now extending their studies.

The Houston scientists also have a large program under way to explore the value of other immunotherapies for cancer patients, such as BCG or transfer factor (SN: 2/9/74, p. 86). BCG added to chemotherapy clearly prolongs cancer remission and patient survival, they have found. They hope to have results on transfer factor within six months to a year. On the whole, they believe immunotherapy for cancer looks exciting. □

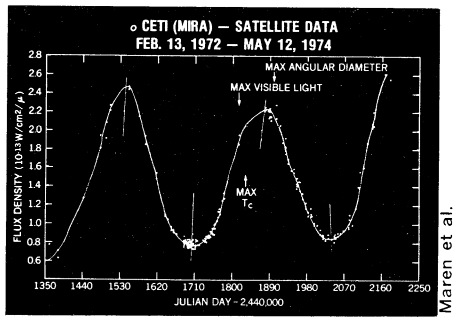
New infrared astronomy results include first from orbit

In its early days infrared astronomy consisted of "looking at what came across the meridian," as Wayne Stein of the University of California at San Diego and the University of Minnesota puts it. Nowadays it is far more sophisticated. Infrared astronomy is beginning to study such things as intensity variations and polarization in infrared sources, to chart their positions more accurately and to obtain better resolution of their spectra. "The field has become very large."

With these remarks Stein opened a session on infrared astronomy at the meeting of the American Astronomical Society in Rochester, N.Y. It was a session that heard, in addition to Stein's general review, a number of new specific results including the first observation of infrared stars from telescopes in earth orbit, what is believed to be the first high-resolution infrared spectrum of the planet Mercury, a determination of the helium-hydrogen ratio in the atmosphere of Jupiter that could have cosmological repercussions, and a study of the polarization of the distant galaxy NGC 1068 that bears on the question of just what the galactic infrared sources are.

Optical, radio and X-ray telescopes have been put into orbit around the earth or are being publicly planned. But ask any member of the astronomical community or the general public or even the space fraternity about infrared telescopes in orbit, and he would say that he had never heard of any. Yet these unheard of and possibly officially nonexistent satellites are there. They belong to the U.S. Air Force, and whatever their cloak and dagger function may be—snooping on what the Russians and the Chinese do in the dark is one that springs immediately to mind—they have been looking at certain long-period variable stars, the kind called Mira variables.

Stephen P. Maran of the NASA Goddard Space Flight Center reported the results of a study done by him and five others of data on two such stars, Mira (also known as Omicron Ceti) and R Aquilae. The data were given to NASA by the Air Force at NASA's request. The important thing that the orbital observations can do that ground-based ones cannot is record single cycles. Ground-based observations give means of many



Mira's cycle from satellite data.

cycles. Knowing individual cycles is important, because the brightness profile does not repeat exactly but varies considerably from cycle to cycle. The infrared cycles are also not in phase with the optical ones. For Mira the two observed infrared maxima lag behind the optical ones by 37 and 39 days. (The total cycle period is 278 days.) For R Aquilae the infrared leads the optical. The checkpoint this time was a minimum, which came 20 days before the corresponding optical minimum.

Knowing all these details is a help toward an understanding of the physical processes going on in the stars. In the case of R Aquilae there is a connection to radio astronomy because natural-maser radio emanations of water and hydroxyl are associated with the star. Knowing the relation between the infrared and radio emissions can tell something about the characteristics of the maser.

Aside from knowledge of particular stars the conclusion that Maran draws that will be most exciting to infrared astronomers is that "infrared telescope systems can be built that will survive for long periods of time in earth orbit." And it comes as a surprise because few people knew they were there.

The planets have been a staple subject of infrared investigation. They are cool bodies in a temperature range characteristic for infrared emission, and infrared can reveal much about them. Always the most difficult planet to observe in any range of the electromagnetic spectrum is Mercury because it lies so near the sun, a very strong emitter across the spectrum. Thus a high-resolution infrared spectrum of Mercury is an achievement just in itself. Ming Hing Tai and Martin Harwit of Cornell University performed the study. The spectrum they got ranges from 8.2 to 10 microns wavelength. It seems to show a surface temperature of 600 degrees K., which conflicts with radio evidence that gives 400 degrees. The discrepancy may be because the infrared measurements are dominated by the sunlit side of the planet and especially by the very hot point where the sun is just overhead.

The atmosphere of Jupiter is of great cosmological interest because it is deemed to be primitive—it represents the ratios of certain gases as they were when the solar system formed. To find the ratio of hydrogen to helium at the time when population II stars (the class the sun belongs to) were formed, the best way is to observe Jupiter. It can't be measured on earth because the earth's primitive atmosphere is long since gone away. The datum is cosmologically relevant because most helium dates from the big bang.

R. A. Reed of Cornell University working with colleagues D. F. Schaak and J. R. Houck, went to Jupiter for the information by means of infrared observations from a NASA Lear jet. If the total amount of both gases is taken as 100, there are 85 hydrogen to 15 helium. The cosmological implications remain to be worked out.

NGC 1068 is an especially interesting galaxy to infrared astronomers because of its large output in the infrared part of the spectrum. Working at Kitt Peak National Observatory, R. F. Knacke of the State University of New York at Stony Brook and R. W. Capps of the University of Arizona succeeded in measuring some polarization in the infrared emitted by NGC 1068. The radiation is 0.4 percent polarized at 3.5 microns wavelength and 2.3 percent polarized at 10.2 microns. The result gives some insight into the mechanisms that are producing the emission, says Knacke.

Interstellar dust grains in NGC 1068 may be doing the polarizing or the source may be a synchrotron process (charged bodies spiraling in a magnetic field) rather than thermal (heat vibrations). The Compton effect, collisions between electrons and photons that can change the photons' wavelength from one spectral range to another, is ruled out because it does not produce polarization. Still it is difficult to imagine a strong nonthermal source that would produce a radio flux much lower that the infrared as is observed. Knacke suggests there might be two sources, a point source in the center of NGC 1068 producing 36 percent of the flux and a more extended source producing the rest.

Thus in one afternoon, infrared astronomy provides a tour of the universe from nearby planets to distant galaxies with way stops in between. □