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Bringing Science Solutions to the World

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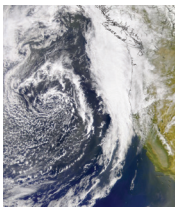
Lawrence Berkeley National Laboratory's science is a global enterprise. From the Lab's site in the hills overlooking the University of California Berkeley campus, to locations across the continent and around the world, Berkeley Lab scientists are working at the frontiers of knowledge to better understand our universe and to address the challenges facing our nation and our planet.

Understanding the Effects of the Gulf Oil Spill

In the aftermath of the explosion of BP's Deepwater Horizon drilling rig in the Gulf of Mexico, a dispersed oil plume was formed at a depth between 3,600 and 4,000 feet, extending some 10 miles out from the wellhead. An intensive study by Berkeley Lab scientists, using a DNA-analytical tool they developed called the PhyloChip, revealed that microbial activity, spearheaded by a new and unclassified species of microbe, completely degraded the entire plume in a matter of weeks. This degradation took place without significant oxygen depletion. The results suggest that a great potential for intrinsic bioremediation of oil plumes exists in the deep-sea.

Tracking Dust From China



About a third of the airborne lead particles recently collected at two sites in the San Francisco Bay Area originated from Asia, a finding that underscores the far-flung impacts of air pollution and heralds a new way to learn more about how pollutants can journey across vast distances. In a first-of-its-kind study, scientists from Berkeley Lab and the California Air Resources Board tracked variations in the amount of lead transported across the Pacific over time. They used the lead's isotopic signature as a chemical return address, which enabled them to trace its origins to coal and metal ore found only in China.

What's Killing the Coral Reefs

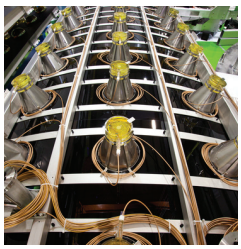
Berkeley Lab scientists are working with UC Merced scientists to discover what's killing the world's coral reefs. The acute susceptibility of coral to environmental change makes it "a canary in a coalmine." If coral suffers, other species will soon follow. Using the PhyloChip, the collaboration has been cataloging the microbes that live among coral off the coast of Puerto Rico. They've found that as coral becomes diseased, the microbial population it supports grows much more diverse. While it is still unclear as to whether this microbial bloom causes the disease or results from it, the PhyloChip provides a powerful tool for tracking this change and shedding light on the pathogens that plague one of the ocean's most important denizens.

Advanced Biofuels

The Joint BioEnergy Institute (JBEI), a partnership led by Berkeley Lab and one of three U.S. Department of Energy Bioenergy Research Centers, is dedicated to advancing the development of a next generation of biofuels – liquid fuels that are clean, green and renewable, can be used in today's infrastructures and engines, and are competitive with gasoline in economics and well as performance. To this end, JBEI researchers are combing the globe in search of plants, such as perennial grasses and fast-growing trees, that can grow on lands not suitable for food crops, and will serve as cost-effective, environmentally friendly sources of biomass. A worldwide search is also underway for microbes that produce enzymes which can break down and ferment the cellulosic sugars in biomass, then synthesize the product into transportation fuels for cars, trucks and planes.

Wind Turbines from Russia

An international collaboration has developed and is testing a small-scale wind turbine designed to generate 3 kilowatts of electricity per hour under moderate winds – enough power for a small home if coupled with other renewable energy sources such as solar panels. The turbine was developed by Berkeley Lab scientists and Empire Magnetics of Rohnert Park, CA, in collaboration with former weapon engineers at the State Rocket Center in Miass, Russia. It is part of a Department of Energy program that fosters partnerships between national laboratories, U.S. companies, and former Soviet weapon scientists.



Weighing Neutrinos at Daya Bay

Neutrinos (and antineutrinos) have mass, if only a tiny bit, which allows them to change "flavors" as they travel through the universe. But no one knows how much the different flavors weigh, or even which is the heaviest. At the immense nuclear power-plant complex at Daya Bay near Hong Kong, Berkeley Lab scientists lead a team that has buried detectors deep in the nearby mountains in a search for mixtures of flavors that could provide the answer to the question of neutrino mass – and also help explain why there is any matter at all in the universe.

India Energy Efficiency

The Indian state of Maharashtra leads India in energy consumption: its citizens endure daily electricity blackouts. One solution is to reduce electricity demand and the need for more power plants by implementing energy-efficiency measures, like those developed at Berkeley Lab and now being used in California. Thanks to a Memorandum of Understanding between energy regulators in the U.S. and India, and Berkeley Lab researchers, officials in India hope to meet a significant portion of Maharashtra's electricity growth through energy efficiency instead of by building new power plants.

Understanding Carbon in the Ocean

Oceanographers at Berkeley Lab are measuring the fate of carbon particles originating in plankton blooms in the world's oceans to help determine how the oceans absorb carbon dioxide from the atmosphere, and what happens to carbon fixed by sea life. Understanding the origins, transport mechanisms, and fate of naturally occurring iron in high-nutrient, low-chlorophyll surface waters is important in calculating how Earth's climate is changing.

Life-saving Stoves in Darfur and Beyond

Berkeley Lab scientists and engineers developed the Berkeley-Darfur stove, which uses three times less wood than the traditional three-stone stoves and prevents up to two tons of carbon dioxide emissions annually. Through the Darfur Stoves Project, thousands of stoves have been produced and distributed, providing jobs to local people who build them. Project members are also working with World Vision to adapt the stove for use in Ethiopia, which has experienced severe deforestation. Scientists are working not only to create a more efficient stove specific for use in Ethiopia, but also to finance the project by selling carbon credits on the world carbon market. Charcoal stoves are also being tested for distribution in Haiti.

Storing Carbon Underground

With the air already awash in carbon dioxide, it's estimated that each year we add another seven billion tons through the burning of fossil fuels. Working at an abandoned oil field just east of Houston, Berkeley Lab researchers, in partnership with the Texas Bureau of Economic Geology, injected 3,000 tons of liquid carbon dioxide into a brine-saturated aquifer called the Frio Formation. They then monitored what happens to the carbon dioxide plume as it moves throughout the formation, displacing the brine from porous rock. The Frio Pilot Test is the first scientific evaluation in the U.S. of brine formations as potential underground carbon sequestration storage sites.

Life-saving Water Filters

Berkeley Lab scientists are developing a cheap and effective way to provide safe drinking water to 60 million citizens of Bangladesh living under the specter of arsenic poisoning. The idea is to create arsenic filters from coal ash, the fine gray powder that piles up at the bottom of furnaces at all coal-fired power stations. Arsenic poisoning in Bangladesh has been called one of the largest mass poisonings in human history. Exposure can lead to debilitating lesions and cancer, and is expected to cause 10 percent of all future adult deaths in the impoverished nation of 130 million. The Berkeley Lab technique involves coating coal ash with a compound that attracts arsenic, then filling teabag-sized pouches with the powder. These filters would be distributed throughout the countryside, one per family per day. Water drawn from the millions of contaminated wells in Bangladesh could be poured through the filter then safely consumed.

Energy Efficient Skyscrapers

The New York Times Company moved into their new headquarters on the west side of Manhattan in 2007. Three years before this milestone, the *Times*' facility team turned to building scientists at Berkeley Lab for reliable and affordable technologies, not yet available in the marketplace, to regulate daylight in the new building.

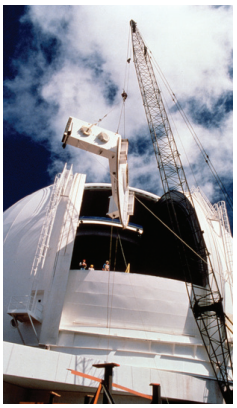
Wind Energy in Eritrea

Eritrea, a small African nation wedged between the sea and Ethiopia, has endured its share of hardships over the years, but it can count among its blessings a relentless breeze funneled from the Red Sea. Berkeley Lab scientists are now helping that nation to embark on a $3.8 million pilot project to determine whether a large portion of its energy can be derived from wind-powered turbines. Berkeley Lab has been contracted to help Eritrea create the most efficient procedures for implementing wind energy systems, as well as develop protocols that track the project's progress. Eritrean officials hope to someday provide as much as 50 percent of their nation's grid electricity using wind turbines.

Extreme Microbes

Berkeley Lab scientists at Siberia's Kamchatka Peninsula, an intensely active volcanic region almost as big as California, study microbial diversity in extreme environments, such as hot springs, fumaroles and acid lakes. The enzymes and other natural products that enable extremophiles to survive their hostile environments are potentially valuable for a broad range of applications, including bioremediation and the production of carbon-neutral biofuels.

Bringing the Stars Closer



Scientists worldwide can glimpse celestial objects that are billions of light years away, thanks to revolutionary telescope technology developed at Berkeley Lab in the late 1970s. A reflecting mirror comprised of individual segments that function together as a single unit is used at many observatories worldwide, including the giant twin telescopes of the Keck Observatory on the summit of Mauna Kea in Hawaii, which are the world's most powerful ground-based optical and infrared telescopes.

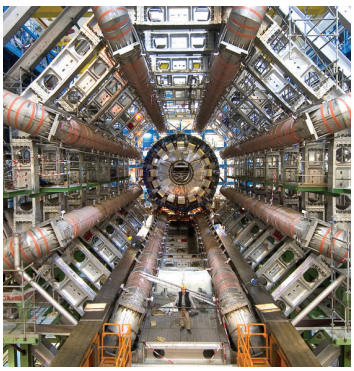
Finding New Life at the Extremes

A team of researchers led by Berkeley Lab scientists used environmental genomics to identify the first-ever ecosystem consisting of a single biological species, found almost two miles underground in a gold mine near Johannesburg, South Africa. The bacterium *Desulforudis audaxviator* – the name, partly borrowed from Jules Verne's *Journey to the Center of the Earth*, means "rod-shaped, sulfur-eating, bold traveler" – exists in complete isolation, total darkness, no oxygen, and at 140 degrees Fahrenheit. Scientists who consider the prospects for life in outer space have debated whether organisms can exist in the absence of other life, without access even to sunlight. We now know the answer is yes.

A Bold New Way to Measure Dark Energy

On top of Apache Peak, New Mexico, a telescope fitted with a special camera is measuring the expansion history of the universe with a technique known as "baryon acoustic oscillation" – cosmology-speak for the periodic clustering of galaxies and other visible matter roughly every 500 million light years, which forms a "cosmic yardstick" that can be used to measure the expansion of the universe at different eras. The program is called BOSS, for Baryon Oscillation Spectroscopic Survey; it's led by Berkeley Lab and is part of the Sloan Digital Sky Survey III.

The Large Hadron Collider

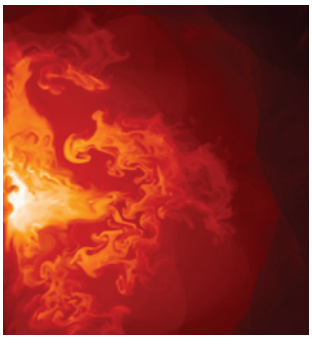


For most of the year the Large Hadron Collider (LHC) at CERN, headquartered near Geneva, Switzerland, explores the debris from protons colliding at the highest energies that can be produced artificially. Then, for one month a year, the LHC collides massive lead ions to recreate the quark-gluon plasma, an extraordinarily hot and dense state of matter that existed only a few millionths of a second after the big bang. As a member of the U.S. LHC Collaboration, Berkeley Lab scientists and engineers helped build the giant accelerator's focusing magnets and are also key players in the ATLAS and ALICE experiments.

Measuring Neutrinos

Berkeley Lab researchers are part of the U.S. team at KamLAND, an underground neutrino detector in central Japan, that can detect low energy neutrinos that originate in nuclear reactors and in outer space. Measurements of electron antineutrinos emanating from deep inside the earth, so-called geoneutrinos, serve as a unique window into the interior of our planet, revealing information that is hidden from other probes.

Hunting for Supernovae



Type Ia supernovae are among astronomy's best "standard candles," objects whose distance can be calculated with confidence because they are both sufficiently similar and bright enough to be seen across billions of light years. Scientists study these exploding stars to better understand the universe. Modern methods of finding distant Type Ia supernovae to measure cosmic parameters were developed by the Supernova Cosmology Project, an international collaboration under the leadership of Berkeley Lab scientists, using powerful telescopes around the world and in outer space. Another international collaboration led by Berkeley Lab scientists, the Nearby Supernova Factory, investigates the physics of Type Ia supernovae.

Underground Science Laboratory

The Homestake Mine, a former gold mine in the Black Hills of South Dakota, has been proposed as the home of the Deep Underground Science and Engineering Laboratory (DUSEL). Researchers, including teams from Berkeley Lab, will use DUSEL to conduct astrophysics and physics experiments that need to be shielded from cosmic rays and other background radiation. DUSEL would also house research on materials and geoscience, and on microorganisms that inhabit extreme environments.

Studying Neutrinos at the South Pole

IceCube is a "telescope" made of thousands of sensitive optical detectors lowered over two kilometers deep into the clear ice at the South Pole, to which Berkeley Lab scientists contributed key components. By capturing flashes of "Cherenkov radiation," faint flashes of light left by muons speeding through the ice from the collisions of neutrinos that have traveled all the way through Earth, IceCube hopes to find the sources of the most energetic cosmic rays in the universe, and even evidence of dark matter particles trapped inside Earth or the sun.