agement, amounts to a crash program, a go-ahead was hustled out of NASA headquarters, the sensor was sent back to the manufacturer for modification of the modifications and Goddard engineers scurried to reshuffle the satellite's existing instrument load to accommodate the additional black box. Fortunately, the main structure of AE-E had been designed in response to a 1967 NASA study calling for a flexible framework adaptable to a variety of payloads. When, after two months, the realtered sensor was delivered to Goddard, says project manager David W. Grimes, "it took us only eight hours to do the integration"—an assembly-and-checkout procedure that has been known to take weeks.

The sensor works by comparing the solar ultraviolet radiation reflected from the ozone layer with that arriving directly from the sun. The more ozone, the more radiation is absorbed. The less ozone, in other words, the "brighter" the atmosphere. To enable its lowest-altitude measurements, the satellite carries a rocket motor which can be fired to reduce its perigee (closest point to earth) for several orbits, then fired again to raise it before atmospheric drag becomes fatal. □

# A vidicon eye on the infrared

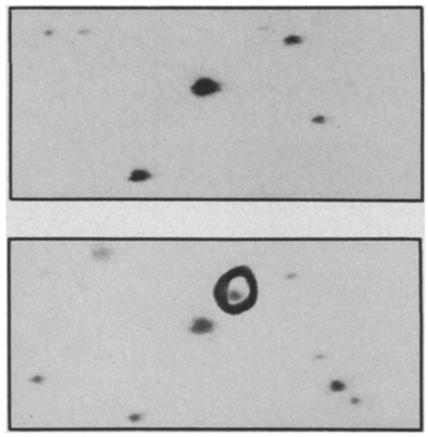
The infrared is a range of the electromagnetic spectrum in which there is a lot of astrophysical action. It is produced by objects that are cooler than those that emit visible light (hundreds of degrees Kelvin rather than thousands), and thus it is the characteristic emission of stars at their birth and in their infancy and sometimes as they die. Infrared is especially important in cosmology because observations in that range may reveal enough cool "hidden" matter to end the long debate over whether the universe is open or closed.

Most infrared does not imprint on photographic film, and all of it is invisible to the human eye. Therefore many astronomers, optical scientists and engineers are at work on ways to record it. One such device, a special kind of vidicon tube, has recently been completed by two astrophysicists from the Los Alamos Scientific Laboratory, Brook Sandford and Charles Gow, and an electro-optical engineer from the Los Alamos Branch of EG&G, Jack Jekowski. It has already found at least one thing astronomers didn't know was there.

The celestial emanations are first received by a special infrared-sensitive television-camera tube, which is called an intensified silicon-intensified (I-SIT) vidicon. Produced for Los Alamos by RCA, it is the only one of its kind in existence. It is sensitive to images in the near infrared, beyond the range of the eye and photographic film. It is coupled to an infrared image-intensifier tube which uses electronic means to increase the brightness of faint images.

Time exposures obtained with this combination are recorded on videotape. The tape is processed through a special editing system developed by EG&G that enhances the definition in the pictures by putting together as many as 600 separate frames. The tones of the enhanced image are then converted to digital pulses on a magnetic tape, and that is processed by CDC 7600 computers to produce sharp black-and-white prints.

Sandford is especially interested in using the device to look for optically invisible haloes around galaxies that those astronomers who postulate a closed universe hope are there. "The most probable candidates for halo mass objects are cool, dwarf stars," he says. "These radiate chiefly at 1 micron in the near infrared and would be undetectable on the blue photographic plates traditionally used to study galaxy structure."



*Infrared star in Cygnus (circled) does not show up in an ordinary red-light photo.*

So far the group has not found any galactic haloes. They have been looking closer to home, within the dust and hydrogen clouds of our own galaxy and other likely places for young cool stars.

To calibrate the equipment they used the U.S. Naval Observatory's 40-inch telescope at Flagstaff, Ariz., and resurveyed some areas of the northern sky that the California Institute of Technology surveyed in the two-micron infrared range in 1966. In so doing they found two truly infrared stars. Both objects had been seen in the Caltech survey, but one of them had been identified with a faint visible red star. The present observers see no visible star in that location, and they believe the object is an infrared-only star. Seven other Caltech identifications were confirmed. The survey also took pictures of the Orion nebula in the infrared light emitted by its helium gas.

Soon the group hopes to get time on the 82-inch telescope at the University of Texas's McDonald Observatory at Fort Davis, Tex., to improve the Orion observations. Later, if as they hope, they can book time on other large telescopes, they will try other regions where stars may be forming: nebulas like Orion, the ionized hydrogen clouds and the Herbig-Haro objects, small regions emitting radiation characteristic of hydrogen and sulfur gases and metal vapors. Then they hope to go on to look for the haloes around the galaxies that may be enough to close the universe. □

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*Los Alamos group at computer console.*

# Nebuchadnezzar's arrow

Archaeologists from Hebrew University in Jerusalem have discovered a layer of ashes and charred wood on the earthen floor of an ancient watchtower in the Jewish Quarter of the old city that may be the remains of a structure destroyed during Nebuchadnezzar's invasion in 586 B.C. Among the ashes were found several arrowheads, at least one of which appears to be foreign, a kind used by Babylonian mercenaries.

The discovery was made during excavation of the "First Wall" of Jerusalem, dating from the Israelite Kingdom, which was described by the ancient Jewish historian Josephus Flavius, but whose existence was doubted by most archaeologists until the current dig was begun. In announcing the finds, the university called remains of the old wall "among the most significant historical monuments discovered so far in Jerusalem." The chief archaeologist at the excavations, Nahman Avigad, told newsmen that discovery of the ashes and arrowheads constitutes the first direct evidence of Nebuchadnezzar's siege. (Remains of buildings presumably destroyed by the Babylonians have been known for some time, however, largely as a result of work by British archaeologist Kathleen Kenyon.)

The watchtower lies to the west and up a hill from Temple Mount, in an area most historians believed was not enclosed by the city wall until the second century B.C. At that time, the Hasmonean kings (descendants of Judas Maccabeus) were busy expanding their empire and fortifying their