No. 169 MAP OF THE GALACTIC NUCLEUS AT 10μ

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ABSTRACT

The galactic nucleus has been mapped at 10 microns with a resolution of a few arc seconds. Four discrete sources were resolved superimposed on an extended background.

We have scanned the center of our galaxy at a wavelength of 10 microns with a beam 5.5 arcsec in diameter. The scans have been combined to produce the map shown in Figure 1. At 10kpc, commonly assumed to be the distance to this region, 5.5 arcsec corresponds to 0.3 pc.

These observations were taken during the day on February 15, 1971, with the sixty-one-inch telescope at the Catalina Observatory. Because of the imprecision in the drive of the telescope, the scans could not be located accurately in declination; the telescope also drifted slowly in right ascension. These problems were overcome by comparing the scans with some made earlier by one of us (FJL) and D. E. Kleinmann with the Steward Observatory 90-inch telescope. Minor distortions may persist in the map. All of the features described below stand out clearly above the noise, which has a peak-to-peak value of about 6×10^{-17} W/m^2 Hz ster.

Four sources can be distinguished and are numbered in Figure 1. An additional broad zone of emission can be seen extending to the north. Sources 2 and 4 are partially resolved and have diameters of about 0.5 pc. There are indications on the individual scans that Source 2 would break up into two or three sources at higher resolution. Source 1 is unresolved and must be less than 0.2 pc in diameter. Source 3 may also be unresolved with our beam, although the ratio of signal to noise is inadequate to permit a strong statement.

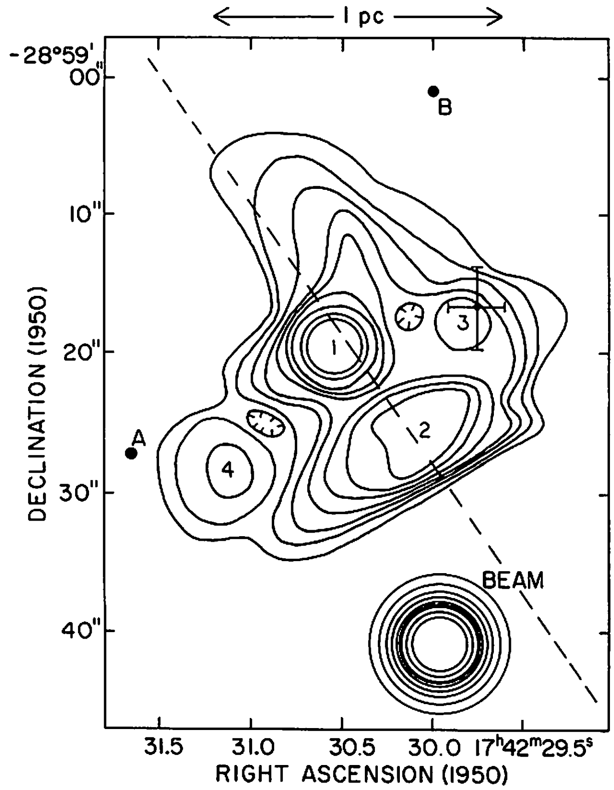

Fig. 1 Map of the galactic center at 10 microns. The peak-to-peak noise of the observations is 6 x 10^{-17} W/m^2 Hz ster. The contours are at levels of 1, 2, 4, 6, 8, 10, 12, 16 and 20 times this value. The brightest 10-micron sources are numbered in order of decreasing maximum flux. The beam used for these observations has a full width at half maximum of 5.5 arcsec. It is shown with the same contour levels as are used for the map. The location of the 2.2-micron "point-like" source is indicated by a set of error bars which correspond to the uncertainty in our measurement of its position. The two most prominent field stars have been plotted and labelled A and B. The direction of the galactic plane is indicated by the dashed line.

We have also made observations at 2.2, 5 and 22 microns. A detailed description of all this work will be published after we have analyzed it more completely. We have located the "point-like" source discovered at 2.2 microns by Becklin and Neugebauer (1968) relative to our map; to within the accuracy of the measurements, its position agrees with that of Source 3. At 5 microns, scans across the complex of sources have been made at five declinations. Although these scans have a relatively low ratio of signal to noise and are insufficient in number to construct a map, they do show the same general features found on the 10-micron map.

At 22 microns, we have constructed a map with the same resolution and nearly the same ratio of signal to noise as for the 10-micron map. The noise for this map has a peak-to-peak value of about 1.8 x 10^{-16} W/m^2 Hz ster; at this level, Sources 2 and 3 were not detected. Source 1 stands out prominently. It lies near the center of an extended source that has a radius of about 20 arcsec.

Two field stars are plotted in Figure 1 and labeled A and B. Additional scans at 10 microns enabled us to locate our map relative to field star A. The coordinates of this star were measured from a Palomar Sky Atlas plate, allowing us to determine the absolute position of the 10-micron sources to within about 2 arcsec. (A finding chart for the galactic center has been published by Spinrad, *et al.*, (1971) (their Fig. 1). Star A is 2.5 mm south and 2.0 mm east of the indicated position of the galactic center on this chart and star B is 1.5 mm north and 1.0 mm west. It should be noted that the position of the 10-micron sources differs somewhat from the one indicated on the published finding chart.)

From our map, we estimate the total flux from the galactic center to be 480 ± 50 x 10^{-26} W/m^2 Hz at 10 microns. The 22-micron map indicates that the flux at this wavelength is 2300 ± 250 x 10^{-26} W/m^2 Hz, of which about 60% or 1400 ± 150 x 10^{-26} W/m^2 Hz would fall within a field of view 25 arcsec in diameter. These results are in reasonably good agreement with earlier measurements made with a 25 arcsec field of view of 550 ± 60 x 10^{-26} W/m^2 Hz at 10 microns, and 1700 ± 200 x 10^{-26} W/m^2 Hz at 22 microns (Low, Kleinmann, Forbes and Aumann, 1969).

Maps of the galactic center at 2.2 microns have already been published (Becklin and Neugebauer, 1968). At this wavelength the detected flux arises almost entirely from unresolved stars. Except for the "point-like" source, the brightest features at 2.2 microns would produce a flux of 0.2 x 10^{-26} W/m^2 Hz in a field of view the size of ours. At 10 microns, the flux from these stars should be an order of magnitude lower. Our peak-to-peak noise is about 3.5 x 10^{-26} W/m^2 Hz; thus, the general stellar background detected at 2.2 microns makes virtually no contribution to the 10-micron map. Becklin and Neugebauer (1969) have published the results of a scan across the galactic center at 10 microns. Their scan appears to have passed near the center of Source 2.

The 10-micron sources fall within the region of maximum intensity of the extended 2.2-micron source, which is centered (Becklin and Neugebauer, 1968) at α (1950) = $17^h\ 42^m\ 30^s \pm 1^s$ and δ (1950) = −28° 59.4 ± 0.1. Their position also agrees with that of the radio source Sgr A (Maxwell and Taylor 1968), α (1950) $= 17^h 42^m 30^s.6 \pm 1^s$ and δ (1950) $= -28° 59' 14'' \pm 15''$.

Despite the consistency of these positions, significant ambiguities remain if one looks closely at the data. Our 22-micron map suggests that source 1 lies at the galactic center. On the other hand, a scan across the maximum of the 2.2-micron extended source, published by Becklin and Neugebauer (1969), places the greatest density of stars near Source 2. The 2.2-micron "point-like" object can be identified with Source 3; if it is, the 2.2-micron scan must be shifted in a direction which improves the correspondence with Source 2. The existence of Source 2 indicates that objects considerably cooler than normal stars lie very near the maximum 2.2-micron intensity. The contribution of these objects to the 2.2-micron flux is not known, leaving the position of the point of maximum stellar density uncertain.

Resolution of 6 arcsec at radio frequencies (Downes, private communication) reveals that Sgr A consists of two objects, one to the east and one to the west of our position for the infrared sources. The published position reflects the contribution of both sources.

Acknowledgments. The first measurements of the discrete sources in the galactic nucleus were made by Low and D. E. Kleinmann (1970). These data were essential to our present efforts. We wish to thank A. A. Hoag for giving us a plate from the Palomar Atlas and E. Roemer for assistance in carrying out the measurements.

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