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Argonne NATIONAL LABORATORY | 70 1946 - 2016

SEVENTY YEARS OF **DISCOVERY**

ARGONNE BREAKTHROUGHS IN 70 YEARS

Since its creation in 1946, Argonne National Laboratory has addressed the nation's most pressing challenges in science, energy, the environment, and national security. On our 70th anniversary, we're looking back on discoveries and inventions created right here that have changed the world.

Taught electrons to surf

Argonne physicists were pioneers in wakefield acceleration, which accelerates electrons by letting them "surf" on the wake of a leading high-current electron beam. Argonne demonstrated an accelerating gradient five times higher than that of traditional linear accelerators.

Helped found quantum computing

In the early 1980s, an Argonne researcher laid the theoretical foundation for quantum computing by developing the first model of a Turing machine based on quantum mechanics. Quantum computers may be able to solve certain computing problems far more quickly than today's computers.

Solving big problems

Scientists all over the world use Argonne's PETSc, a suite of codes for large-scale problems, in their simulations to model everything from blood flow to earthquakes.

Understanding cystic fibrosis

Argonne and Harvard Medical School discovered the structure of a key protein believed to play a role in a deadly infection that afflicts the lungs of cystic fibrosis patients.

Explained nuclear structure

Argonne physicist Maria Goeppert Mayer shared the 1963 Nobel Prize in physics for explaining the shell structure of the atomic nucleus.

Built the nation's first high-energy physics user facility

Argonne designed, built, and operated the Zero Gradient Synchrotron (1963-1979), the nation's first high-energy physics facility open for scientists around the country to come and use.

World's first usable electricity from nuclear power

In December 1951, Argonne's Experimental Breeder Reactor-I lit up a string of four lightbulbs with the world's first usable electricity from nuclear energy.

LED THE WORLD IN SOLVING PROTEIN STRUCTURES

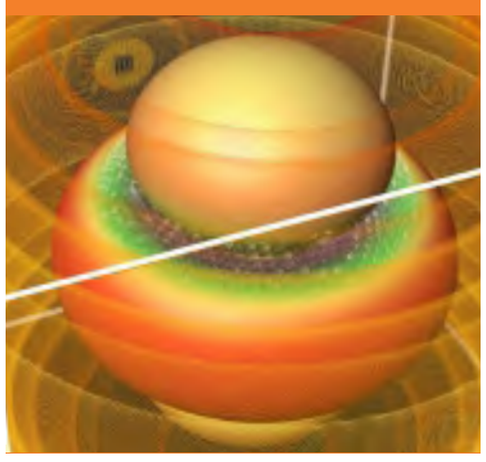
Protein structures help pharmaceutical companies identify targets for new drugs. Argonne's Structural Biology Center was the first organization to contribute 1,000 structures, including those of key proteins in tuberculosis, bird flu, and gut microbes, to the international Protein Data Bank.

POWERED NUCLEAR SUBMARINES

Argonne developed the reactor core for the U.S.S. *Nautilus*, the world's first atomic-powered submarine, which can cross beneath the Arctic polar cap without coming up for air.

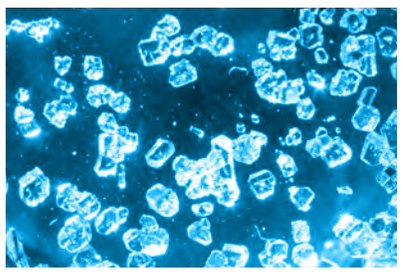
GREW THE GRID

The Globus Toolkit lets people share computing power, databases, and other tools securely online. It is now the world standard for grid computing.



Built a passively safe nuclear reactor

Argonne's Experimental Breeder Reactor-II was proven safe in tests that simulated accidents more severe than the one that took place at Fukushima. Engineers watched as the reactor shut itself down without intervention by automatic safety systems or people.



Made the impossible possible

In 1962, Argonne chemists created the first simple compound of xenon, a gas previously thought to be inert, by combining it with fluoride. Xenon compounds are now used widely, including to make computer chips and in lasers for LASIK eye surgery.

Shaped global radiation standards

Argonne's Janus reactor (1964-1992) was the first reactor ever built exclusively for biological research. Janus research helped shape radiation safety standards around the world.

Pioneered early computers

Argonne helped pioneer early computing research in 1953 when physicists built AVIDAC, the lab's first digital computer. It was the size of a large room and contained 2,500 electronic tubes.

Reduced machine wear

Argonne materials scientists developed near-frictionless carbon, an ultra-hard coating many times slicker than Teflon. It can reduce wear and improve efficiency in machines and engines.

Pioneered neutrons for research

From 1954 to 1979, Argonne's Chicago Pile-5 reactor was one of the nation's most useful tools for studying solid and liquid materials.

FOUGHT CANCER

Research at the Advanced Photon Source at Argonne helped drug companies develop new cancer treatments, including Votrient, which treats advanced kidney cancer and soft-tissue sarcomas, and Venclexta, which treats leukemia.

First town lit by nuclear electricity

In 1955, Argonne's BORAX-III was the first nuclear reactor to light an entire town—Arco, Idaho—with electricity from atomic energy.

THE ARCO ADVERTISER

Serving America's Newest Atomic Center — Voice of the Lost River Country Since 1909 — 10 Cents Per Copy

Vol. XLVI—Number 24 — Arco, Butte County, Idaho — Friday, August 12, 1955

Arco First City In United States Lighted By Atomic Power

ARCO — UTAH POWER & LIGHT CO. — BORAX — TRANSMISSION

Arco On Atomic Power One Hour In Nuclear Test From Energy Produced At Experimental Reactor At AEC

Northern District Posse Meet Here Saturday; Six Riding Clubs To Vie For Honors In Two Performances

Peep Sights

Rites Held For Sidney L. Martin

Three Highway Accidents Are Reported Here

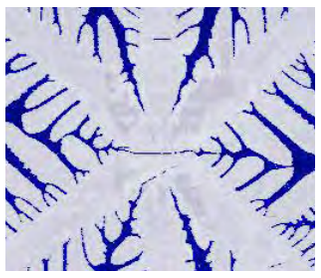
We Knew About It All The Time

Stake Old Folks

Patrolman Tells Rotarians High

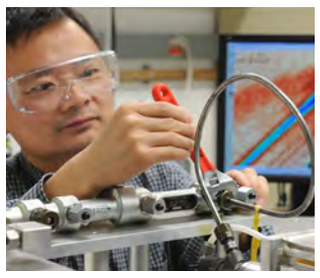
Helped the blind see

An Argonne scientist invented ultrananocrystalline diamond, the world's smoothest, hardest diamond film, resulting in new industrial coatings that prevent wear as well as a key component in an FDA-approved artificial retina that restores useful vision to people blinded by retinal disease.



Made ball bearings more efficient

Argonne tribologists discovered that graphene, a one-atom-thick form of carbon, dramatically reduces friction on sliding steel surfaces. This research promises to reduce wear and tear in machines from table fans all the way up to giant wind turbines.

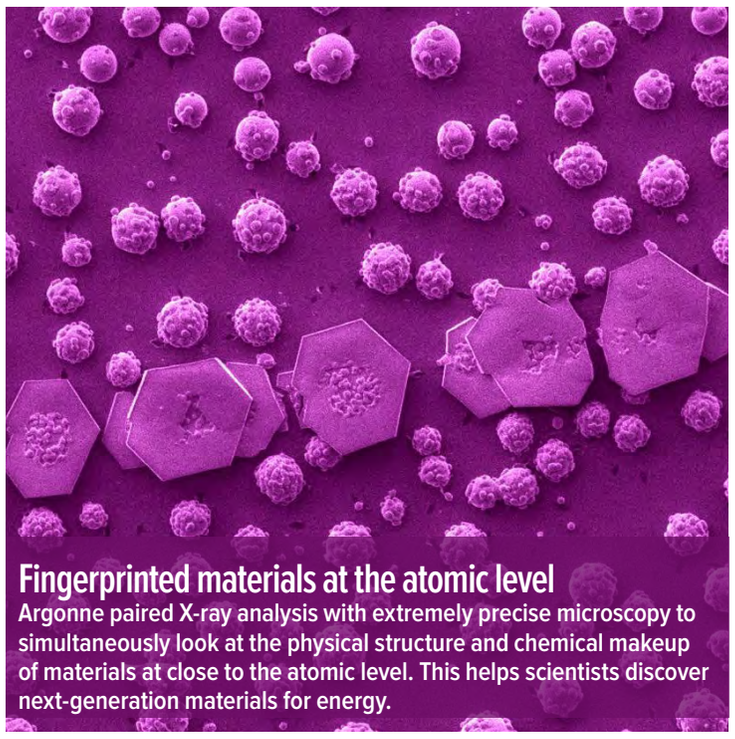


Improved fuel injectors

Argonne researchers developed a new technique that uses X-rays from the Advanced Photon Source to peer through high-speed liquid jets, leading to improved fuel injectors for cars and trucks.

Made reactors proliferation-resistant

Argonne nuclear engineers have worked to convert 67 scientific reactors around the world to run on low- rather than high-enriched uranium, which helps reduce the risk of the spread of nuclear weapons and material.



Fingerprinted materials at the atomic level

Argonne paired X-ray analysis with extremely precise microscopy to simultaneously look at the physical structure and chemical makeup of materials at close to the atomic level. This helps scientists discover next-generation materials for energy.

Extended machine life

Argonne's ultra-fast boriding process coats metal parts with boride three times as hard as conventional boriding—and it takes minutes instead of hours to apply. It's used in industry to improve the performance and reliability of engines, pumps, and other machines.

Seeing nanoparticles one by one

Argonne researchers helped develop new lenses and techniques to help scientists see very small individual nanoparticles and formations—some as small as a single nanometer, which is how far your fingernails grow in one second.

Pioneered grid collaboration

Argonne developed the Access Grid in the 1990s; at its peak it had more than 3,400 users in 47 countries and was used for large-scale distributed meetings, seminars, and lectures involving participants at many different locations.

Creating material of the stars

Researchers developed and installed the CARIBU system at the Argonne Tandem Linac Accelerator System to produce and study special nuclei normally created only in stars.

Made nuclear fuel processing safer

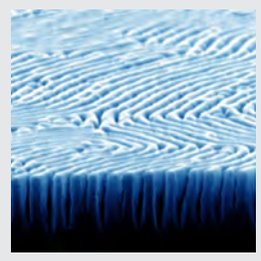
Argonne scientists developed a simpler, safer method to reprocess used nuclear fuel.

Solved the structure of chlorophyll *c*

Argonne chemists solved the chemical structure of chlorophyll c, used by marine and freshwater algae to convert sunlight into energy.

Extracted medical isotopes

Argonne developed a new chemical process to help produce Tc-99m—the world's most used medical isotope for diagnostic imaging—without a nuclear reactor. Tc-99m is used in tens of millions of diagnostic procedures each year, helping doctors and patients around the globe.



Invented better lithography

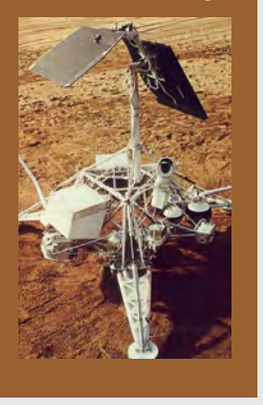
Argonne scientists invented SIS lithography, a new way to create nanoscale patterns for microelectronics at lower cost and better performance.

Saved truckers money and fuel

Argonne researchers proposed that long-haul trucking companies and their drivers can save fuel, reduce emissions, and cut operating costs by adopting technology that eliminates the need to idle trucks overnight.

Discovered the moon's volcanic history

An instrument developed by Argonne, the University of Chicago, and the Jet Propulsion Lab was carried to the moon in 1967 by *Surveyor* V. It tested the moon's surface with alpha particles and provided evidence that part of the moon's surface had been volcanic.



Put the jolt in the Volt

The batteries in the Chevy Volt use a revolutionary new cathode material invented at Argonne that makes them last longer and store more energy.

Photo Courtesy of General Motors and U.S. Department of Energy.

Made nuclear reactors safer

Argonne experiments helped develop models used today by industry and regulators around the world to understand and prevent severe nuclear accidents.

U.S. DEPARTMENT OF ENERGY

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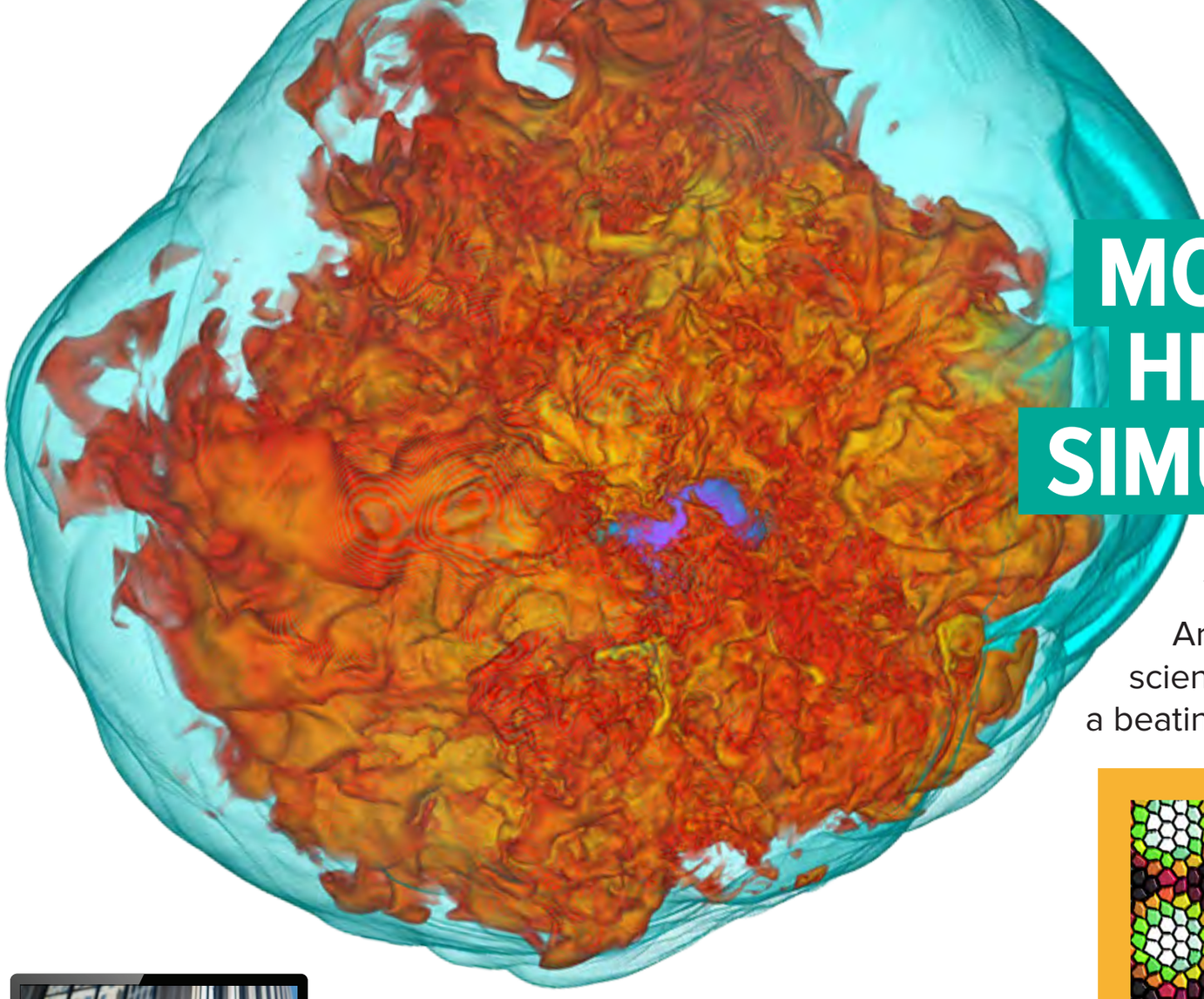
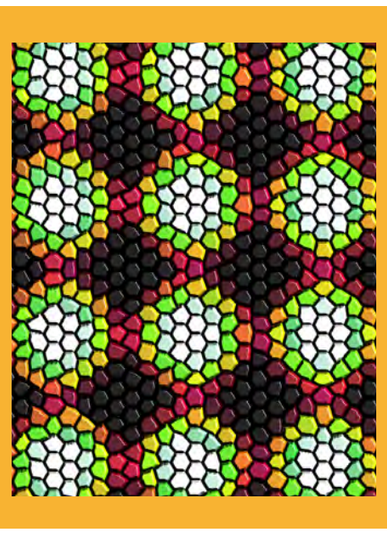


MODELED HEARTBEATS AND SIMULATED THE COSMOS

Computers that use multiple processors need a standard interface so programs written for one can run on others. Argonne's MPICH software is the world standard; it's helped scientists run the largest-ever cosmological simulation and model a beating human heart at near-cellular resolution.

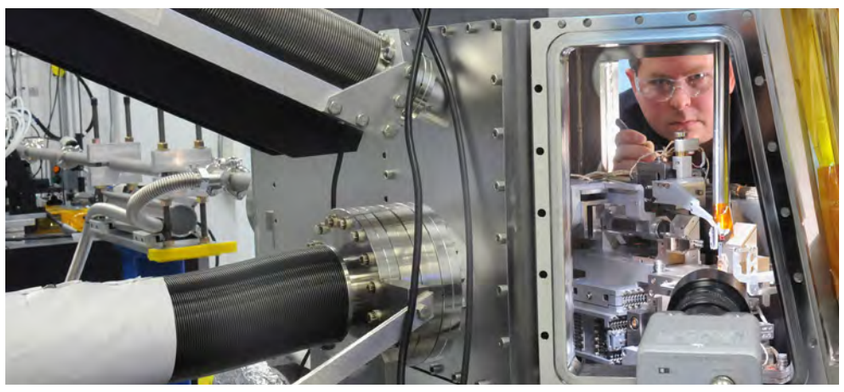


Led high-temperature superconductor research

In 1986 the discovery of high-temperature superconductors made a splash in science—and Argonne became a world leader in research on these materials, which carry electricity with no energy loss. Argonne solved the structure of the material, made America's first wire out of it, and was first to run electrical current through the wire.

Foreseeing economic risk and opportunity

Argonne is a national leader in complex adaptive systems simulations, which model the behavior and interactions of thousands of decision-making individuals. These sims can help identify trends in consumer behavior and avert economic catastrophes.



BUILT POWERFUL X-RAY MICROSCOPES

Argonne's Hard X-ray Nanoprobe is one of the world's most powerful microscopes, capable of focusing X-rays tightly enough to see objects as small as 100 atoms. The probe is used in research to make better solar cells, more efficient lighting, and next-generation computers.

EXPLAINED SUPERCONDUCTIVITY

Argonne physicist Alexei Abrikosov shared the 2003 Nobel Prize in physics for contributions to the theory of superconductors—materials that conduct electricity with zero energy loss at extremely cold temperatures.

BUILT AN ARTIFICIAL LEAF

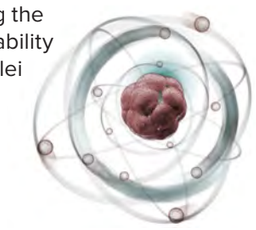
Argonne chemists created a new chlorophyll molecule in 1976 that mimicked the behavior of natural chlorophyll in green plants, an early breakthrough in understanding how nature gets energy from the sun.

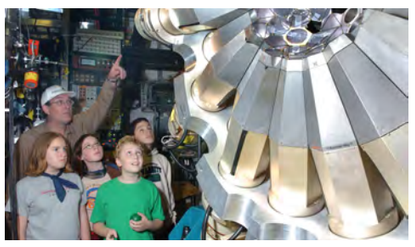
FOUGHT AIDS

Research at the Advanced Photon Source at Argonne helped Abbott Laboratories develop Kaletra, a world-leading drug that fights the HIV virus and has extended the lives of thousands of AIDS patients.

Calculated nuclear stability

Argonne physicists published the V18 model, now the world standard for calculating the forces and stability of atomic nuclei with 4 to 12 protons or neutrons.





Invented superconducting linear accelerator technology

German and Argonne scientists developed a technique for building superconducting parts for particle accelerators, which led to the Argonne Tandem Linac Accelerator System (1985–present)—the world's first superconducting accelerator for heavy ions.

Testing emissions from alternative fuels

Argonne's Advanced Powertrain Research Facility measures the emissions and performance of new engine designs—including engines that run on new fuels like hydrogen and natural gas—for major auto manufacturers.

INVENTED CERAMICRETE

Argonne scientists invented CERAMICRETE, a low-cost concrete replacement that can be used for hazardous waste disposal, low-cost insulation, pothole repair, and low-cost housing for developing nations.

DECONTAMINATED RADIOACTIVE WATER

SC

Argonne invented an extraction process used to clean up radioactive cesium at a site in South Carolina.

CO-DISCOVERED TWO ELEMENTS

99 Es 252.00 | 100 Fm 257.00

Argonne scientists co-discovered **einsteinium** and **fermium**, elements 99 and 100 in the periodic table.

USED BACTERIA TO CLEAN UP CHEMICALS

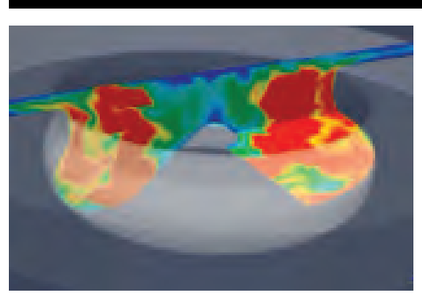
Argonne demonstrated a way to encourage naturally occurring bacteria to clean soil contaminated with toxic carbon tetrachloride.

Protected public places from attack

Argonne's PROTECT early-warning system is installed in subway systems in Boston, New York, and Washington, D.C., to detect chemical and biological attacks from terrorists and speed up evacuation and emergency response.

Helped develop new auto technologies

Autonomie is a modeling tool that helps the automotive industry reduce costs by accelerating the development of advanced automotive tech. More than 175 companies, universities, labs, and government agencies use Autonomie worldwide.



Conducted the world's largest diesel engine simulation

Argonne scientists conducted the world's largest diesel engine simulation through VERIFI, which combines fuel chemistry and combustion science with supercomputers, engine labs, and X- rays to help industry shrink the time and cost of developing new engines.

PIONEERED MODERN NUCLEAR POWER

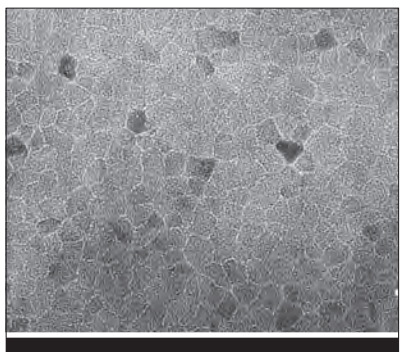
Argonne conceived, developed, built, and tested the concepts and prototypes for most commercial nuclear reactors operating in the world today. These reactors provide 20% of the nation's electricity—and 48% here in Illinois.

Created nation's first pulsed spallation neutron source

Argonne designed and built the nation's first pulsed spallation source of neutrons and then the Intense Pulsed Neutron Source (1981-2008), where researchers solved the structure of a superconductor, identified the structure and formation of Alzheimer's plaques, and discovered nanotube water, a new form of water that doesn't freeze, even at temperatures near absolute zero.

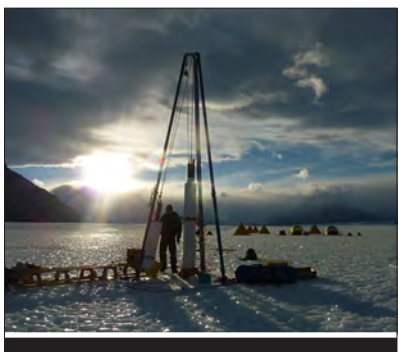
Made solar shingles possible

Research at the Advanced Photon Source at Argonne helped Dow Chemical develop Powerhouse Solar shingles, the first shingles that can harvest solar energy from homeowners' rooftops.



Co-discovered superinsulation

Superinsulation, the ability of some materials to completely block the flow of electricity at low temperatures, was discovered by a team that included Argonne scientists.



Measured the age of glaciers

Argonne physicists developed an ultra-sensitive method for measuring elements at levels as low as a few parts per trillion. It has been used to measure the age of glaciers and to find out how fast aquifers refill.

IMPROVED COMBUSTION PROCESSES

Argonne scientists proved that the conventionally held measurement of the energy of the bond between oxygen and hydrogen was too high by almost 5%. The result significantly improved the modeling of combustion, the atmosphere, and many industrial processes, ultimately leading to better fuel efficiencies and better models of how human activity affects air pollution.

DISCOVERED THE 'ROAMING' MECHANISM

Argonne and Emory University discovered the "roaming" mechanism, in which two molecular fragments orbit each other until they find a new stable orientation. It is now understood to occur in a wide range of environments; the discovery changed our understanding of the chemistry of pollution in the atmosphere and of the reactions inside engines and industrial processes.

GREW PROTEINS FOR PHARMACEUTICALS

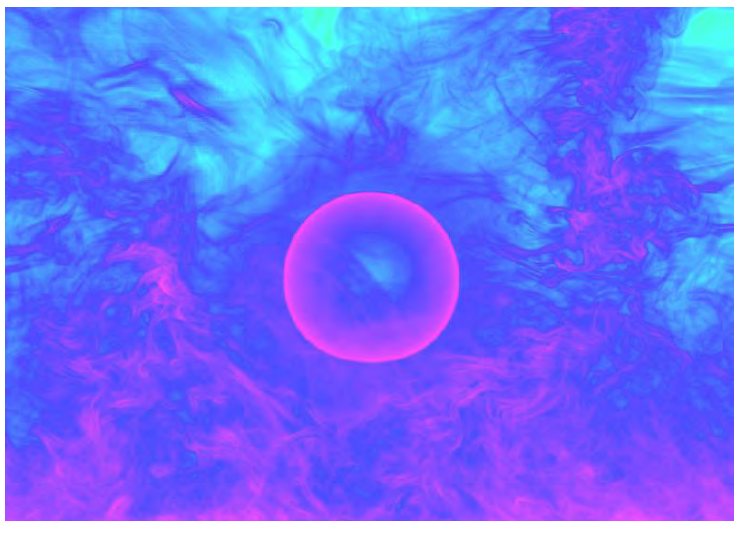
60% of all drugs target membrane proteins, but these proteins are expensive to produce for drug research. Argonne biologists drove down the costs by developing the first technique for growing large amounts of membrane proteins.

TRACKED HIGH-RISK MATERIALS IN REAL TIME

Argonne's radio-frequency identification system remotely tracks and monitors thousands of packages of nuclear and hazardous materials around the clock.

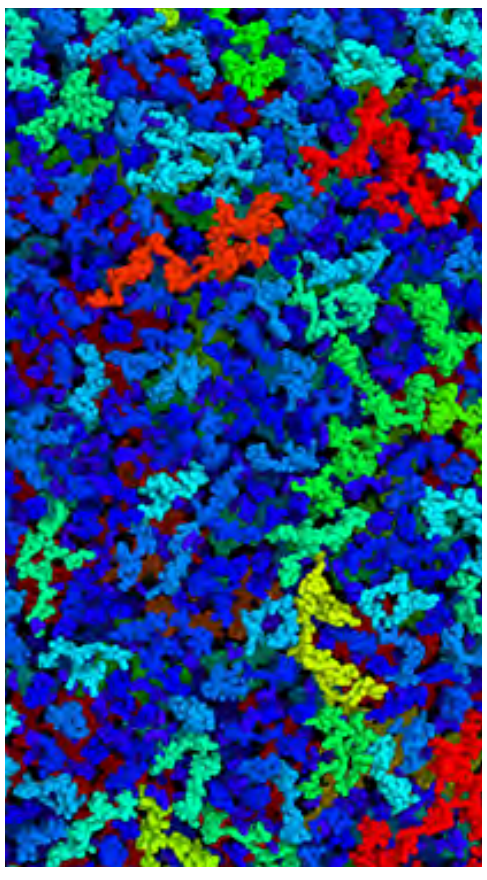
Revolutionized X-ray science

Since 1996, the Advanced Photon Source at Argonne has been the nation's leading source of synchrotron X-rays, attracting thousands of users every year from industry, universities, and national labs to conduct research in almost every field of science.



Providing leading-edge computational capabilities

Established in 2004, the Argonne Leadership Computing Facility develops leading-edge computational capabilities and makes them available to researchers in all fields. Its next supercomputer, Aurora, will be able to calculate 180 quadrillion operations per second. if every single person on earth solved one calculation per second, it would take them nine months to do what Aurora will do in a single second.



Watched nanomaterials grow and change in real time

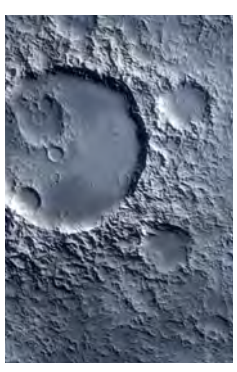
Researchers at Argonne were the first to observe nanoparticles growing in real time and to watch them assemble themselves into chains. This work helps create new devices for medicine, energy, electronics, and many other fields.

Created scientific software used worldwide

Applied mathematicians at Argonne in the 1970s and '80s developed linear algebra and optimization software libraries that became standards used by scientists and mathematicians around the world.

FOUND AN ELECTRON THAT LIKES WATER

An Argonne scientist in 1962 co-discovered the hydrated electron, a type of electron that is highly attracted to water. Considered a breakthrough, the discovery clarified many previously misunderstood concepts in radiation chemistry.



DISCOVERED RADIOACTIVE ELEMENTS ON THE MOON

Argonne researchers were the first to discover transuranic elements neptunium and uranium-236 in a soil sample brought back from the moon.

Invented molecular modeling

In 1960, an Argonne scientist helped create the science of molecular dynamics, using an early PC to calculate the reactions of simple molecules. Today, molecular dynamics is widely used to model existing materials and to find new materials with potentially useful properties.

ANALYZING EMISSIONS FROM CRADLE TO GRAVE

Argonne's GREET model is the world standard for evaluating how much energy different cars and fuels use and the emissions they produce over the lifetime of the vehicle, from mining raw materials through vehicle disposal.

SPEEDING MEDICAL RESEARCH

Research at the Advanced Photon Source at Argonne dramatically slashed the time and cost of unraveling protein structures, which are key to making more effective drugs to fight disease.