

## A journey back in time

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FROM time immemorial, we gazed at the night sky and were fascinated by the sight of the moon, stars, meteors, comets, and neighboring planets. We wish upon a shooting star. We wonder how our lives are connected to the objects that adorn the sky.

This is naked eye astronomy practiced by ancient astronomers who gazed at the sky and studied the complex ballet of motion of visible objects for years and years. Their universe the totality of all space, time, matter, energy - was small, quaint, and tidy with gods playing a dominant role.

Modern astronomy is a journey through two inseparable "abstract entities" - space and time. Some of the journeys are voyages made by us, like the lunar missions of the 1960's. Others involved machines we have built - the space-based telescopes and unmanned space probes, for example. These journeys have expanded the realm of our experience from the Earth to the Moon and allowed us to reach the outer edge of the solar system and beyond.

Astronomy is also a trip of the intellect through the universe. The distances that our mental journeys took us have

grown steadily to the point where we now have astounding knowledge of how the universe works. We know its properties as a whole: its physiology, origin, evolution, and eventual fate.

and radiation from far away objects, we know precisely the chemical composition of distant stars, their distance, size, surface temperature, luminosity, brightness, etc. We can figure out the nuclear reactions

star, do we see it as it is at the time of observation? The answer is no. Because it takes time for light to travel through space, astronomy is a journey back in time. When we look out to large distances, we look back in time and see the universe at an earlier epoch. For example, when we observe the nearest star Proxima Centauri which is about 4.24 light years (ly) away, we are observing the star as it was 4.24 years ago. (One light year is the distance traveled by light in one year which is 9.46 trillion km.) Thus by looking into the past, we can observe the birth and growth of galaxies as the universe ages. Some of the stars and galaxies that we see today probably don't even exist anymore because their light has taken so long to get to us. They are either dead, or have exploded and collapsed into white dwarfs, or supernovae, or black holes.

The speed of light puts a limit on the size of the universe. The finite age of approximately 14 billion years of the universe means light from beyond 14 billion light years (ly) away has not yet reached us. The observable universe, therefore, extends 14 billion ly in all direction from the Earth. In other words, we can describe the universe as it looked 14 billion

years ago. Furthermore, if we looked at objects that are nearly 14 billion ly away, we would see them as they were moments after the Big Bang. It is an amazing thought that today we have the scientific tools to witness the cosmic birth.

It is also amazing to realize that any "snapshot" of a distant galaxy is a picture of both space and time. For example, the galaxy Andromeda is about 2.5 million ly away from earth. A picture of Andromeda, therefore, shows how it looked like 2.5 million years ago. Moreover, its diameter is about 100,000 ly. So light from the far side of the galaxy required 100,000 years longer to reach us than light from the near side. Thus the picture will show 100,000 years of time. This is what the Hubble telescope has been doing for the past two decades.

"We find them smaller and fainter, in constantly increasing numbers, and we know that we are reaching into space, farther and farther, until, with the faintest nebulae that can be detected with the greatest telescopes, we arrive at the frontier of the known universe." Edwin P. Hubble

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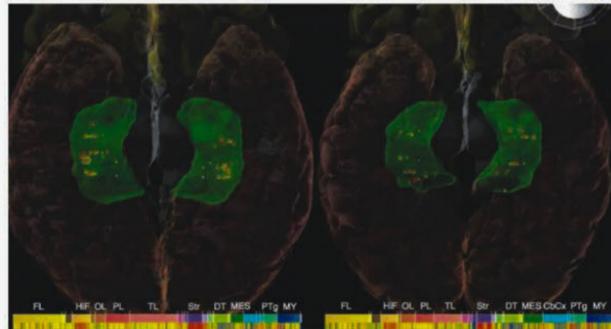
Ancient white dwarf stars in the Milky Way galaxy.

Electromagnetic radiation, ranging from high energy gamma rays to radio waves, is our measuring stick in space. It is the cosmic messenger that carries far more information than any other messenger. By studying and analyzing light

that are taking place at their core. We can determine whether a galaxy is approaching us or receding away from us. We can also calculate their speed of approach or recession with great degree of accuracy.

When we look at a distant

## Intelligence linked to genes



Variant of growth gene boosted gene expression level (colored dots) enlarged memory (shaded in green).

RAIN size and smarts are, to some extent, genetic and now, a team of more than 200 researchers has uncovered specific genes that are linked to both brain volume and IQ.

Though scientists have suggested bigger brains are "smarter," this study is the strongest case yet for a genetic connection to brain size and to IQ. Of course, brain size is not 100 percent correlated with a person's intelligence, and other factors, including connections between brain cells and even a person's experiences, play roles.

"We found fairly unequivocal proof supporting a genetic link to brain function and intelligence. For the first time, we have watertight evidence of how these genes affect the brain," said lead researcher Paul Thompson, a neurologist at the University of California, Los Angeles,

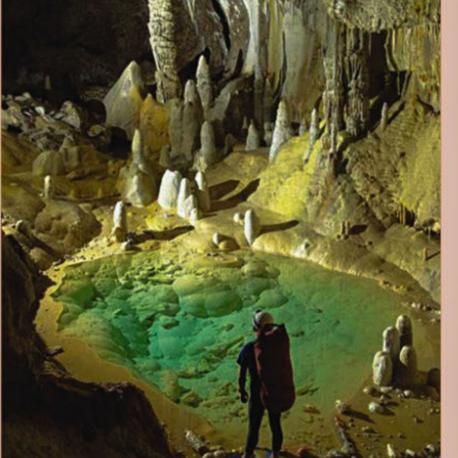
School of Medicine. The international research team pooled brain scans and genetic data from around the world as part of a collaboration known as ENIGMA (Enhancing Neuro Imaging Genetics through Meta-Analysis). They scoured the data for single genes that influence disease risk as well as for genes linked to brain-tissue atrophy and brain size, said lead researcher Paul Thompson, a neurologist at the University of California, Los Angeles, School of Medicine.

"Our individual centers couldn't review enough brain scans to obtain definitive results," Thompson said in a statement. "By sharing our data with Project ENIGMA, we created a sample large enough to reveal clear patterns in genetic variation and show how these changes physically alter the brain."

Source: Live Science

### CAVE FIGHTERS

## Underground resistance



Dozens of strains of bacteria discovered in Lechuguilla Cave are resistant to antibiotics.

Even though bacteria in Lechuguilla Cave have been cut off from the surface for millions of years and were never exposed to antibiotics for medicine or agriculture, most of the 93 strains analyzed in a new study are resistant to several antibiotics. Bacteria found in the cave have ways of fighting off up to 21 kinds of antibiotics, researchers from the University of Akron in Ohio and McMaster University in Hamilton, Canada, report online April 11 in PLoS ONE.

Most can defuse antibiotic substances made by other microbes, but unlike aboveground bacteria have little resistance to human-made antibiotics such as ciprofloxacin.

At least one cave species has evolved a new mechanism for inactivating daptomycin, a drug based on a compound made by some bacteria, raising the possibility that natural populations of bacteria could pass on antibiotic resistance genes to bacteria that infect people.

Source: Science News

### CHALLENGE TO NATURE

## Artificial photosynthesis breakthrough

Researchers from the Department of Chemistry at the Royal Institute of Technology (KTH) in Stockholm, Sweden, have managed to construct a molecular catalyzer that can oxidize water to oxygen very rapidly. In fact, these KTH scientists are the first to reach speeds approximating those in nature's own photosynthesis. The research findings play a critical role for the future use of solar energy and other renewable energy sources.

Researchers all over the world, including the US, Japan, and the EU, have been working for more than 30 years on refining an artificial form of photosynthesis. The results have varied, but researchers had not yet succeeded in creating a sufficiently rapid solar-driven catalyzer for oxidizing water.

"Speed has been the main problem, the bottleneck, when it comes to creating perfect artificial photosynthesis," says Licheng Sun, professor of organic chemistry at KTH.

But now, together with research colleagues, he has imitated natural photosynthesis and created a record-fast molecular catalyzer. The speed with which natural photosynthesis occurs is about 100 to 400 turnovers per seconds. The KTH have now reached over 300 turnovers per seconds with their artificial photosynthesis.

"This is clearly a world record, and a breakthrough regarding a molecular catalyzer in artificial photosynthesis," says Licheng Sun.

The fact that the KTH researchers are now close to nature's own photosynthesis regarding speed opens up many new possibilities, especially for renewable energy sources.

"This speed makes it possible in the future to create large-scale facilities for producing hydrogen in the Sahara, where there's an abundance of sunshine. Or to attain much more efficient solar energy conversion to electricity, combining this with traditional solar cells, than is possible



Grass. Scientists have imitated natural photosynthesis and created a record-fast molecular catalyzer

today," says Licheng Sun. He points to the problem of skyrocketing gasoline prices, and these advances with the rapid molecular catalyzers can in turn lay the groundwork for many important changes. They make it possible to use sunlight to convert carbon dioxide into various fuels, such as methanol. And, technology can be created to convert solar energy directly into hydrogen. Licheng Sun adds that he and his research colleagues are working hard and pursuing intensive research to make this technology reasonably inexpensive.

"I'm convinced that it will be possible in ten years to produce technology based on this type of research that is sufficiently cheap to compete with carbon-based fuels. This explains why Barack Obama is investing billions of dollars in this type of research," says Licheng Sun.

He has conducted research in this field for nearly twenty years, more than half of that time at KTH, and adds that he and many

other researchers see efficient catalyzers for oxidation of water as key to solving the solar energy problem.

"When it comes to renewable energy sources, using the sun is one of the best ways to go," says Sun.

The research findings are of such importance that they have recently attracted the attention of the scientific journal Nature Chemistry.

The research pursued by Licheng Sun and his colleagues is funded by the Wallenberg Foundation and the Swedish Energy Agency. They collaborate with researchers at Uppsala University and Stockholm University, and, together with Professor Lars Klou at KTH, they run a joint research center involving KTH and Dalian University of Technology (DUT) in China.

Source: Science Daily

### BIG STRIDE

## Engineered stem cells kill HIV

EXPANDING on previous research providing proof-of-principle that human stem cells can be genetically engineered into HIV-fighting cells, a team of UCLA researchers have now demonstrated that these cells can actually attack HIV-infected cells in a living organism.

The study, published April 12 in the journal PLoS Pathogens, demonstrates for the first time that engineering stem cells to form immune cells that target HIV is effective in suppressing the virus in living tissues in an animal model, said lead investigator Scott G. Kitchen, an assistant professor of medicine in the division of hematology and oncology at the David Geffen School of Medicine at UCLA and a member of the UCLA AIDS Institute.

"We believe that this study lays the groundwork for the potential use of this type of an approach in combating HIV infection in infected individuals, in hopes of eradicating the virus from the body," he said.

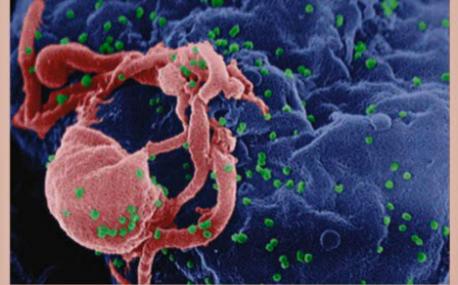
In the previous research, the scientists took CD8 cytotoxic T lymphocytes -- the "killer" T cells that help fight infection -- from an HIV-infected individual and identified the molecule known as the T cell receptor, which guides the T cell in recognizing and killing HIV-infected cells. However, these T cells, while able to destroy HIV-infected cells, do not exist in great enough quantities to clear the virus from the body. So the researchers cloned the receptor and used this to genetically engineer human blood stem cells. They then placed the engineered stem cells into human thymus tissue that had been implanted in mice, allowing them to study the reaction in a living organism.

The engineered stem cells developed into a large population of mature, multi-functional HIV-specific CD8 cells that could specifically target cells containing HIV proteins. The researchers also discovered that HIV-specific T cell receptors have to be matched to an individual in much the same way an organ is matched to a transplant patient.

In this current study, the researchers similarly engineered human blood stem cells and found that they can form mature T cells that can attack HIV in tissues where the virus resides and replicates. They did so by using a surrogate model, the humanized mouse, in which HIV infection closely resembles the disease and its progression in humans.

In a series of tests on the mice's peripheral blood, plasma and organs conducted two weeks and six weeks after introducing the engineered cells, the researchers found that the number of CD4 "helper" T cells -- which become depleted as a result of HIV infection -- increased, while levels of HIV in the blood decreased. CD4 cells are white blood cells that are an important component of the immune system, helping to fight off infections. These results indicated that the engineered cells were capable of developing and migrating to the organs to fight infection there.

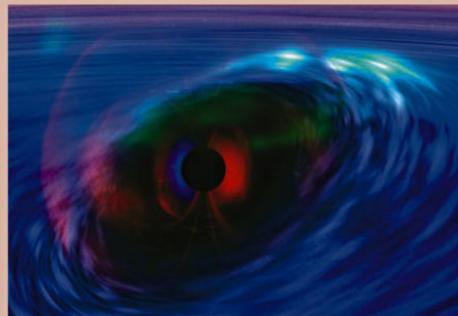
Source: Science Daily



Human immunodeficiency virus (HIV).

### PULSED PROBE

## Pulsing stars could look into space



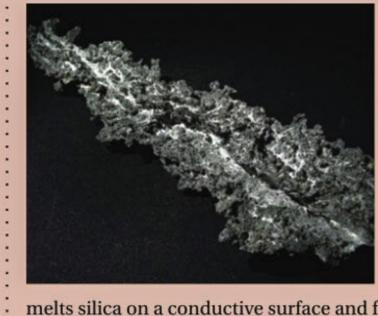
Source: Live Science

If a pulsing star exists near the center of our Milky Way galaxy, where a giant black hole is thought to lurk, it could shed light on the workings of Albert Einstein's general theory of relativity, scientists say. The flashes of light from such a star, called a pulsar, could be used to determine how much the behemoth black hole distorts space-time around it.

Unlike a standard star, pulsars emit steady pulses of light that allow their motion to be tracked precisely. An international team of astronomers has proposed that such precision could create a better understanding of this space-time around a black hole.

### WHAT YOU KNOW?

## What is fulgurite?



Source: Science Daily

Fulgurite is the name for fossilized lightning. They are natural hollow glass tubes formed in quartzose sand, or silica, or soil by lightning strikes and are formed when lightning with a temperature of at least 1,800 degrees Celsius instantaneously melts silica on a conductive surface and fuses grains together. The image above is a fulgurite.