Electrons display their antisocial nature

Soon after the birth of quantum mechanics early in this century, physicists theorized that force-carrying particles, known as bosons, tend to bunch together. By contrast, the elementary particles of matter, called fermions, demand a little elbowroom from their peers.

In a landmark 1950s experiment, researchers directly observed the predicted preference for bunching among photons—the bosons of electromagnetic radiation—and created a new research field. Called quantum optics, it eventually led to practical benefits such as the laser.

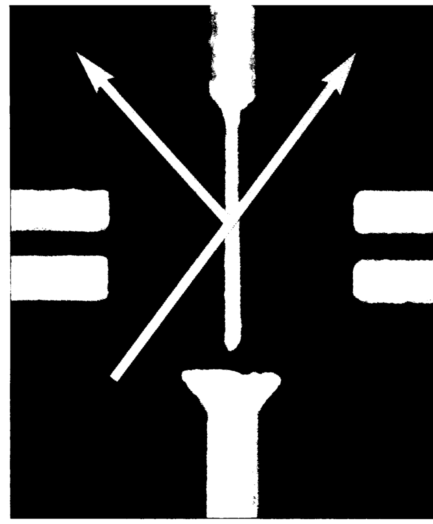
In the April 9 SCIENCE, two independent research groups report that they have finally performed a comparable experiment for fermions. Their results demonstrate the complementary, standoffish nature of electrons, one of the lighter members of the fermion clan, which also includes protons and neutrons.

In doing so, the investigators have confirmed the validity of the Pauli exclusion principle, part of the bedrock of quantum mechanics. This dictum states that no two identical fermions can occupy the same quantum state, such as a single atomic-energy level.

Although physicists commonly invoke the exclusion principle, "you have to measure [its effects] before people really believe it," says Stefan Oberholzer of the University of Basel in Switzerland, where he and his colleagues conducted one of the confirming tests. William D. Oliver and other researchers at Stanford University carried out an analogous experiment.

The new results "will certainly be the stuff of future textbook discussions," comments Marlan O. Scully of Texas A&M University in College Station. Oberholzer notes that until recently scientists could not make dense enough fermion streams to explore the particles' chumminess.

In the new studies, both teams used electrons chilled to ultralow temperatures and confined to an extraordinarily thin layer between semiconductors. The scientists forced the particles into a narrow region blocked by an electrode's voltage so that only half of the electrons, on average, had enough energy to pop through. The others bounced off and exited via a different path.


Y. Yamamoto/ERATO Quantum Fluctuation Project, Stanford

A 40-nanometer-wide electrode shaft splits an electron stream (blue) passing beneath it.

The scientists measured currents from each arm of these beam splitters. As the currents fluctuated, the researchers consistently found that an increase in one arm was offset by a decrease in the other—the sign of fermionic, one-at-a-time, passage through the beam-splitter.

The experimental techniques may also help scientists probe the nature of mysterious quasiparticles, which can mix fermion and boson characteristics (SN: 10/17/98, p. 247), and test properties of very small electronic devices, the researchers say.

—*P. Weiss*

Social fears may raise alcoholism risk

Much research has noted that outgoing children who impulsively misbehave, bully others, and get into numerous fights have more than their share of alcohol problems as young adults. A new study suggests that kids in families with widespread alcoholism may tend to find themselves on the other side of the temperamental coin—withdrawing and clamming up when confronted with unfamiliar people and situations. Such children may also gravitate toward alcoholism, the researchers suggest.

"Children from alcoholic families may be at greater risk for displaying a behaviorally inhibited temperament," says a team led by psychologist Shirley Y. Hill of the University of Pittsburgh Medical Center. "While the childhood risks associated with [poorly controlled behavior] are well known and more prominent among children from alcoholic families, the risks associated with extreme inhibition are less well studied."

Hill and her coworkers examined 36 white children, 4 to 6 year olds living in middle-class households. Half the children came from families in which about one-quarter of the members, from the past several generations, had suffered from alcohol dependency with no other psychiatric disorders. The remaining youngsters came from families with few or no cases of alcoholism or any other mental ailments.

Accompanied by a parent, each child attended from one to three sessions in a playroom. Experimenters videotaped and rated children's behavior as they had opportunities to play with an unfamiliar child of the same age and sex.

Children from the families with high rates of alcoholism displayed far more inhibition during play sessions than their counterparts did, reports Hill's team in the April JOURNAL OF THE AMERICAN ACADEMY OF CHILD AND ADOLESCENT PSYCHIATRY. Inhibition appeared mainly as a pronounced tendency to stare at the other child while refusing to play with or to speak to him or her.

Some children from high-alcoholism families may experience sensitized biological reactions to stress that foster inhibition, the researchers theorize, and as adolescents, may use alcohol to quell anxiety. Other studies find that kids in families with pervasive alcohol problems often develop alcoholism.

Further studies should explore possible biological influences on these unusually inhibited kids as well as the psychological effects of living with an alcoholic parent, the researchers add.

Childhood inhibition merits "attention and concern" as an influence on alcoholism, remarks psychiatric epidemiologist Naimah Z. Weinberg of the National Institute on Drug Abuse in Rockville, Md., in a published comment in the same journal. However, evidence for this link remains sparse, Weinberg says.

Subtle language disorders may contribute to the inhibition of some children from families with many alcoholic members, she proposes. —*B. Bower*

The green genes don't get out much

Could genes from a genetically modified crop escape and create a superweed that could take over the world, as some people fear? One preventive measure might be to confine any transplanted genes to the cell's photosynthetic structures, or chloroplasts.

Escape of such genes would be "extremely rare and scattered," predict Susan E. Scott and Mike J. Wilkinson of the University of Reading in England, who for 3 years have tracked chloroplast DNA in fields of unmodified oilseed rape. They report their results in the April Nature Biotechnology.

The work grows out of proposals that tinkering with the DNA in chloroplasts poses less risk of runaway genes than the more common strategy of modifying DNA residing in the cell's nucleus. Henry Daniell of the University of Central Florida in Orlando, a pioneer of gene insertion in tobacco chloroplasts, last year advocated that approach. In many plants, he argues, chloroplasts are inherited maternally and thus don't show up in hard-to-control, wind-blown, insect-riding pollen.

Wilkinson and Scott evaluated chloroplast-gene escape routes in *Brassica*