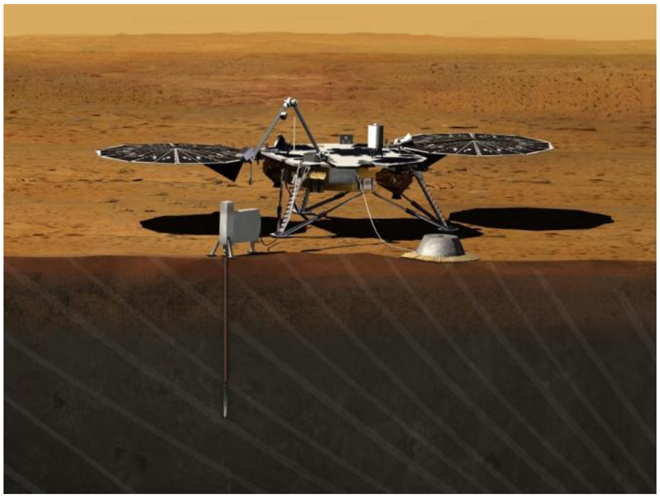
For images and more information about this study and the Hubble Space Telescope, visit:

http://hubblesite.org/news/2012/26
http://www.nasa.gov/hubble

New NASA Mission to Take First Look Deep Inside Mars

PASADENA, Calif. -- NASA has selected a new mission, set to launch in 2016, that will take the first look into the deep interior of Mars to see why the Red Planet evolved so differently from Earth as one of our solar system's rocky planets.

The new mission, named InSight, will place instruments on the Martian surface to investigate whether the core of Mars is solid or liquid like Earth's, and why Mars' crust is not divided into tectonic plates that drift like Earth's. Detailed knowledge of the interior of Mars in comparison to Earth will help scientists understand better how terrestrial planets form and evolve.



Artist rendition of the proposed InSight (Interior exploration using Seismic Investigations, Geodesy and Heat Transport) Lander. InSight is based on the proven Phoenix Mars spacecraft and lander design with state-of-the-art avionics from the Mars Reconnaissance Orbiter and Gravity Recovery and Interior Laboratory missions. Image credit: JPL/NASA

"The exploration of Mars is a top priority for NASA, and the selection of InSight ensures we will continue to unlock the mysteries of the Red Planet and lay the groundwork for a future human mission there," NASA Administrator Charles Bolden said. "The recent successful landing of the Curiosity rover has galvanized public interest in space exploration and today's announcement makes clear there are more exciting Mars missions to come."

InSight will be led by W. Bruce Banerdt at NASA's Jet Propulsion Laboratory in Pasadena, Calif. InSight's science team includes U.S. and international co-investigators from universities, industry and government agencies. The French space agency Centre National d'Etudes Spatiales, or CNES, and the German Aerospace Center are contributing instruments to InSight, which is scheduled to land on Mars in September 2016 to begin its two-year scientific mission.

InSight is the 12th selection in NASA's series of Discovery-class missions. Created in 1992, the Discovery Program sponsors frequent, cost-capped solar system exploration missions with highly focused scientific goals. NASA requested Discovery mission proposals in June 2010 and received 28. InSight was one of three proposed missions selected in May 2011 for funding to conduct preliminary design studies and analyses. The other two proposals were for missions to a comet and Saturn's moon Titan.

InSight builds on spacecraft technology used in NASA's highly successful Phoenix lander mission, which was launched to the Red Planet in 2007 and determined water existed near the surface in the Martian polar regions. By incorporating proven systems in the mission, the InSight team demonstrated that the mission concept was low-risk and could stay within the cost-constrained budget of Discovery missions. The cost of the mission, excluding the launch vehicle and related services, is capped at $425 million in 2010 dollars.

"Our Discovery Program enables scientists to use innovative approaches to answering fundamental questions about our solar system in the lowest cost mission category," said John Grunsfeld, associate administrator for the Science Mission Directorate at NASA Headquarters. "InSight will get to the 'core' of the nature of the interior and structure of Mars, well below the observations we've been able to make from orbit or the surface."

InSight will carry four instruments. JPL will provide an onboard geodetic instrument to determine the planet's rotation axis and a robotic arm and two cameras used to deploy and monitor instruments on the Martian surface. CNES is leading an international consortium that is building an instrument to measure seismic waves traveling through the planet's interior. The German Aerospace Center is building a subsurface heat probe to measure the flow of heat from the interior.

JPL provides project management for NASA's Science Mission Directorate. NASA's Marshall Space Flight Center in Huntsville, Ala., manages the Discovery Program for the agency's Science Mission Directorate in Washington. Lockheed Martin Space Systems in Denver will build the spacecraft. JPL is a division of the California Institute of Technology in Pasadena.

For more information about InSight, visit: http://insight.jpl.nasa.gov .

For more information about the Discovery Program, visit: http://discovery.nasa.gov .

For information about NASA and agency programs, visit: http://www.nasa.gov .

Voyager at 35 - Break on Through to the Other Side

Thirty-five years ago, NASA's Voyager 2 spacecraft, the first Voyager spacecraft to launch, departed on a journey that would make it the only spacecraft to visit Uranus and Neptune and the longest-operating NASA spacecraft ever. Voyager 2 and its twin, Voyager 1, that launched 16 days later on Sept. 5, 1977, are still going strong, hurtling away from our sun. Mission managers are eagerly anticipating the day when they break on through to the other side – the space between stars.

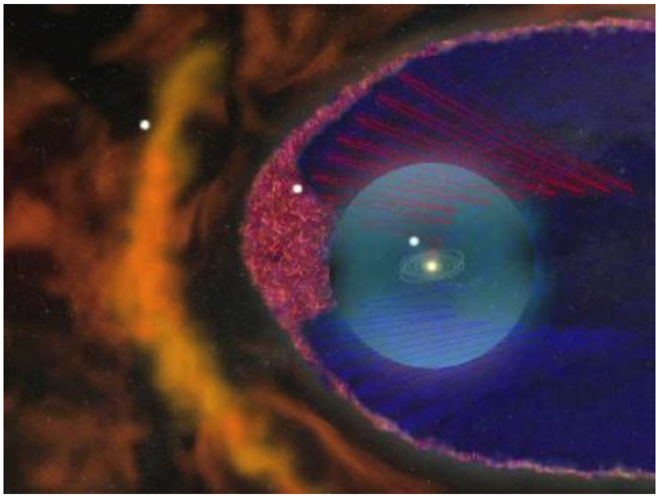
Voyager 2 was launched on August 20, 1977, from the NASA Kennedy Space Center at Cape Canaveral in Florida, propelled into space on a Titan/Centaur rocket. Image credit: NASA/JPL-Caltech

"Even 35 years on, our rugged Voyager spacecraft are poised to make new discoveries as we eagerly await the signs that we've entered interstellar space," said Ed Stone, Voyager project scientist at the California Institute of Technology in Pasadena. "Voyager results turned Jupiter and Saturn into full, tumultuous worlds, their moons from faint dots into distinctive places, and gave us our first glimpses of Uranus and Neptune up-close. We can't wait for Voyager to turn our models of the space beyond our sun into the first observations from interstellar space."

Voyager 2 became the longest-operating spacecraft on Aug. 13, 2012, surpassing Pioneer 6, which launched on Dec. 16, 1965, and sent its last signal back to NASA's Deep Space Network on Dec. 8, 2000. (It operated for 12,758 days.)

Scientists eagerly awaiting the entry of the two Voyagers into interstellar space have recently seen changes from

Voyager 1 in two of the three observations that are expected to be different in interstellar space. The prevalence of high-energy particles streaming in from outside our solar system has jumped, and the prevalence of lower-energy particles originating from inside our solar system has briefly dipped, indicating an increasing pace of change in Voyager 1's environment. Voyager team scientists are now analyzing data on the direction of the magnetic field, which they believe will change upon entry into interstellar space.



The latest data from the Voyager spacecraft indicate the edge of our solar system is much different from what was previously imagined. This resulted in a new computer model that shows the edge of our solar system is not smooth, but filled with a turbulent sea of magnetic bubbles. The heliospheric boundaries are very important in shielding the inner solar system from the galactic cosmic ray flux. The heliopause, the last region that separates us from the rest of the galaxy, acts more like a membrane that is permeable to galactic cosmic rays than a shield that deflects those energetic particles. The galactic cosmic rays slowly wander into the heliosphere and can get trapped in the sea of magnetic bubbles. Eventually they access the solar magnetic field lines that connect back to the sun, and can move quickly towards the sun and Earth. Credit: NASA/Goddard Space Flight Center/CI Lab

Notable discoveries by Voyager 2 include the puzzling hexagonal jet stream in Saturn's north polar region, the tipped magnetic poles of Uranus and Neptune, and the geysers on Neptune's frozen moon Triton. Although launched second, Voyager 1 reached Jupiter and Saturn before Voyager 2, first seeing the volcanoes of Jupiter's moon Io, the kinky nature of Saturn's outermost main ring, and the deep, hazy atmosphere of Saturn's moon Titan. Voyager 1 also took the mission's last image: the famous solar system family portrait that showed our Earth as a pale blue dot.

Voyager 2 is about 9 billion miles (15 billion kilometers) away from the sun, heading in a southerly direction. Voyager 1 is about 11 billion miles (18 billion kilometers) away from the sun, heading in a northerly direction. For the last five years, both spacecraft have been exploring the outer layer of the heliosphere, the giant bubble of charged particles the sun blows around itself.

"We continue to listen to Voyager 1 and 2 nearly every day," said Suzanne Dodd, Voyager project manager at NASA's Jet Propulsion Laboratory, Pasadena, Calif. "The two spacecraft are in great shape for having flown through Jupiter's dangerous radiation environment and having to endure the chill of being so far away from our sun."

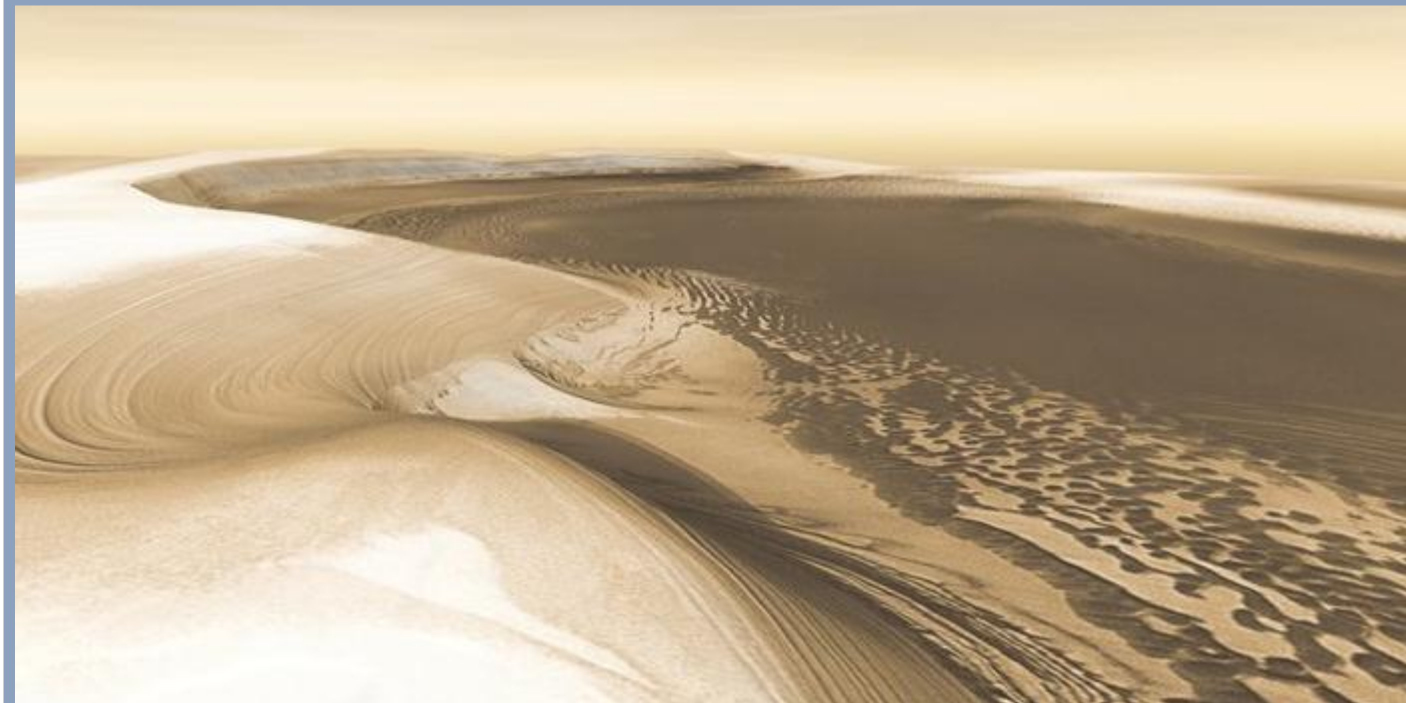
This image highlights the special cargo onboard NASA's Voyager spacecraft: the Golden Record. Each of the two Voyager spacecraft launched in 1977 carry a 12-inch gold-plated phonograph record with images and sounds from Earth. An artist's rendering of the Voyager spacecraft is shown at bottom right, with a yellow circle denoting the location of the Golden Record. The cover of the Golden Record, shown on upper right, carries directions explaining how to play the record, a diagram showing the location of our sun and the two lowest states of the hydrogen atom as a fundamental clock reference. Image credit: NASA/JPL-Caltech

Dodd and her team have been carefully managing the use of power from the continually diminishing energy sources on the two spacecraft. They estimate that the two spacecraft will have enough electrical power to continue collecting data and communicating it back to Earth through 2020, and possibly through 2025. While no one really knows how long it will take to get to interstellar space, Voyager scientists think we don't have long to wait. And, besides, the first 35 years have already been a grand ride.

The Voyager spacecraft were built by JPL, which continues to operate both. JPL is a division of the California Institute of Technology. The Voyager missions are a part of the NASA Heliophysics System Observatory, sponsored by the Heliophysics Division of the Science Mission Directorate in Washington.

For more information about the Voyager spacecraft, visit: http://www.nasa.gov/voyager and http://voyager.jpl.nasa.gov

Year of the Solar System
Astrobiology - Are We Alone in the Universe?: Got Life?



Chasma Boreale is a valley that cuts deep into Mars' north polar icecap. Where the ice cap has retreated, sand from warmer climate cycles is exposed and has been shaped into dunes by the wind. This eerily Earth-like vista was made by combining data from NASA's Mars Odyssey and Global Surveyor orbiters. Image Credit: NASA/JPL-Caltech/Arizona State University, Thermal Emission Imaging System (THEMIS)

Meeting relatives often provokes the question, "How are we related?" As humans, we gather perspective through our relationships with other people and with our environment. Similarly, as we study our solar system and worlds beyond, we search for that information about our relationship with the Universe -- where else does life exist? How does life evolve? Are we alone?

These are among the big questions that drive NASA's science research and its planetary and astronomical missions; their search for life is at an exciting stage right now! The Mars Science Laboratory's **Curiosity rover** is currently investigating whether the region has ever offered conditions favorable for microbial life; the rover will also examine any complex organic molecules it finds.

California's Mono Lake is naturally hypersaline -- roughly 2-3 times saltier than the ocean and includes trace amounts of minerals, including arsenic. Recently, bacteria which appear to incorporate arsenic rather than phosphorus into their basic biological molecules were found living in Mono Lake.

The Cassini Solstice mission to continues to study Saturn's moon Enceladus, where it discovered an icy plume with complex organic chemicals. With heat, organic chemicals and, potentially liquid water, Enceladus could be a place where primitive life forms might evolve. [For more information and activities on the search for water, go to Water in the Solar System.]

Missions are searching for evidence of life outside of our solar system as well. The Spitzer Space Telescope examines the infrared Universe to observe organic molecules that may hold the secret to life on planets. The Hubble Space Telescope is measuring the atmospheres of distant worlds and detecting many of the ingredients for life.

Join us as we explore one of the most fundamental questions: are we alone in the Universe? Check out activities related to our search for life in the Classrooms and Organizations and Clubs sections, and find a variety of powerpoints, articles, videos, interactives, and more under Educational Resources.

2012 Sept. Celestial Events: supplied by J. Randolph Walton (Randy)

Day	Date	Time (EDT)	Event
Sat	1	02:45	Venus Rises
		06:28	Sunrise
		19:31	Sunset
		19:46	Moon Rise
		21:30	Saturn Sets
		21:45	Mars Sets
		23:45	Jupiter Rises
Sat	8	02:55	Venus Rises
		06:25	Mercury Rises
		06:35	Sunrise
		09:15	**Last Quarter Moon**
		14:14	Moon Set
		19:19	Sunset
		21:05	Saturn Sets
		21:25	Mars Sets
		23:20	Jupiter Rises
Sat	15	03:05	Venus Rises
		06:41	Sunrise
		18:37	Moon Set
		19:08	Sunset
		19:23	Mercury Sets
		20:40	Saturn Sets
		21:15	Mars Sets
		22:11	**New Moon**
		22:55	Jupiter Rises
Sun	16	Before 06:00	**Zodiacal Light** visible in E before morning twilight for next two weeks
Sat	22	03:15	Venus Rises
		06:48	Sunrise
		10:49	**Fall Equinox**
		15:41	**First Quarter Moon**
		18:00	**Lunar X near crater Werner**
		18:56	Sunset
		19:20	Mercury Sets
		20:15	Saturn Sets
		21:00	Mars Sets
		22:30	Jupiter Rises
		23:59	Moon Set
Sun	23	14:54	Moon Rise, **Lunar Straight Wall visible**
Sat	29	03:30	Venus Rises
		06:55	Sunrise
		18:16	Moon Rise
		18:45	Sunset
		19:16	Mercury Sets
		19:45	Saturn Sets
		20:45	Mars Sets
		22:02	Jupiter Rises
		23:19	**Full Moon**

In the Eyepiece

Here is a list of objects for this month. This is reproduced from www.skyhound.com with the kind permission of its creator and author of SkyTools Greg Crinklaw.

Object(s)	Class	Con	RA	Dec	Mag
Garnet Star	Multiple Star	Cepheus	21h43m30.5s	+58°46'48"	4.2
Zeta Aqr	Multiple Star	Aquarius	22h28m49.9s	-00°01'12"	3.7
LW Cyg	Multiple Star	Cygnus	21h55m13.8s	+50°29'50"	9.2
M2	Globular Cluster	Aquarius	21h33m28.4s	-00°49'39"	7.3
M15	Globular Cluster	Pegasus	21h30m01.0s	+12°10'12"	7.3
Helix	Planetary Nebula	Aquarius	22h29m38.4s	-20°50'13"	7.6
Humason 1-2	Planetary Nebula	Cygnus	21h33m06.6s	+39°38'17"	12.7
NGC 7139	Planetary Nebula	Cepheus	21h46m08.2s	+63°47'59"	13.0
NGC 7139	Planetary Nebula	Cepheus	21h46m08.2s	+63°47'59"	13.0
Cocoon	Diffuse Nebula	Cygnus	21h53m24.0s	+47°16'00"	10.0
IC 5217	Planetary Nebula	Lacerta	22h23m55.7s	+50°58'00"	12.6
NGC 7094	Planetary Nebula	Pegasus	21h36m53.0s	+12°47'19"	13.7
Stephan's Quintet	Galaxy Group	Pegasus	22h36m00.5s	+33°57'57"	12.0
NGC 7354	Planetary Nebula	Cepheus	22h40m20.9s	+61°17'39"	12.9
NGC 7354	Planetary Nebula	Cepheus	22h40m20.9s	+61°17'39"	12.9
Einstein's Cross	Gravitational Lens	Pegasus	22h40m32.5s	+03°21'48"	17.4