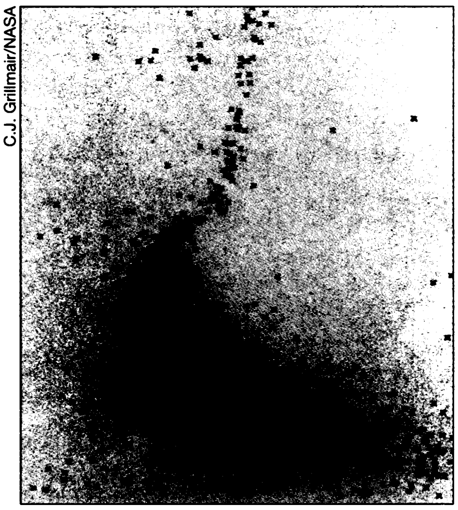
argue that galaxies with too few stars to be seen at all have even higher densities of dark matter and may be the most populous. It's even possible—but by no means certain—that these unseen galaxies, estimated to be only one ten-thousandth as massive as the Milky Way, could account for a significant fraction of the mass of the universe, Kormendy suggests.

He explains how dark matter became such a prominent component of the small galaxies. When the first massive stars in these galaxies died, some exploded as supernovas. Because the dwarfs have relatively little mass, the explosions easily drove gas—the raw material of stars—out of the galaxies. The dark matter stayed put, however, because it reacts only to gravity. The galaxies, believed to be the first to form, became pristine relics of the dark-matter content of the early cosmos, Kormendy says.

Wyse speculates that a dwarf galaxy recently discovered near the Milky Way (SN: 4/9/94, p. 228) has maintained its shape despite the tug of our galaxy because it possesses a dense core of dark material. The interaction between this seemingly gossamer galaxy and our own might explain the warp of the outer edge of the Milky Way, she adds. —*R. Cowen*



C.J. Grillmair/NASA

X's show stars in the Draco dwarf spheroidal galaxy.

Puddle that spins together stays together

In conventional electronics, typified by semiconductor devices, charge rules. Circuits sense, direct, store, and process electrons as units of electric charge. In the infant field of spin electronics, or "spintronics," however, a different electron property, known as spin, serves as the coin of the realm.

Researchers have harnessed spin in metals already—for instance, in the circuits used in computers' hard magnetic disk drives. For semiconductors, however, scientists are still exploring rudimentary manipulations of electron spin, which physicists describe as analogous to the rotation of a particle about an axis. Development of a spin-based semiconductor could hasten the advent of extraordinarily compact, speedy computer memory and other circuits. The devices would combine advantages of spintronics with the low-cost mass production typical of semiconductor circuits.

In the Jan. 14 NATURE, James M. Kikkawa and David D. Awschalom of the University of California, Santa Barbara report experimental evidence hinting at practical control of electron spin in semiconductors.

The researchers used electric fields to propel "puddles" of electrons within ultracold strips of gallium arsenide. First, they used a laser pulse to induce the millions of electrons in the sample to orient their spins alike. The experimenters found that they could move this puddle more than 100 micrometers—a distance hundreds of times greater than the spacing between components in an integrated circuit—before the spin coordination broke down.

"This experiment shows that the spin puddles can move without significantly increasing the loss of quantum information to outside of the electronic system," Kikkawa says.

One potential use of spintronics is in quantum computers (SN: 9/12/98, p. 165). Although extremely rudimentary today, such devices may eventually outdo conventional computers by exploiting the quantum-mechanical nature of matter.

The new result suggests that scientists may yet find a way to shuttle fragile data around inside a quantum computer without loss or damage, says Bruce E. Kane of the University of New South Wales in Sydney, Australia. "Maybe the physics is going to allow us to do that. It's a very interesting result."

The physics itself may have to stretch. Theories of electron spin flow seem unable to fully explain the surprising distance the puddles go. "The data suggest there's new semiconductor physics here that people may have missed," Awschalom says.

The fragility of quantum data arises because the spin orientation of a quantum-mechanical entity, such as an electron, can be represented as a complex set of probabilities of different spin directions. This complexity collapses to a single state—with loss of valuable data—if the electron's spin is measured or in other ways interacts with the environment.

The authors stress that the experiment stopped short of proving that the spin characteristics of the individual puddle electrons remained fully intact. Although not affected by outside forces, the electrons themselves may have interacted to cause collapses. —*P. Weiss*

New polymer soaks up more cholesterol

A plastic may one day help people control their cholesterol by preventing the greasy, artery-clogging stuff from being absorbed by the gut. Scientists in Germany report that they have designed a polymer that soaks up cholesterol in simulated intestinal fluid.

Some commonly prescribed drugs, such as cholestyramine, use a related strategy. In the intestines, they bind to, or adsorb, bile acids, which are derived from cholesterol. The bile acids are then eliminated in feces and are replaced via a process that removes cholesterol from the bloodstream.

The new polymer, however, "instead of adsorbing bile acids, would adsorb cholesterol directly," says Börje Sellergren of Johannes Gutenberg University in Mainz. He and his colleagues at Gutenberg and the University Hospital Grosshadern in Munich report their findings in the Dec. 21, 1998 CHEMISTRY OF MATERIALS.

The researchers made the polymer with a technique known as molecular imprinting, which allowed them to pack each particle with binding sites customized for cholesterol (SN: 2/27/93, p. 132). To do this, they added cholesterol to a solution containing the polymer's building blocks, which then solidified around the cholesterol molecules. "By removing cholesterol," Sellergren says, "we have a material that contains pockets that can take up cholesterol again."

Sellergren and his coworkers measured how much cholesterol the polymer adsorbs in a solution designed to mimic intestinal fluid. They found that 1 gram of the material took up about 17 milligrams of cholesterol—30 percent more than the same polymer prepared without molecular imprinting. To make the polymer practical, they would like to double or triple that capacity, Sellergren says.

He would also like to enhance the selectivity of the material, since it also binds to steroid compounds that are found in plants. "If you have a lot of those present in the intestine, they might occupy the binding sites on the polymer," he says. In such a case, for instance after eating vegetables, the material would adsorb less cholesterol.

The building blocks used by the German team are cheap, which is an advantage for a potential drug, says Michael J. Whitcombe, a chemist at the Institute of Food Research in Reading, England. He and his group synthesized an imprinted polymer several years ago that binds to cholesterol in organic solvents that could be used in food processing. The method used by Sellergren and his colleagues is more practical in water-based solutions, such as intestinal fluid, Whitcombe says. —*C. Wu*