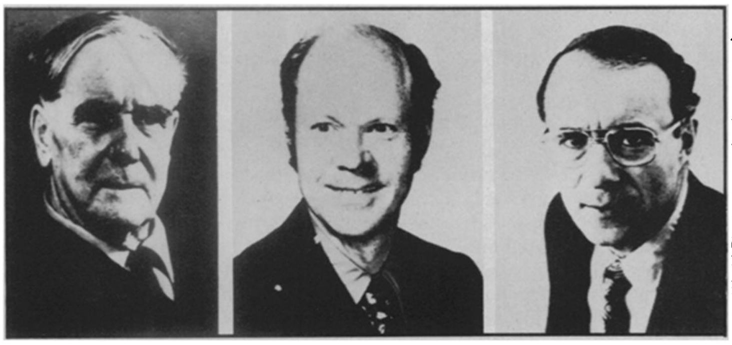
Nobel Prizes: Research With An Impact

Physics: It's a cold world



Wide World Photos

Kapitsa made 4° common in the lab; Wilson and Penzias found 3° in the sky.

Astronomers tend to resist the classification of astronomy as a branch of physics; they have their own clubs, observatories, academic departments and so on. But radio astronomy is the observational offspring of physics and astronomy, and cosmology is the theoretical child of both. So it comes about that half the 1978 Nobel Prize in Physics honors a radio astronomical observation that has become, more than any other single datum, the foundation for the present virtual unanimity among cosmologists — the discovery, made in 1965 by Arno Penzias and Robert Wilson, then and now radio astronomers with the Bell Telephone Laboratories, of the famous 3° K microwave radiation that permeates the universe.

Three degrees Kelvin is pretty cold, and it is making routine work at those temperatures much more practical than it used to be that won the other half of the prize for Piotr Leontevich Kapitsa, director of the Institute of Physical Problems of the Soviet Academy of Sciences. He was cited for his invention, in 1934, of a device for cooling liquid helium by periodic expansions. It made large quantities of liquid helium without precooling by liquid hydrogen, and thus made experiments at extremely low temperatures — liquid helium's boiling point is 4° K — much more practicable.

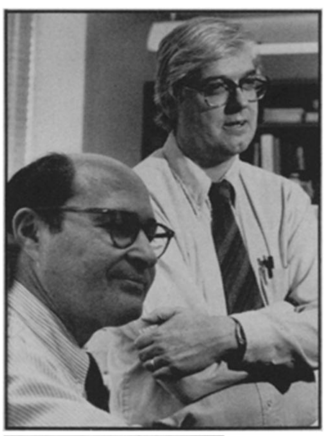
When Penzias and Wilson began their observation with a horn antenna set up in a field at Holmdel, N.J., they were not looking for anything to do with the big bang. They were studying the radio noise coming from the sky. They noticed a curious background radiation that came from all over the sky, and it seemed the numbers might fit the spectrum of a blackbody at a temperature about 3°K. It was then remembered that Ralph Alpher and Robert Hermann had predicted the existence of such a background as a consequence of the explosion at the beginning of the universe. The big bang theory in general had been worked out by Alpher and George Gamow and published by them and Hans Bethe in the late 1940s.

After the discovery of Penzias and Wilson, astronomers began looking for the background radiation at other frequencies, and gradually the shape of the spectrum was filled in. As the spectrum filled in, so did the list of cosmologists and astronomers who believe in the big bang, until now that is nearly universal. The spectrum is now well enough known, as the Nobel announcement pointed out, that observers can begin to use it in attempts to measure motion against an absolute universal standard. Such experiments have just begun, and the data and their interpretation (SN: 8/26/78, p. 142) are still highly quizzical, but they may have revolutionary importance for the future of physics.

Kapitsa, who is one of the last living links to the golden age in which the foundations of modern physics were laid, was born in Kronstadt, near St. Petersburg, in 1894. He spent the 1920s and half the 1930s working in Cambridge under Sir Ernest Rutherford. There he discovered superfluidity in liquid helium and a number of magnetic effects as well as working out the principle of his helium cooling apparatus.

He returned to the Soviet Union in 1934 for a visit and was trapped by the confiscation of his passport. Stalin forced him to accept the directorship of the S.I. Vavilov Institute for Physical Problems. To continue his work, Kapitsa needed equipment not available in Russia, and through Rutherford's influence the contents of the Mond Laboratory in Cambridge (which had been set up for Kapitsa) were shipped to Moscow so he could work. He managed thereafter to continue working, though subsequent difficulties included seven years of house arrest for refusing to work on nuclear weapons and a severe automobile accident that nearly killed him. He managed, nevertheless, to maintain his reputation as one of the world's foremost physicists, as well as the respect and affection of his colleagues in other countries. □

Medicine: Enzyme scientists get prize



Susie Fitzhugh

Wide World Photos

Nathans, Smith (top) and Arber: Discoverers of enzymes that opened the recombinant DNA field.

The 1978 Nobel Prize in Medicine has been awarded to two American scientists and a Swiss scientist for their work on restriction enzymes — enzymes that chop DNA molecules at specific sites. This work has helped make the exciting (and controversial) field of recombinant DNA possible and has enormous potential for furthering the understanding of healthy and diseased human genes and of cancer virus genes. The recipients are Werner A. Arber of the Basel University Microbiological Center in Basel, Switzerland, and Hamilton O. Smith and Daniel Nathans of Johns Hopkins University Medical School in Baltimore.

Arber has been awarded a Nobel Prize for his pioneering work in the late 1950s and early 1960s on restriction enzymes. He is considered the discoverer of this class of enzymes. Smith has been granted a Nobel for the next major advance in this area — in 1969. While studying the ability of bacterial cells to take up "naked" DNA from the surrounding culture medium, Smith noticed that the cells he was working with produced a substance that cut the DNA at specific sites. It was a restriction enzyme. Smith wrote Nathans, who was then doing research in Israel, about his discovery. Nathans's interest was sparked, and he suggested that restriction enzymes might be used as tools for cutting up DNA molecules and hence for learning all sorts of things about these molecules. In 1970 Nathans started using restriction enzymes to chop up cancer virus DNA molecules and to learn more about the DNA molecules' ability to cause cancer. For this work he has been awarded a Nobel.

Arber, Smith and Nathans, however, are sharing the Nobel Prize in Medicine not only for their specific restriction enzyme contributions, but also for the impact that their discoveries are having on the entire field of medical research. In other words, not only Nathans but numerous other investigators are now using restriction enzymes to map the genes of cancer viruses, to identify the genes responsible for the viruses' cancer-causing abilities and to investigate how these genes and the proteins they code for change normal cells into cancer cells. Restriction enzyme methodology is helping scientists analyze complex DNA molecules from human and other higher organisms — something that was tough if not impossible to do before — and thus providing valuable insights into healthy and diseased human genes. Restriction enzymes are allowing researchers to study the way that proteins recognize and interact with specific base sequences in DNA interactions that are important in gene regulation. And, most crucially, restriction enzymes have helped open up the field of recombinant DNA research by making it possible to snip a gene that codes for a particular protein out of a DNA molecule, to insert the gene into a plasmid, to place the plasmid in a bacterium, and to have the plasmid produce the protein coded for by the gene within the bacterium (SN: 3/8/75, p. 148).

Ironically, Nathans was one of the scientists who in 1974 urged that recombinant DNA researchers move with great caution. Arber, however, took the opposite stance. "You cannot slow down research," he insisted (SN: 11/2/74, p. 277). □

Economics: Decision-making behavior

Nearly 30 years ago, Herbert A. Simon used a little psychology to challenge traditional theories about how organizations and individuals behave. Last week, the Carnegie-Mellon professor, now studying human problem solving and artificial intelligence, was awarded the Nobel Prize in Economics for his novel ideas.

According to more conventional theory, businesses, organizations and individuals carefully make decisions to gain the most in long-term profits or satisfaction. Such behavior guarantees the economy will be in the best possible shape.

Simon's theory says such behavior is not possible. Individuals and organizations cannot know what decisions will maximize their profits or satisfaction and can only make the best choice for the immediate circumstances. Simon labeled such behavior "satisficing."

Satisficing is far from economic doctrine, according to Harvard University economist Harvey Leibenstein, but it is "important, innovative work." Simon's greatest influence has been with business schools, Leibenstein said, where his work with computer simulation of decision-making has made major changes. □

Chemistry: Energy for the cell

A cell's activities are powered by the energy released from the breakdown of molecules of adenosine triphosphate (ATP). ATP is manufactured for the cell by the mitochondria in a process called oxidative phosphorylation. In this process, the breakdown of sugars releases energy which then is transferred to ATP.

But *how* is the energy transferred? "A chemist likes to go from A to D via B and C, but in this case B and C, the chemistry of the reaction, are unknown," says University of Pennsylvania's Britton Chance.

Peter Mitchell of Glynn Laboratories, a small private company in Cornwall, England, received the Nobel Prize in Chemistry last week for his theory about B and C. But the recognition is not without controversy.

While other researchers have proposed a more strictly chemical means of trapping energy into ATP, Mitchell's theory, called chemiosmotic coupling, suggests a physical mechanism, which relies on a proton gradient. Some investigators, such as Chance and Patrick Storey of the University of Pennsylvania, postulate that reactions between high-energy chemical intermediates, possibly proteins carrying a high-energy phosphate group, pass the energy to ATP. Mitchell's theory, developed while he was at the University of Edinburgh, proposes that protons are transported across the mitochondrial membrane, creating an ion gradient. The potential energy created by the gradient is then transferred to ATP. Since Mitchell proposed his idea in 1961, the battle lines, though friendly, have been drawn.

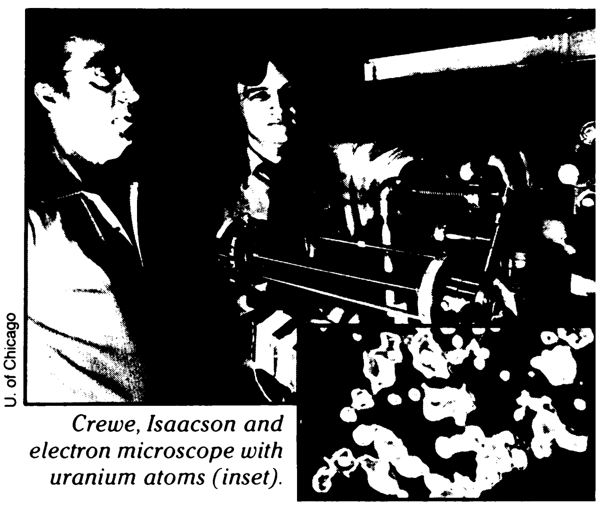
The results of recent experiments using mitochondria in solution with artificially created proton gradients, which showed that ATP formed, add strength to Mitchell's work, says Philip Feigelson of Columbia University. However, research by Chance and others disputes these findings.

Nevertheless, Chance says Mitchell's selection "speaks well for the committee to have the courage to indicate their opinion, in a unique way, that science is controversial. The choices on the roulette wheel are so manifold it is only just that it would stop in favor of someone who is so good a scientist." □

Atoms in nonliving color

The physicist S.A. Goudsmit used to give popular lectures on atomic physics, and a lady — peace, dear feminists, in Holland in those days she *was* a lady — a lady once asked him what color an electron was. Goudsmit being Goudsmit made a wisecrack about electrons being green and protons brown. Well, they might as well be, or any color fancy dictates. Electrons and protons are objects smaller than the wavelengths of visible light. They reflect none and therefore have no color, a concept that the lady, like most people, found difficult to take in.

Atoms are colorless for the same reason. They may emit colored light, but they do not reflect it. So an announcement that Albert V. Crewe and Michael S. Isaacson of the University of Chicago are making color movies of atoms leads one to wonder. It turns out that they are doing exactly what



U. of Chicago

Crewe, Isaacson and electron microscope with uranium atoms (inset).

Goudsmit said, assigning colors at will to atoms of different elements.

Crewe and Isaacson use a transmission electron microscope to visualize atoms. The apparatus fires a beam of electrons at atoms deposited on a thin carbon film. The electrons scatter from the target atoms, and how they scatter can be translated into electrical currents that visualize the atoms. Until now it worked in black and white. Now they have added what is called false color to it: The imaging part of the system can now automatically apply prechosen color to a given image. The atoms of different densities have different reflectivities for electrons. Noting the varying reflectivities the apparatus applies different colors to the images of different atoms and clusters of atoms.

Thus atoms of one element can be distinguished from those of others and followed as they move around the carbon films, form crystals or combine with other elements in compounds. Crewe says a lot of basic physics and chemistry can be followed this way. □