SCIENCE NEWS OF THE WEEK

Nobel Prizes: Research With An Impact

Physics: It's a cold world

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 Leonidovich 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, 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 Herman 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 quizical, 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 Cambridge 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

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 mole-
cules’ 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 in-
vestigators are now using restriction en-
zymes to map the genes of cancer viruses,
to identify the genes responsible for the
viruses’ cancer-causing abilities and to in-
vestigate how these genes and the pro-
teins 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. Re-
striction enzymes are allowing re-
searchers 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 re-
search 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 bac-
terium, 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 scien-
tists who in 1974 urged that recombinant
DNA researchers move with great caution.
Arber, however, took the opposite stance.
“You cannot slow down research,” he in-
sists (SN: 11/2/74, p. 277).

Economics:
Decision-making behavior

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

According to more conventional theory,
businesses 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 organiza-
tions 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 doc-
trine, 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 pro-
cess, the breakdown of sugars releases en-
ergy 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 Univer-
sity of Pennsylvania’s Britton Chance.

Peter Mitchell of Glynn, Laboratories, a
small private company in Cornwall, Eng-
land, received the Nobel Prize in Chemis-
try last week for his theory about B and C.

But the recognition is not without contro-
versy.

While other researchers have proposed
a more strictly chemical means of trap-
ing 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 Uni-
versity 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 Edin-
burgh, proposes that protons are trans-
ported across the mitochondrial mem-
brane, creating an ion gradient. The poten-
tial 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 and artificial solutions 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 opin-
ion, in a unique way, that science is con-
troversial. 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 Holl-
land 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. Elec-
trons and protons are objects smaller than
the wavelengths of visible light. They re-
fect 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 rea-
son. They may emit colored light, but they
do not reflect it. So an announcement that
Albert V. Crewe and Michael S. Isaacs-
on of the University of Chicago are making color
movies of atoms leads one to wonder. It
turns out that they are doing exactly what

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

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

Crewe and Isaacs 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 pre-
chosen color to a given image. The atoms
of different densities have different re-
flectivities for electrons. Noting the varying
reflectivities the apparatus applies differ-
cent colors to the images of different atoms
and clusters of atoms.

Thus atoms of one element can be dis-
tinguished from those of others and fol-
lowed 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 fol-
lowed this way.