ASTRONOMY

No Hidden Starstuff in Nearby Universe

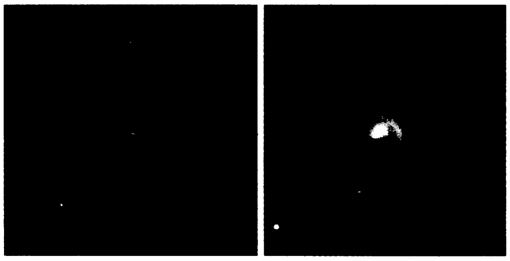
Many astronomers have suspected that there is more to the nearby universe than meets the eye. But, according to a team of Dutch and U.S. astronomers, perhaps it's not very much more.

The team has been analyzing a radio survey of a large swathe of the nearby universe, carried out with the world's largest single-dish radio telescope, to make a comprehensive inventory of neutral hydrogen gas, the principal raw material for stars. Some astronomers had proposed that, besides the hydrogen in the "known" galaxies, large caches of hydrogen—perhaps many times more than in known galaxies—might be hidden in intergalactic clouds or in dim, "low–surface-brightness" galaxies (LSBs). But as the team will report in a November issue of the *Astrophysical Journal*, the extra hydrogen was nowhere to be found. "We're not saying that low–surface-brightness galaxies don't exist," says team member Martin Zwaan of the University of Groningen in the Netherlands. "It's just that they contribute very little to the total mass of neutral hydrogen gas in the local universe."

Although much fainter than normal spiral galaxies, LSBs are not much smaller than our Milky Way—indeed, some are much larger. As a result, the feeble light from their dim stars is spread out over a relatively large area of the night sky, making them notoriously hard to detect using optical telescopes. The first of them was not spotted until 1986, by Gregory Bothun, now at the University of Oregon in Eugene. According to Zwaan, recent deep-optical surveys have turned up many dim LSBs, suggesting that they might be as numerous as normal high–surface-brightness galaxies. If a majority of the LSBs are laden with neutral hydrogen gas, they might represent a major contribution to the universe's hydrogen inventory. Besides implying that the universe has the potential to form many more stars, the extra hydrogen could also make a small, but not insignificant, contribution to "dark matter"—the large quantity of invisible mass that cosmologists believe resides somewhere in the universe.

To find these hypothetical hydrogen reserves, Zwaan and his colleagues Frank Briggs and David Sprayberry (both at Groningen), along with Ertu Sorar of the University of Pittsburgh, analyzed the results of a radio survey of a narrow strip of the sky, carried out a couple of years ago by Sorar with the 300-meter Arecibo radio dish in Puerto Rico. Neutral hydrogen gas emits radio waves at a characteristic frequency, enabling the sensitive Arecibo receiver to detect any significant amounts of hydrogen out to a distance of some 200 million light-years. The researchers then used the Very Large Array of radio telescopes in New Mexico to study in detail any reserves of hydrogen spotted at Arecibo. The radio sources all turned out to be associated with already-known galaxies.

Bothun is not surprised, saying that his



COURTESY: M. VERHEIJEN

Gloomy galaxy. A low–surface-brightness galaxy *(left)* compared to a normal one.

belief "has always been that most LSBs have no gas at the present epoch." In the distant, early universe, he explains, the faint galaxies that are probably the precursors of today's LSBs are blue in color, indicating that ample hydrogen reserves were forming hot young stars. But closer to the present, such galaxies appear dimmer and redder, suggesting that they have used up their star-forming gas.

Nor did the survey bear out the belief of some astronomers that large, starless clouds of protogalactic mist have survived into the present universe. "Some people have suggested that many intergalactic [neutral hydrogen] clouds would be found," says Rachel Webster of the University of Melbourne, who is currently participating in a large radio survey of the southern sky with the Parkes Radio Telescope in Australia. The Parkes survey, to be completed in 2001, is less sensitive than Sorar's effort at Arecibo, but it covers a much larger area. "I can't exclude the possibility that they will find some intergalactic hydrogen clouds," says Zwaan. However, Webster says that "the numbers must be small if there are any at all. I have adjusted my expectations accordingly."

–Govert Schilling

Govert Schilling is a writer in Utrecht, the Netherlands.

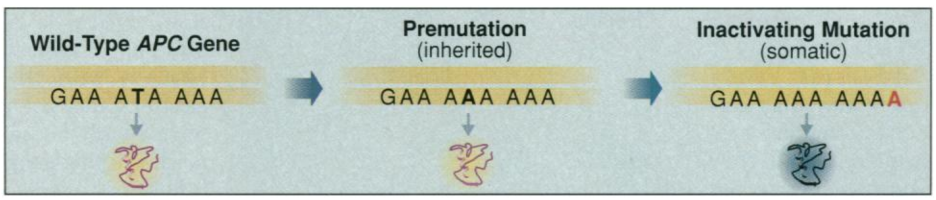
CANCER GENETICS

New Kind of Cancer Mutation Found

Researchers studying the genes for colon cancer may have accounted for part of a puzzling shortfall. Somewhere between 15% and 50% of colon cancers and the benign polyps that are often their precursors seem to have some hereditary component. Yet the colon cancer genes found so far have been linked to less than 5% of the total cases. Now, through a meeting of chance and clever detective work, Bert Vogelstein and Kenneth Kinzler at Johns Hopkins University School of Medicine and their colleagues have tracked down a genetic culprit that might explain at least part of the discrepancy—and it works in a way never seen before for any cancer-causing mutation.

In the September issue of *Nature Genetics*, the researchers report that they have found an inherited mutation in a gene called *APC*, which normally holds cell growth in check and can cause colon cancers when mutated. But unlike previously identified mutations, the new one does not directly affect the function of the gene. Rather, the mutation may render the surrounding DNA susceptible to mistakes by the enzyme that copies genes when cells replicate, thereby creating new mutations that do lead to loss of gene function. "This could be a landmark study of a novel mechanism," says molecular biologist Jeffrey Trent of the National Human Genome Research Institute (NHGRI) in Bethesda, Maryland.

Indeed, Trent and others say that the same mechanism might be at work in genes linked to other cancers, such as breast and prostate cancer, which have been found to contain similar "harmless" variations. "Clearly, we should look at other tumor-suppressor genes for other such sequences that people might have walked right past," says NHGRI director Francis Collins.



Paving the way. A single base change—adenine (A) replaces thymine (T)—leads to further mutations that inactivate the *APC* gene and increase the risk of colon cancer.

The discovery may also have immediate applications for early detection of colon cancers, especially in Ashkenazi Jews. The Vogelstein-Kinzler team found that 6% of Ashkenazim carry the mutation, making it the most common cancer-predisposing mutation in a defined ethnic group. Screening for the novel mutation in that population would thus be a good way of identifying people who have a high risk of colon cancer, so that they could be watched carefully and treated early.

Identification of the new *APC* mutation was serendipitous, the result of a social visitor to Johns Hopkins, who mentioned that he had had several colorectal polyps and a slight family history of colon cancer. Vogelstein, whose lab had already uncovered a fistful of genes involved in the disease, offered to test the 39-year-old male for mutations.

Vogelstein's group did find a change in the *APC* gene. But at first glance it appeared to be innocuous—a simple switch from a thymine (T) to an adenine (A) at position 1307 that didn't look like it would disrupt the gene's ability to function. Such gene changes, called polymorphisms, are common.

What raised the researchers' suspicions was a strange phenomenon that occurred when they tested the patient's *APC* gene in a routine assay that allows it to make its protein product. They found that the protein began to pick up extra mutations in and around the region that contains the T-to-A switch. That apparently happened, Kinzler says, because the mutation creates a stretch of eight consecutive adenines, which are often misread by polymerase enzymes that transcribe genes into messenger RNAs (mRNAs)—the first step toward making proteins. "The DNA strands can get a little one-to-two base-pair bubble," says Kinzler. "That allows the polymerase to put in an extra base without realizing there is a mistake." Such "frameshift" mutations can totally garble the rest of the message, creating shortened forms of the protein or rendering it useless.

If just mRNA synthesis were affected, the situation might not be harmful, because it wouldn't lead to permanent loss of all functional APC protein. But the same kind of error can also occur in the DNA itself during replication. The Johns Hopkins team found that this may in fact be happening in the colon cells of some patients who have an increased risk of colon cancer but don't carry the original *APC* mutations. When the investigators looked at the *APC* gene in tumor and blood samples of these patients, they found that all the tumors that carried the second type of inactivating mutation also had the T-to-A change. Blood cells from the same patients only had the T-to-A switch, however. These results suggest that the patients inherited the base change and developed the other mutations later, but only in the colon cells that became cancerous.

The work so far has shown that the T-to-A mutation is present in about 6% of Ashkenazi Jews and in 28% of Ashkenazim with familial colon cancer. The Hopkins team and others are now expanding those studies and looking at how common the gene is in the general population. Another big question is whether other tumor-suppressor genes are prone to similar problems. "Everyone has seen polymorphisms in cancer genes," says Vogelstein. "And all of us have assumed they are just harmless variants. This study suggests that those kinds of mutations may not really be harmless, but rather a kind of wolf in sheep's clothing."

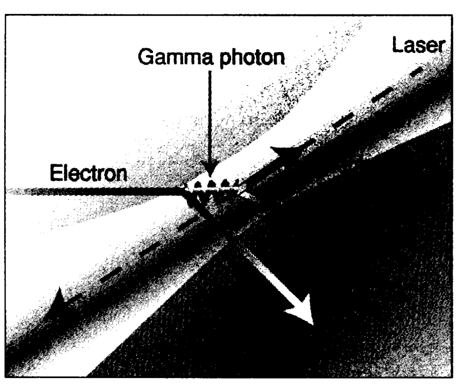
–Trisha Gura

Trisha Gura is a writer in Cleveland, Ohio.

PHYSICS

Conjuring Matter From Light

Turning matter into light, heat, and other forms of energy is nothing new, as nuclear bombs spectacularly demonstrate. Now a team of physicists at the Stanford Linear Accelerator Center (SLAC) has demonstrated the inverse process—what University of Rochester physicist Adrian Melissinos, a spokesperson for the group, calls "the first creation of matter out of light." In the 1 September *Physical Review Letters*, the researchers describe how they collided large crowds of photons together so violently that the interactions spawned particles of matter and antimatter: electrons and positrons (antielectrons).



Flash dance. An electron beam intersects a laser pulse, boosting photons to gamma energies and triggering an interaction that spawns particles.

SOURCE: A. MELISSINOS ILLUSTRATION: D. PUGH

Physicists have long known that this kind of conjuring act is possible, but they have never observed it directly. The experiment is also a proof of principle for a technology, based on intense laser beams boosted to enormous energies with the help of SLAC's electron beam, for exploring a theory known as quantum electrodynamics. QED describes electromagnetic fields, such as those of light, and their interactions with matter, and its predictions are notoriously accurate. But physicists are eager to study it at so-called "critical" electromagnetic fields—fields so strong that their energy can be converted directly into the creation of electrons and positrons.

To create a field as close as possible to critical, the 20-physicist collaboration started with a short-pulse glass laser that packs a half-trillion watts of power into a beam measuring just 6 micrometers across at its narrowest point, resulting in extraordinary intensities. To increase the energy of the photons, the team collided the pulses with SLAC's 30-micrometer-wide pulsed beam of high-energy electrons—a feat that required precise alignment and synchronization. When laser photons collided head-on with the electrons, they got a huge energy boost, much like ping-pong balls hitting a speeding Mack truck, changing them from visible light to very high energy gamma rays. Because of the laser's intensity, these backscattered gamma photons sometimes encountered several incoming laser photons simultaneously; a collision with four of them concentrated enough energy in one place to produce electron-positron pairs.

Melissinos views the result as the first direct demonstration of "sparking the vacuum," a long-predicted phenomenon. In it, the energy of a very strong electromagnetic field promotes some of the fleeting, "virtual" particles that inhabit the vacuum, according to QED, to become pairs of real particles.

Electron-positron pairs are often spawned in accelerator experiments that collide other particles at high energies, and photons produced in the collision are what actually generate the pairs. But at least one of the photons involved is virtual—produced only for a brief moment in the strong electric field near a charged particle. The SLAC experiment marks the first time matter has been created entirely from ordinary photons.

Princeton University physicist Kirk McDonald, another spokesperson for the collaboration, which also includes the University of Tennessee and SLAC, thinks the high-field experiments could shed light on phenomena at the surface of a neutron star, where magnetic fields are very strong, and in other exotic astrophysical settings. On a more practical level, the conversion of light into matter could also give particle physicists a new source of positrons that are exceptionally uniform in energy and momentum.

The result is also the first step toward using powerful lasers and electron beams to test high-field QED predictions, such as what McDonald calls "vacuum optics"—the behavior of light in a strong-field environment. "We're exploring new regimes and trying to map out the basic phenomena," he says. Physicist Tom Erber of the Illinois Institute of Technology looks forward to the results: "Hopefully, this will open the door to future experiments which will approach [more probing] tests of QED."

–David Ehrenstein