A Test to Distinguish HIV-1 from HIV-2

As the number of related human retroviruses increases, the need for a simple test that will accurately distinguish one from another also increases. Erling Norrby of the Karolinska Institute in Stockholm and his colleagues have developed a new type of test that can distinguish between infection by the AIDS virus, which is also known as human immunodeficiency virus–1 (HIV-1), and its relative HIV-2.

Whereas current AIDS tests use whole proteins from HIV-1 to detect antibodies to the virus in infected individuals, the new method, called "site-directed serology," detects the antibodies by means of a short synthetic peptide corresponding to a segment of a viral protein. The peptide segment used, Norrby says, has to be a good elicitor of antibody production, and also conserved among the many variants of HIV-1 or HIV-2. A peptide that fits this description and the one chosen by Norrby and his colleagues, who include Richard Lerner of the Research Institute of Scripps Clinic in La Jolla, California, is from the outer segment of the viral transmembrane protein.

The researchers synthesized the peptide, which contains 22 amino acids, for HIV-1 and they also made the corresponding peptide for HIV-2. When they tested the peptides against 20 serum samples each from healthy individuals and from persons with known HIV-1 or HIV-2 infections, the results, Norrby says, were "beyond expectations." None of the serum samples from healthy individuals reacted with either of the peptides, whereas all 20 of the samples from persons infected with HIV-1 or HIV-2 reacted with the corresponding peptide. Only one sample from each group showed low cross-reactivity with the other peptide.

These new generation tests, which are under development in several laboratories in addition to those of Norrby and Lerner, should have a number of advantages over the original AIDS virus tests, especially in developing countries where medical facilities may be limited. The need for a specific HIV-2 test is greatest in West Africa, where the virus is endemic.

Tests based on site-directed serology are both sensitive and specific because they detect a single antigenic site of a particular virus. Moreover, Norrby says, the materials used are more stable than those in the current tests. But perhaps the greatest advantage of the newer tests is that they can be completed in one step. Current tests require two. With the new methods, Norrby says, "The screening test gives you the final answer." ■ JEAN L. MARX

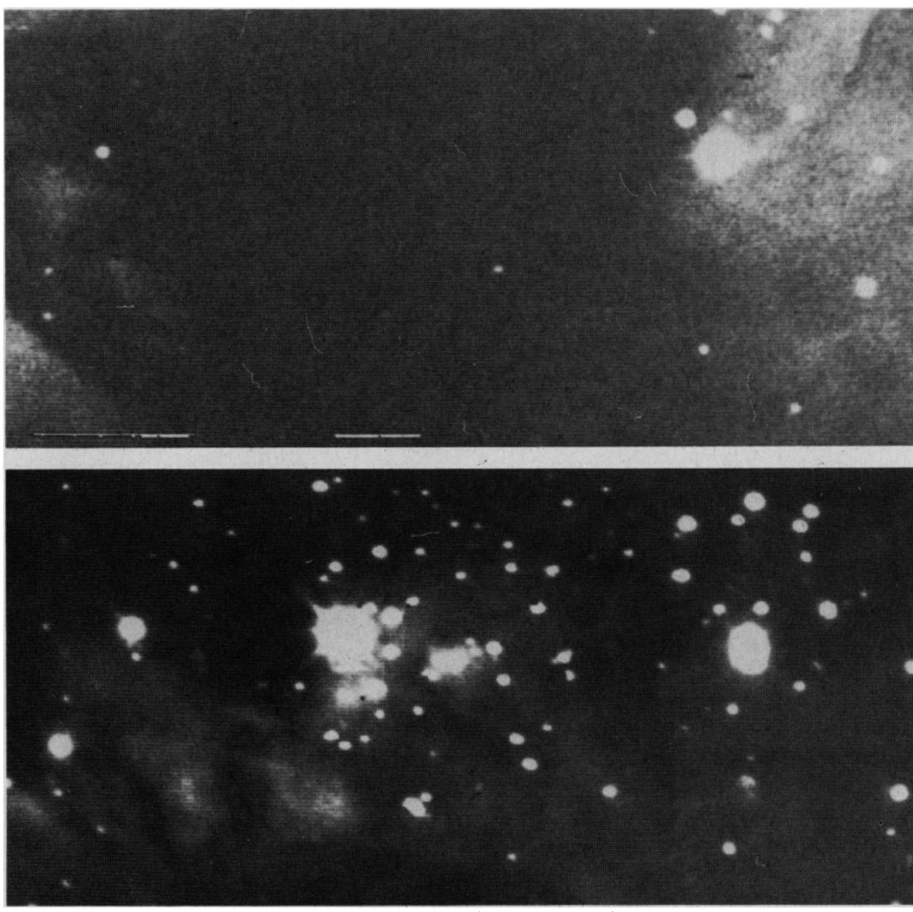
Imagery Comes to Infrared Astronomy

A new semiconductor detector should greatly speed up data taking; the infrared astronomers are understandably excited

A tiny, cryogenically cooled detector derived from military space research is being hailed as a milestone in infrared astronomy comparable to the invention of the photographic plate in optical astronomy. Not only is the device as much as 100 times more sensitive than conventional infrared detectors, but it is also among the first sensors in this wavelength band that can actually form images of the sky instead of just taking data one point at a time. Certainly it is the first to be generally available to the whole astronomical community. Thus, astronomers will no longer have to construct their infrared maps by painstakingly scanning their telescopes back and forth.

"You do what used to be a night's work in a few minutes," says one astronomer at the National Optical Astronomy Observatories (NOAO) in Tucson, where the new sensor is being tested. "It represents a marvelous advance in what we can do," agrees Fredrick Gillett, project scientist on the NOAO infrared team. "It opens up all sorts of applications where before you had to say, 'No, that's just too difficult.' "

At the heart of the new sensor is a 58 by 62 matrix of individual detectors etched on an indium antimonide crystal, which is about the size of a flake of confetti. Each of these individual detectors produces an electronic signal when exposed to photons, with the strength of the signal being almost exact-



National Optical Astronomy Observatories (NOAO)

Stellar nursery. *The nebula NGC 2024, a dense region of interstellar dust and gas, is nearly opaque at visible wavelengths (top). As seen by the new infrared array detector, however, it is swarming with newborn stars (bottom).*

ly proportional to the number of photons. (To minimize thermal background during the actual observations, the detector is first cooled to 40 K with liquid helium.) When an exposure is complete, the signals are then read out through a conventional silicon microchip and fed to a computer, which reconstructs the image.

The new detector is actually quite similar to the charge-coupled device (CCD) detectors that are now widely used in optical astronomy, says Gillett. The major difference is that indium antimonide is sensitive to photons in the near infrared region of the spectrum, between 1 and 5 micrometers in wavelength, whereas the silicon used in conventional CCDs is only sensitive to wavelengths less than about 1 micrometer.

While indium antimonide is not a particularly difficult material to work with, says Gillett, it is not nearly as well understood as the more familiar semiconductors such as silicon or germanium. The basic technology was pioneered by the Santa Barbara Research Center, a subsidiary of the Hughes Aircraft Company, as part of its classified work on detectors for military satellite surveillance. Indeed, it was the Santa Barbara center that first approached NOAO several years ago with the idea of applying the technology to astronomy. The two institutions have worked closely ever since.

"We don't have nearly as much money as the Defense Department has [for state of the art infrared development]," says Gillett. Indeed, he is quick to point out that other astronomical groups are hard at work developing other types of infrared arrays, particularly at the universities of Arizona, Hawaii, and Rochester. "But all of those groups have found one way or another to tap into the aerospace industry," he says. "I don't know of any independent detector array technology going on in universities. . . . The technology is being driven by SDI [the Strategic Defense Initiative] and Defense Department surveillance work."

This relationship does have its disadvantages, he concedes: "I don't think we have good access to the current state of the art. We only hear about technology after it's been around for awhile." On the other hand, he says, for the purposes of routine observation "I don't think we want to be at the cutting edge of technology. There are too many things that can go wrong."

In any case, the Santa Barbara Research Center delivered the first two science-grade arrays to NOAO in March. Both are still undergoing tests, one at the Kitt Peak National Observatory near Tucson, and the other at the Cerro Tololo Interamerican Observatory in Chile. Another pair will be delivered later and installed in infrared spectrometers at each observatory. "We're pushing them into general use as fast as we can," says Gillett. The detectors will be available for routine observing runs starting in early September and should be in nearly constant use for about 2 weeks out of every month thereafter. (Infrared observations are generally scheduled for times when the moon is visible, since moonlight is a negligible problem at those wavelengths.) The observatory is already receiving proposals from astronomers all over the country.

As the image on the previous page suggests, the new detectors should be especially valuable in the study of the galaxy's star-forming regions, where visible light is blocked by thick gas and dust, but where infrared radiation can penetrate quite readily. Another application is planetary science. In visible light, for example, the elusive rings of Uranus are much darker than the planet, which makes them very difficult to study from the ground. In the infrared around a wavelength of 2 micrometers, however, the planet is dark and the rings are bright. Thus, the NOAO team was able to image the rings easily with the new detector during tests this spring. In later tests they hope to image the fragmentary rings of Neptune. Still other applications of the detector include the search for Jupiter-sized planets in other solar systems; the search for "brown dwarfs"—starlike objects that just miss having enough mass to shine by thermonuclear fusion; studies of galaxies at very high red-shift, whose spectral features have been pushed all the way out of the visible band; and investigations of the center of our own Milky Way galaxy, where the ubiquitous interstellar gas and dust seem to be masking a massive black hole.

Meanwhile, the infrared team at NOAO is keeping abreast of the military developments, trying, in Gillett's words, "to perturb the system in the direction of our interests." Those interests are twofold. First, the researchers would like to see improvements in the resolution of the indium antimonide detectors, with smaller individual pixels and with more of them per chip. Second, they would like to see arrays of specially doped silicon detectors that would be sensitive at longer wavelengths, especially in the region of 10 and 20 micrometers, where Earth's atmosphere is relatively transparent. ■

M. MITCHELL WALDROP

A New Route to Oxide Superconductors

Materials scientists at the Massachusetts Institute of Technology (MIT) have come up with a new method of preparing the rare earth–barium–copper–oxygen superconductors that operate above liquid nitrogen temperature. The new approach, or variations of it, may help overcome one of the main problems with the brittle ceramic oxides—the difficulty of forming them into useful shapes, such as magnet coils.

At present, the oxide superconductors are prepared by reacting starting materials to form a compound of the proper composition, grinding the compound into a powder, and sintering the powder to form a comparatively homogenous solid, but one with poor mechanical properties. To make wires, tapes, and other forms, groups at Argonne National Laboratory and AT&T Bell Laboratories in the United States, as well as at some Japanese laboratories, have circumvented the lack of ductility by leaving the sintering step until after the formation of the desired shape. For example, powder superconductor can be loaded into a metal tube, which is then drawn into a fine wire only a few thousands of an inch in diameter and wound into a coil before sintering. Argonne has begun a collaborative program with Brookhaven National Laboratory and the Ames Laboratory to pursue such processes.

At MIT, Gregory Yurek, John VanderSande, Wu-Xian Wang, and David Rudman are taking a different tack, but one with the same general philosophy of avoiding the synthesis of the brittle ceramic until the end. The investigators melt the metallic elements (a rare earth, barium, and copper), which then solidify as a ternary metal alloy. The idea is that the alloy can be readily formed into the desired shape by traditional methods, although this has not yet been demonstrated. One possible method is melt spinning, the rapid solidification of a stream of molten alloy on a spinning metal wheel to make a continuous thin ribbon. After shaping, the highly reactive alloy is heated in an oxygen atmosphere, where it readily converts to the oxide superconductor.

So far, the researchers have shown the idea works with "buttons" of solidified europium–barium–copper alloy, which become superconducting with a transition temperature of 90 K after oxidation. After making wires by this method, VanderSande says the group would like to try for more complex composite structures of metal and superconductor that retain some ductility even after the superconductor is formed. ■

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