

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

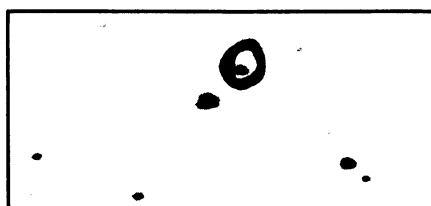
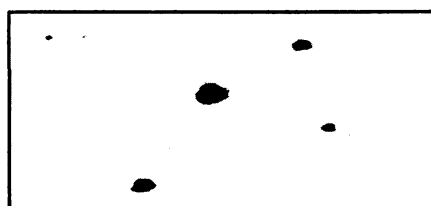
The infrared is a range of the electromagnetic spectrum in which there is a lot of astrophysical action. It is produced by objects that are cooler than those that emit visible light (hundreds of degrees Kelvin rather than thousands), and thus it is the characteristic emission of stars at their birth 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 uni-



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

verse 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."

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



*Los Alamos group at computer console.*

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. □

## 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



Hebrew University of Jerusalem

*Eighth-century tower (rough-hewn stones), with later structure in front.*

cities, but Josephus (who lived in the first century A.D.), insisted that the Hasmonian wall superseded one "from the time of David and Solomon and the kings thereafter."

Following the 1967 war, the Israeli government launched a campaign to re-

build this part of the old city, which had been largely destroyed, and archaeologists were brought in to salvage what they could of ancient remains. At the site of one condemned house, Avigad and his colleagues dug down nearly 36 feet and unearthed a sturdy Hasmonian watch-tower with walls nine feet thick. Then came the surprise; adjoining the neatly cut blocks of the second-century structure were the rough-hewn stones of a far older tower.

This older structure, says Avigad, represents "the first authentic part of the 'First Wall' of Jerusalem, which fits the description of Josephus." The early fortification, he says, dates from the seventh or eighth century B.C. (It was during this period that Assyria carried off the northern tribes of Israel and besieged Jerusalem.)

The early fortifications apparently served the city well for at least two centuries, until the Assyrian empire declined and was replaced by Babylonia as the major power in the area. Though well documented in writing, the presence of Nebuchadnezzar's troops in Jerusalem has never been confirmed by direct archaeological evidence, because of the utter destruction that accompanied it. Now a pile of ashes and a few arrowheads add their mute testimony; in Avigad's words, "It all fits together." □

## Shanidar: The cave with soul

High in the Zagros Mountains of Iraq lies Shanidar, a cave that continues to alter our concepts of Neanderthal society and humanity. Among the first human fossils found in Shanidar was the skeleton of a 40-year-old, one-armed crippled male who died more than 40,000 years ago. Examination of the skeleton showed that the man was probably a cripple from childhood (his right arm and shoulder had never fully developed) and that his arm had been amputated below the elbow. This man would have been of little help hunting and probably had to be cared for by his cave mates. The fact that he survived to manhood showed a degree of humanity not previously attributed to the Neanderthals.

Another fossil skeleton (Shanidar IV) from deeper in the same cave now yields further insights into the Neanderthal way of life. In the early 1960's, T. Dale Stewart of the Smithsonian Institution and Ralph S. Solecki of Columbia University described (separately) the discovery of several skeletons believed to be about 60,000 years old. The fossils appeared to have been buried. The grave contained an infant that had been laid in first, two women and, finally, an adult male. At the time of the find, Solecki took soil samples from around the male and set them aside for pollen analysis. A. Leroi-Gourhan of Paris examined the soil and found it to be rich in flower pollen.

"The recovery of pollen grains around

the Neanderthal burial was in itself unusual and without precedent to our knowledge," says Solecki in the Nov. 28 *SCIENCE*, "but to find flower pollen, and in quantity, was an added extraordinary dividend. The association of flowers with Neanderthals adds a whole new dimension to our knowledge of his humanness, indicating that he had 'soul.'"

After the specific flowers were identified, Solecki took the research one step further and found that seven of the eight flower species found in the grave are known in Iraq for their herbal and medicinal properties. Says Solecki: "It is extremely likely that, as practicing naturalists (and early-day ecologists?), the Neanderthals must have known and appreciated all of their environment, since their very existence depended on it." The buried man may have been an important individual or may have been some kind of medicine man, Solecki speculates.

Identification of the pollen adds other information, such as the time of year of the burial, calculated by when the flowers would have been in bloom. The amount of pollen found (especially the hollyhock, which grows in individual stands) suggests that bouquets were collected purposely for the burial. All of this may be coincidence, admits Solecki, "but the coincidence does raise speculation about the extent of human spirit in the Neanderthals." □

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