AIR FORCE OFFICE of SCIENTIFIC RESEARCH [AFOSR]
Manager of the Basic Research Investment for the Air Force

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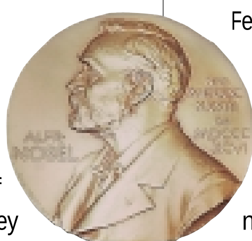
Research HIGHLIGHTS

Dr. Daniel Kahneman — Economic Sciences & Dr. John Fenn — Chemistry

AFOSR-sponsored 2002 Nobel Laureates

Building on its legacy of Nobel Prize-winning scientists, the Air Force Office of Scientific Research (AFOSR) added two additional laureates to its list of distinguished researchers.

Dr. Daniel Kahneman of Princeton University was named as one of the shared winners of the Nobel Prize in economic sciences, and Dr. John Fenn of Virginia Commonwealth University, shared the Nobel Prize in chemistry. The AFOSR has sponsored 48 Nobel Prize researchers since 1955; 45 of whom were funded before they received the prize.

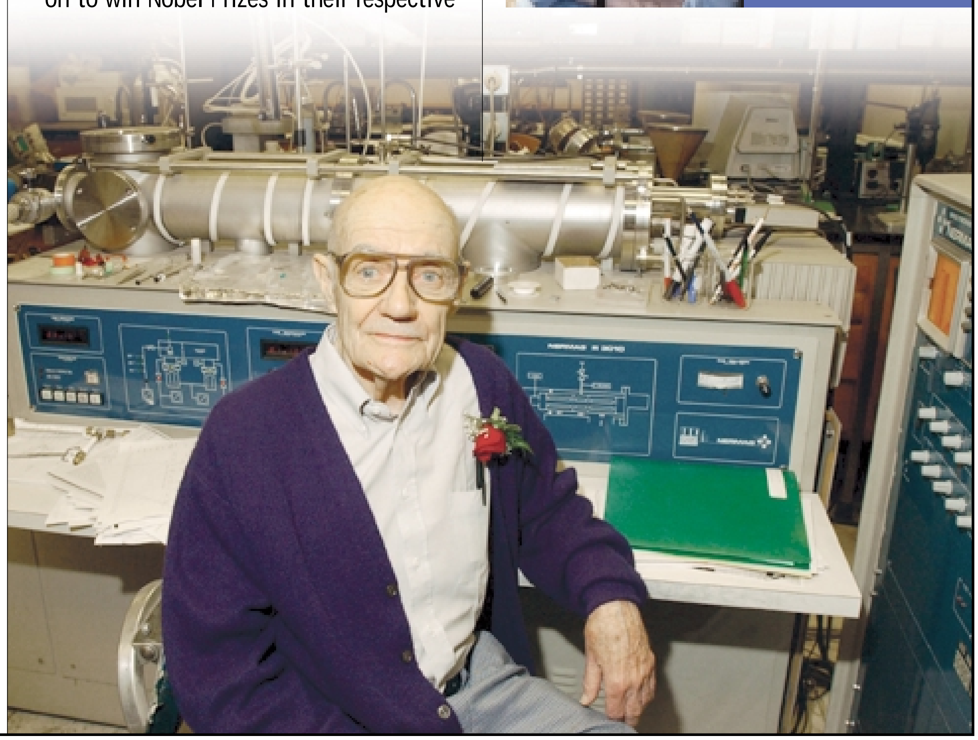


The AFOSR began funding Dr. Kahneman in 1971 when the Life Sciences Directorate supported his ground-breaking work on human perception, attention and decision-making. Along with psychologist Amos Twersky, Kahneman studied the determinants of human choice in risky situations. Kahneman and Twersky showed that a person's decisions depend on how the decision problem is framed or described, and this dependence results in decisions that deviate in predictable ways from the rational choice strategy. This research directly supported one of the long-standing goals of the directorate for advancement in improved human performance.

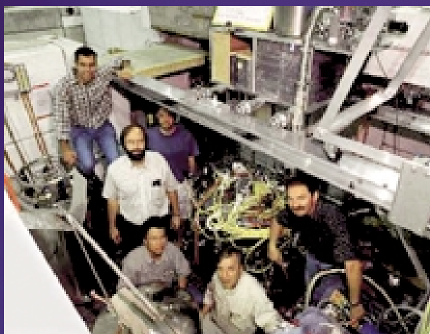
Dr. John Fenn also began his relationship with AFOSR in the early 1970s when it funded his work on molecules seeded in atomic beams. AFOSR continued to support Fenn during the 1980s, while he was at Yale University, with several contracts dealing with molecular collision processes. These studies and other associated systems were then used to study fundamental chemical reaction dynamics, which ultimately resulted in the Nobel Prize for chemistry for Herschbach, Lee and Polanyi, in 1986. The 2002 Nobel Prize in chemistry for Fenn was for his work in electrospray mass spectroscopy that grew out of Fenn's experience and expertise from his earlier molecular research.

For the past 50 years, AFOSR has identified, early-on, a significant number of researchers who have gone on to win Nobel Prizes in their respective fields. With the addition of Drs. Fenn and Kahneman to that list, AFOSR has enhanced a legacy of Nobel Prize-winning research that has resulted in world-class scientific contributions that support the Air Force's mission of supremacy on the battlefield.

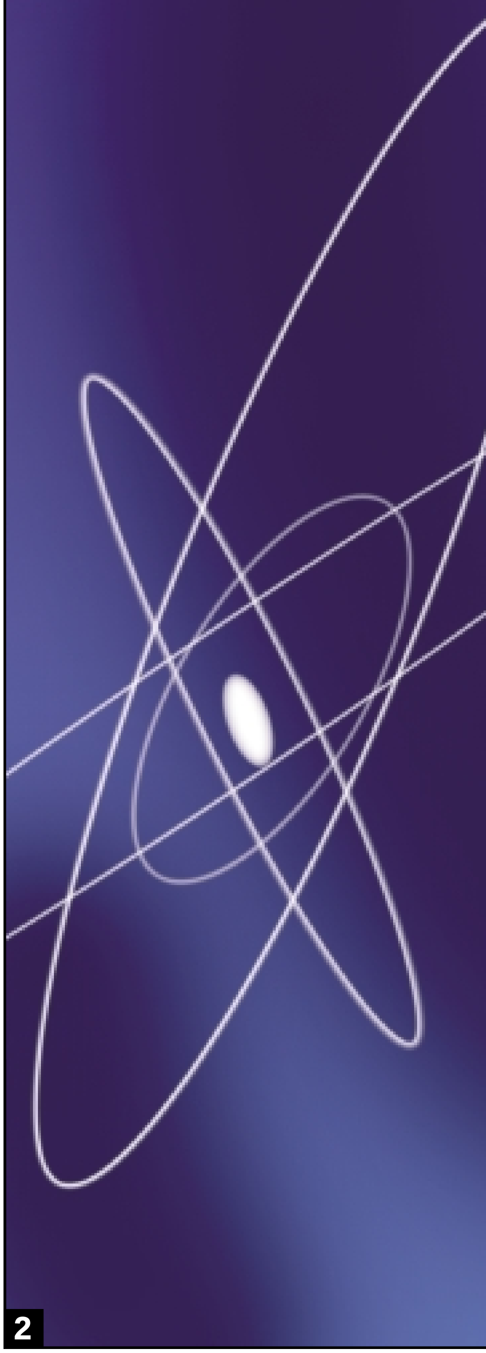
Left: Dr. Daniel Kahneman of Princeton University; and, pictured below: Dr. John Fenn in his Yale University laboratory.



Looking In from the Outside: Antimatter Atoms (ATRAP)



Members of the ATRAP team shown in their laboratory.



Observing the internal structure of antimatter atoms was once thought to be a dream out of reach. Now, thanks to the recent international research efforts led by Dr. Gerald Gabrielse, the dream has been realized.

Gabrielse, a Harvard University professor of physics, has been working with scientists from Germany, England and the United States. Since 1988, the Air Force Office of Scientific Research's Physics and Electronics Directorate has been a prominent sponsor of Dr. Gabrielse's efforts, called the ATRAP Collaboration, at the European Laboratory for Particle Physics (CERN), in Geneva, Switzerland.

"Without AFOSR's support for our program, CERN's AD (antiproton decelerator) storage ring would not have been built," Gabrielse insisted, "and cold antihydrogen would not have been observed."

The ATRAP team's historic achievement in directly observing atoms made entirely of antimatter — in this case, antihydrogen atoms — was invigorated by other discoveries along the way.

Anti-hydrogen is an atom composed of two antimatter particles, an antiproton and a positron, compared to a normal hydrogen atom composed of a proton and an electron. The antiparticles have the same mass as their normal counterparts, but they carry the opposite charge. Current theories predict that antihydrogen and hydrogen should have the same properties, including their internal structure. The antihydrogen atoms are created by colliding antiprotons with cold positrons. The ATRAP team uses antiprotons from CERN's Antiproton Decelerator, and positrons from a radioactive source. The antiprotons are dramatically slowed, cooled, and accumulated. Then the positrons are slowed, cooled and accumulated using techniques developed by ATRAP members. The antihydrogen forms in a nested Penning trap, a device developed by ATRAP scientists, to allow the gentle collisions of antiprotons and positrons needed to form cold antihydrogen. In essence, the ATRAP team produces an antiatom, moves it to another location, and then deconstructs the antiatom.

Dr. Gerald Gabrielse

Maj. Jay Lowell, Ph.D., and the AFOSR program manager, said the ATRAP collaboration has developed a novel field-ionization technique that permits direct observation of the antihydrogen atoms with no residual background signal. ATRAP, he noted, is now able to detect more antihydrogen atoms in an hour than the sum of all antimatter atoms ever reported.

Gabrielse, ATRAP spokesperson, noted that the ultimate goal will be to trap neutral cold antihydrogen atoms and to study their spectra with the same precision they are able to with plain hydrogen atoms. One could then tell whether the laws of physics apply the same, or differently, to atoms and antiatoms.

"With substantial numbers of antihydrogen atoms there is hope that eventually enough atoms will be created to allow lasers to probe for any tiny differences between antihydrogen and hydrogen atoms," Gabrielse explained. "Such measurements would test fundamental theories of physics, and might even provide some information about the mystery of why our universe is made of matter rather than antimatter."

Antihydrogen — and antimatter in general — has many potential benefits to the military and defense of our nation. It is a potential candidate for extremely high energy density applications. These include ultra-lightweight satellite and UAV power supplies and high specific impulse engines, and missile defense interceptors.

Maj. Jay Lowell, AFOSR/NE
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HYPERSONIC SUCCESS:

“Scramjet” Achieves Velocity of 7.6 Times the Speed of Sound

An aerospace milestone was achieved thanks to an Air Force Office of Scientific Research-funded project, when a 10-minute test flight above the Australian Outback proved the concept of supersonic ignition in the atmosphere. The successful test of an experimental hypersonic “scramjet” engine achieved a speed of 7.6 times the speed of sound.

Principal investigator and project leader Dr. Allan Paul, who heads the University of Queensland “Hyshot” program, was pleased with the results.

“Our honest understanding from preliminary data is that the experiment worked... we do believe we have achieved supersonic flight for the first time utilizing scramjet technology,” Paul stated.

Over two years ago, the Air Force Research Laboratory’s Propulsion Directorate’s Chief Scientist recommended funding of the Hyshot program to a program manager with the Asian Office of Aerospace Research and Development (AOARD). The initiated funding was dedicated to the Hyshot program in 2000.

“Hyshot was funded under the AOARD Asian Initiative Program. It was a very low budget operation,” Lt. Col. Mark Nowack, an AOARD program manager, noted. “The money received was quite important to getting the program going, and it gave us access to the data collected by Hyshot.”

The July 30 test was not the first time that scramjet technology was put to the operational test. In 2001, the National Aeronautics and Space Agency (NASA) tested a multimillion dollar unmanned scramjet prototype — the X-43A — that failed. Hyshot had its share of failure as well, when a rocket used to launch the engine spun out of control in October 2001.

According to the Hyshot project proposal, the scramjet engine is a supersonic version of a ramjet, which itself is an aircraft engine that uses compressed atmospheric oxygen, along with ignited fuel, to achieve faster-than-sound flight. Scramjets, first proposed in the 1950s, require few parts and negate the need for onboard oxygen.

One drawback of the scramjet engine process is that it does not efficiently begin until the engine’s speed hits Mach 5, necessitating the need for an assist from a conventional rocket. Secured within the nose of a rocket and blasted into a near vertical 190-mile high trajectory, the Hyshot experiment was performed as the vehicle fell back to earth. At 22 miles above the earth, the scramjet engine engaged and reached a speed of Mach 7.6.

This speed is noteworthy when one realizes that, if the technology were applied to commercial aircraft, flight times would be reduced by up to 90 percent. If applied to space launches, this technology could drastically reduce the weight and cost of launches, as liquid oxygen would not be needed to ensure combustion.

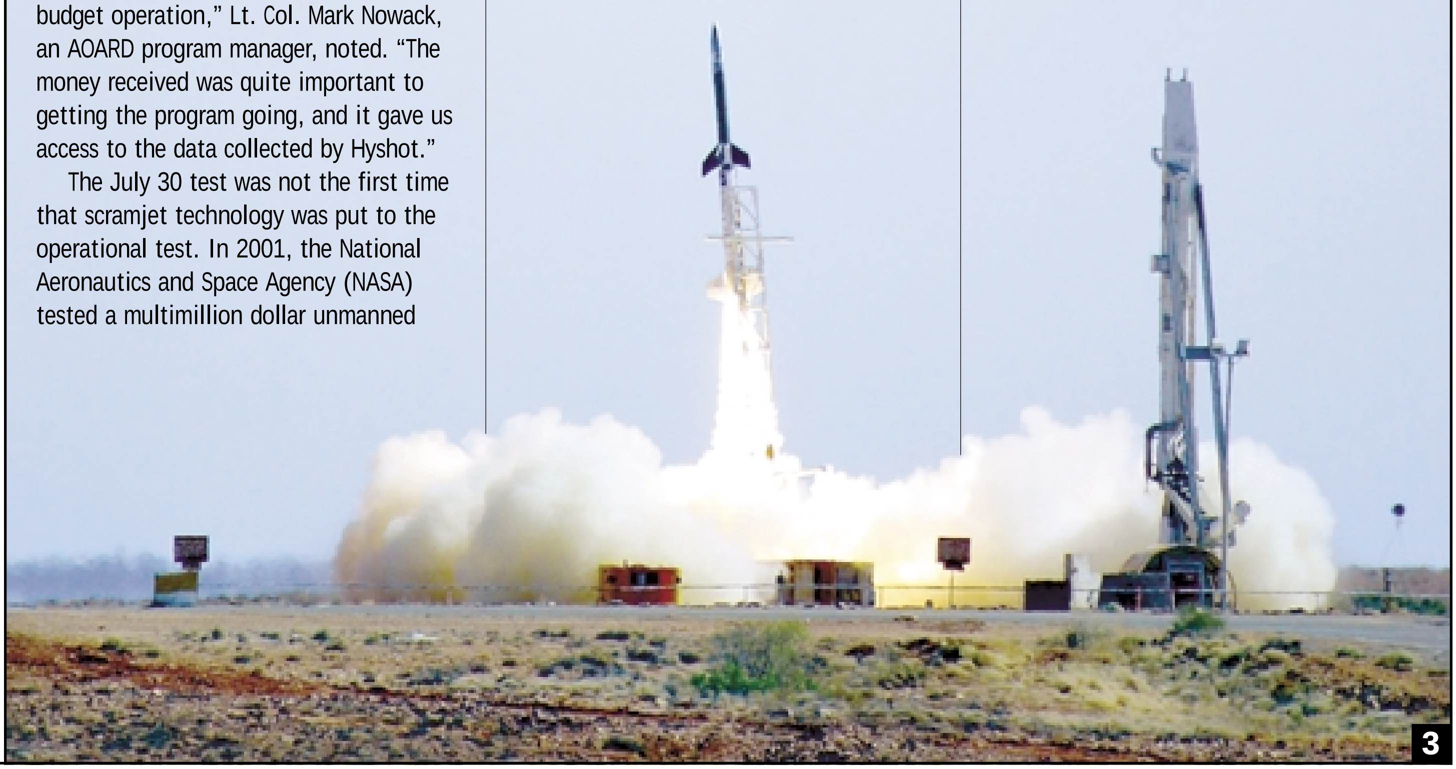
Although scramjet technology is still in its infancy, the AFOSR-supported Hyshot program has demonstrated that the technology works and there is significant promise for future applications.

This program is funded by AFOSR’s Asian Office of Aerospace Research and Development.

Lt. Col. Mark Nowack, AFOSR/AOARD
DSN 315-229-3516

ABOVE: Team Hyshot takes time out to celebrate their successful hypersonic test.

BELOW: The Hyshot program in actual testing.



AWARDS:


Dr. Emil Wolf

Dr. Emil Wolf was presented the 2002 Esther Hoffman Beller Award recently for his numerous outstanding contributions as an educator and the influence his books have had on optical scientists and engineers for more than 40 years. The Optical Society of America sponsors the award.

Dr. Wolf, who has been funded by the Air Force Office of Scientific Research (AFOSR) for nearly 10 years, is the Wilson Professor of Optical Physics at the University of Rochester, N.Y., as well as Provost's distinguished research professor at the University of Central Florida. He is best known for his seminal text, co-authored with Nobel Laureate Max Born, *Principles of Optics.*

Wolf's current research deals with a subclass of lasers whose beams would be less disturbed by passage through turbulent atmospheres. His efforts could result in a new field of laser communication.

Wolf is funded by the Mathematics and Space Sciences Directorate of the AFOSR.


Capt. (Dr.) Dwight Holland

Capt. (Dr.) Dwight Holland lectured about aerospace, engineering and medical aviation issues at the Annual Potocnik and Rusjan Memorial Conference in Ljubljana, Slovenia.

Holland, the only U.S. military officer in attendance, gave three speeches and co-chaired three sessions. While in Slovenia, he was invited by the Slovenian military to give a special lecture at the 15th Brigade Headquarters on leadership. Senior officials from Yugoslavia, Croatia, Slovenia, Montenegro, Austria, Germany, England and Hungary were in attendance.

Research Highlights

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Research Highlights is published every two months by the Air Force Office of Scientific Research. This newsletter provides brief descriptions of AFOSR basic research activities including topics such as research accomplishments, examples of technology transitions and technology transfer, notable peer recognition awards and honors, and other research program achievements. The purpose is to provide Air Force, DoD, government, industry and university communities with brief accounts to illustrate AFOSR support of the Air Force mission. *Research Highlights* is available on-line at:

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CORRECTION

In the July/August 2002 issue of *Research Highlights,* Dr. David McLaughlin's research is funded by AFOSR's Mathematics and Space Sciences directorate, managed by Dr. Arje Nachman, not by the Aerospace and Materials Sciences directorate.

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