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IRAS[1] IMAGES OF THE GALACTIC CENTER

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ABSTRACT

Images at wavelengths of 12, 25, 60, and 100 μm of an $8° \times 16°$ field around the galactic center at 4′ resolution reveal details of structure both in and away from the galactic plane not seen in previous large-scale infrared surveys.

Subject headings: galaxies: Milky Way — galaxies: nuclei — infrared: sources

I. INTRODUCTION

Only the techniques of infrared and radio astronomy are able to penetrate the thick dust clouds toward the center of the Galaxy to explore and map structural details of that region. Over the past decade, measurements from 1.6 μm to radio wavelengths have made important progress toward mapping and understanding the inner parts of the Galaxy (see Okuda 1980, and references therein). The all-sky infrared survey conducted by the *IRAS* satellite has now made sensitive, new absolute intensity measurements at wavelengths from 12 to 100 μm of large areas of sky toward the galactic center.

This *Letter* presents some preliminary *IRAS* results in the form of images of an $8° \times 16°$ area around the galactic center. The final calibration of the *IRAS* survey instrument is not yet complete, making a quantitative presentation of absolute intensity maps inappropriate at this time. The utility of the wide field, absolute intensity observations now available, however, warrants presentation in the form of images.

II. OBSERVATIONS

The construction, operation, and calibration of the *IRAS* survey instrument is discussed by Neugebauer *et al.* (1984, hereafter Paper I), so only details unique to the production of wide field, absolute intensity maps from the *IRAS* data are discussed here.

For assembly into images, the *IRAS* survey data are smoothed to 4′ resolution and sampled at 2′ intervals. The position of each sample on the sky is mapped onto a grid of $2' \times 2'$ pixels using a gnomonic projection. The whole *IRAS* survey will be projected into 212 such grids with projection centers spaced every 15° on the sky (Paper I).

Figures 1–4 (Plates L2–L5) show the *IRAS* observations near the galactic center. A false-color format was chosen to allow better reproduction of the large dynamic range of brightness present near the galactic center. The random noise in the images is about 4×10^5 Jy sr^{-1} (1 σ) for 12, 25, and 60 μm and 9×10^5 Jy sr^{-1} (1 σ) for 100 μm.

As of this writing, hysteresis effects and nonlinearities have not been fully removed, and flat-fielding has not been completed. A combination of these effects introduces systematic variations across the images of 5%–10% in the 12 and 25 μm bands, somewhat more in the 60 μm band and up to 20% in the 100 μm band. These imperfections produce the stripes seen in the Sagittarius A region of the 100 μm image. Absolute baseline intensities are good to at best 3×10^6 Jy sr^{-1} in all bands (Hauser *et al.* 1984).

III. DISCUSSION

The absolute intensity maps presented here have unprecedented sensitivity combined with high angular resolution, wide field coverage, and large wavelength range. They give a broad view of the central galaxy revealing previously unseen details, especially in regions far from the well-studied central few arc minutes.

The most prominent feature in the maps is the galactic center itself. Well-defined infrared features in the nucleus correspond to the nuclear radio sources Sgr A, B2, C, and D. The high sensitivity of *IRAS* allows detection of extremely faint structures. For instance, the cold molecular cloud associated with Sgr B2 has never before been detected at wavelengths shorter than 40 μm, yet it is seen in all four *IRAS* images. Other prominent features are the two components of the H II region NGC 6357, G353.2+0.9, and G353.1+0.7, and the striking, wispy or filamentary structures which extend outward from the plane, especially around the nucleus, in the 60 and 100 μm images. Similar structures, "infrared cirrus," not clearly related to the nucleus, continues with diminishing brightness out to and beyond the edge of this field and, in fact, are seen over the whole sky in the *IRAS* data (Low *et al.* 1984).

The bright point source at $l = 357.31$, $b = -1.34$, in the 12 and 25 μm images is unidentified. It has flux densities of 1430 ± 60, 2860 ± 60, 1270 ± 60, and 550 ± 50 Jy in the 12, 25, 60, and 100 μm bands respectively. These correspond to a

[1]The *Infrared Astronomical Satellite* was developed and is operated by the Netherlands Agency for Aerospace Programs (NIVR), the US National Aeronautics and Space Administration (NASA), and the UK Science and Engineering Research Council (SERC).

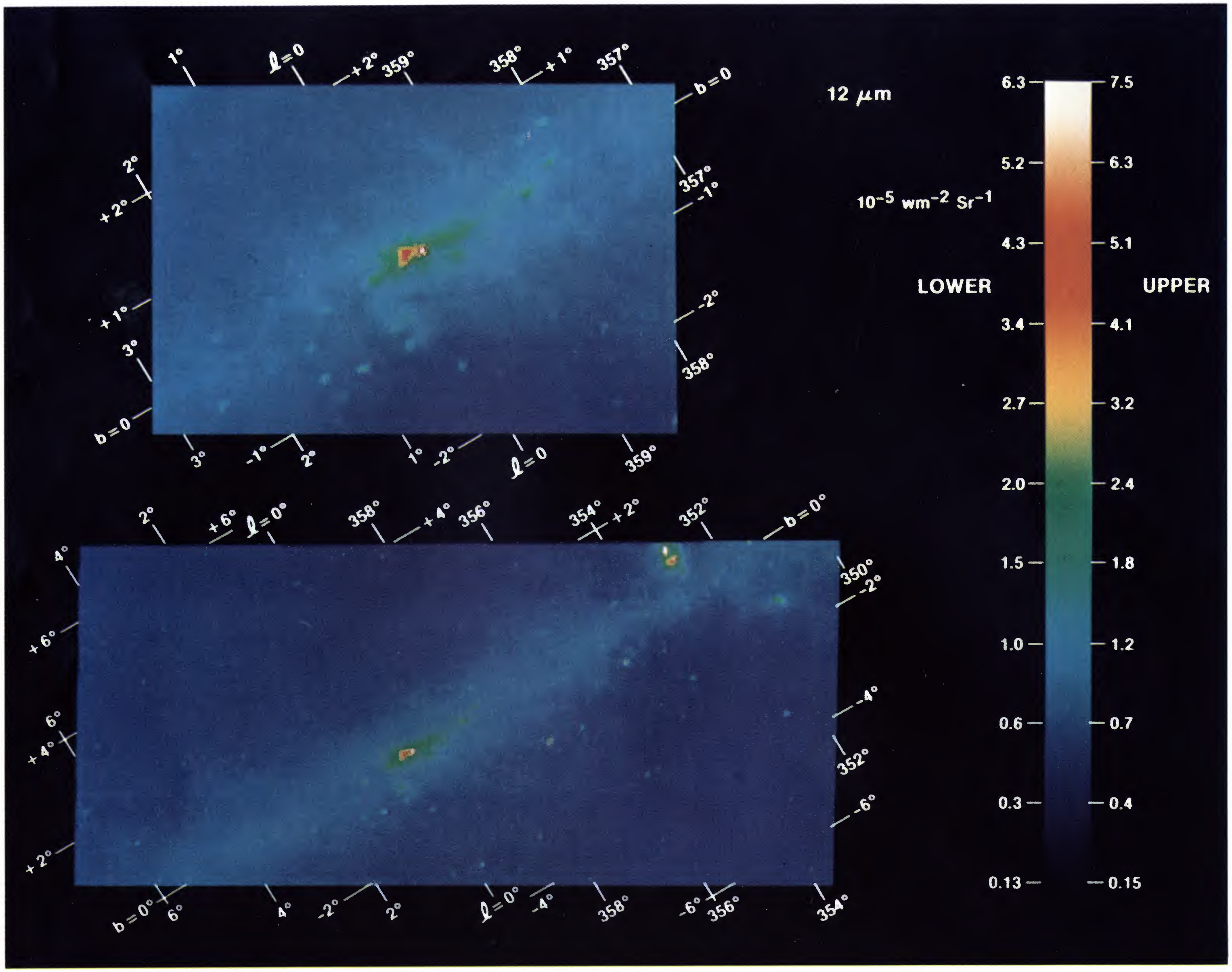

FIG. 1.—False-color intensity image from 12 μm *IRAS* data. Intensity vs. color scales are shown. The region of the galactic center saturated in the large-area image is reproduced with large dynamic range in the smaller image. Separate images of the nucleus and the rest of the field are necessary to accommodate the full dynamic range. The peak 80% in intensity in the large-area map has been truncated; there has been no truncation in the small-area map. Intensities are *IRAS* in-band intensities.

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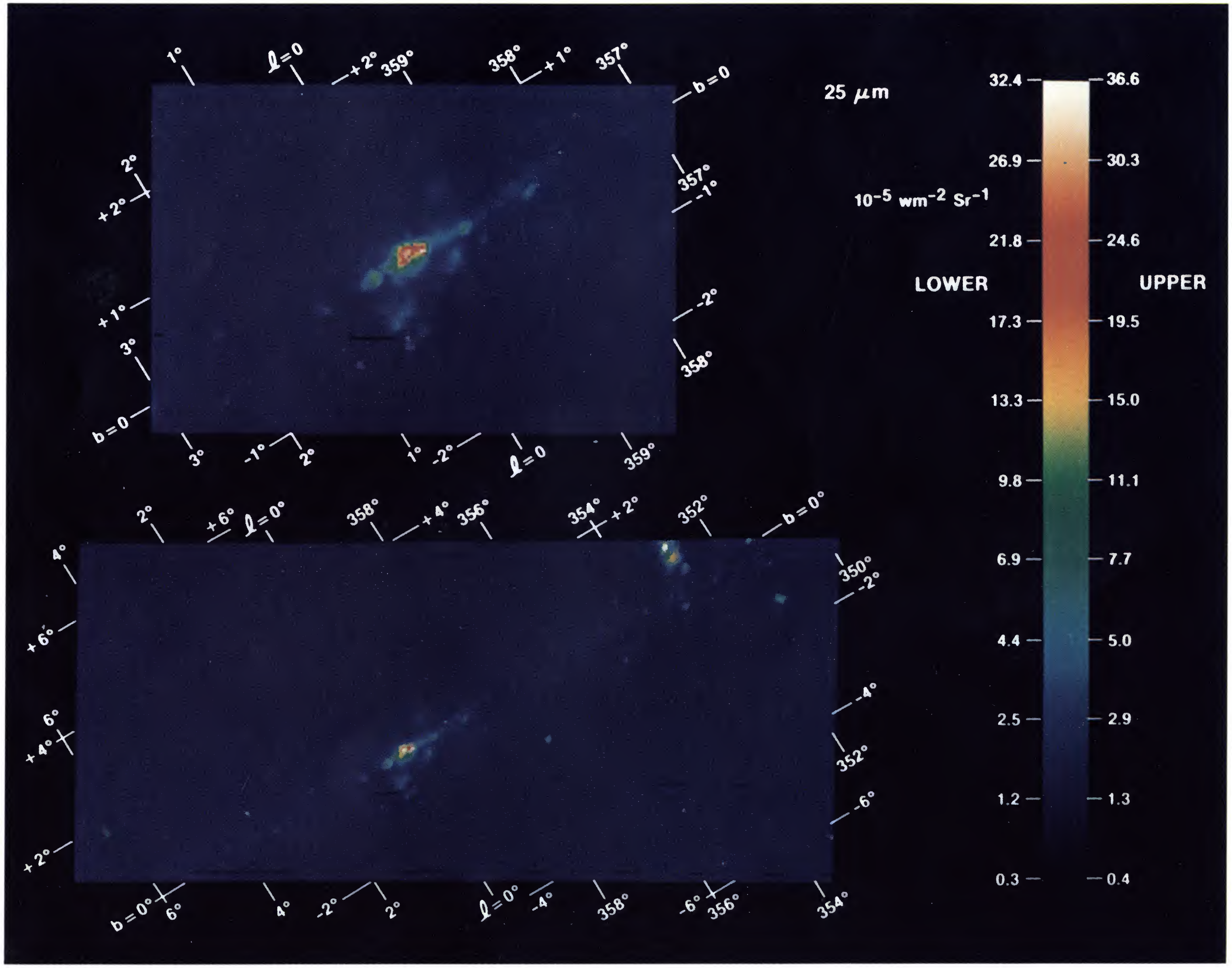

FIG. 2.—False-color intensity image from 25 μm *IRAS* data. Other details same as Fig. 1.

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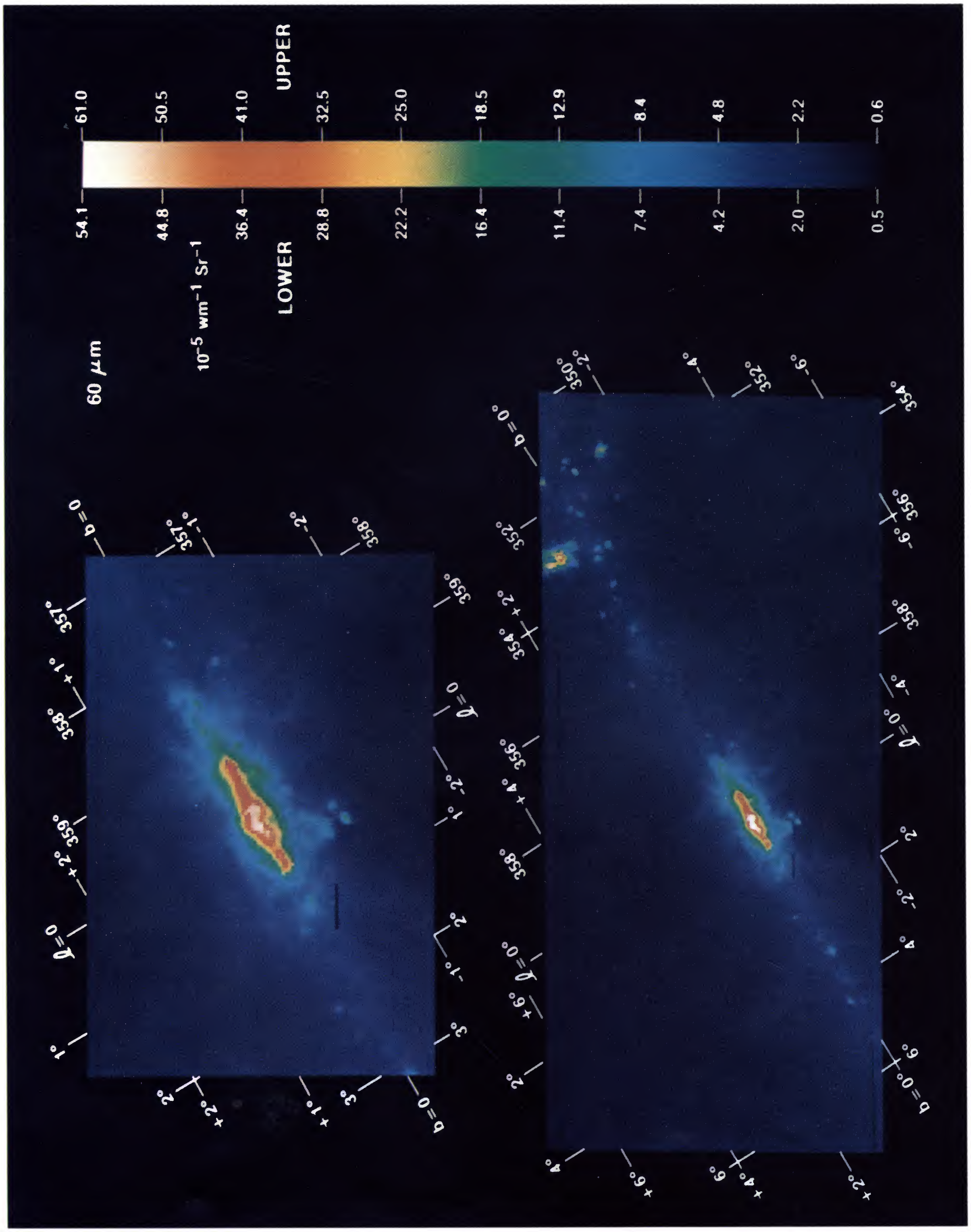

FIG. 3.—False-color intensity image from 60 μm *IRAS* data. Other details same as Fig. 1. Filamentary structures which extend to great distances from the plane can be seen.

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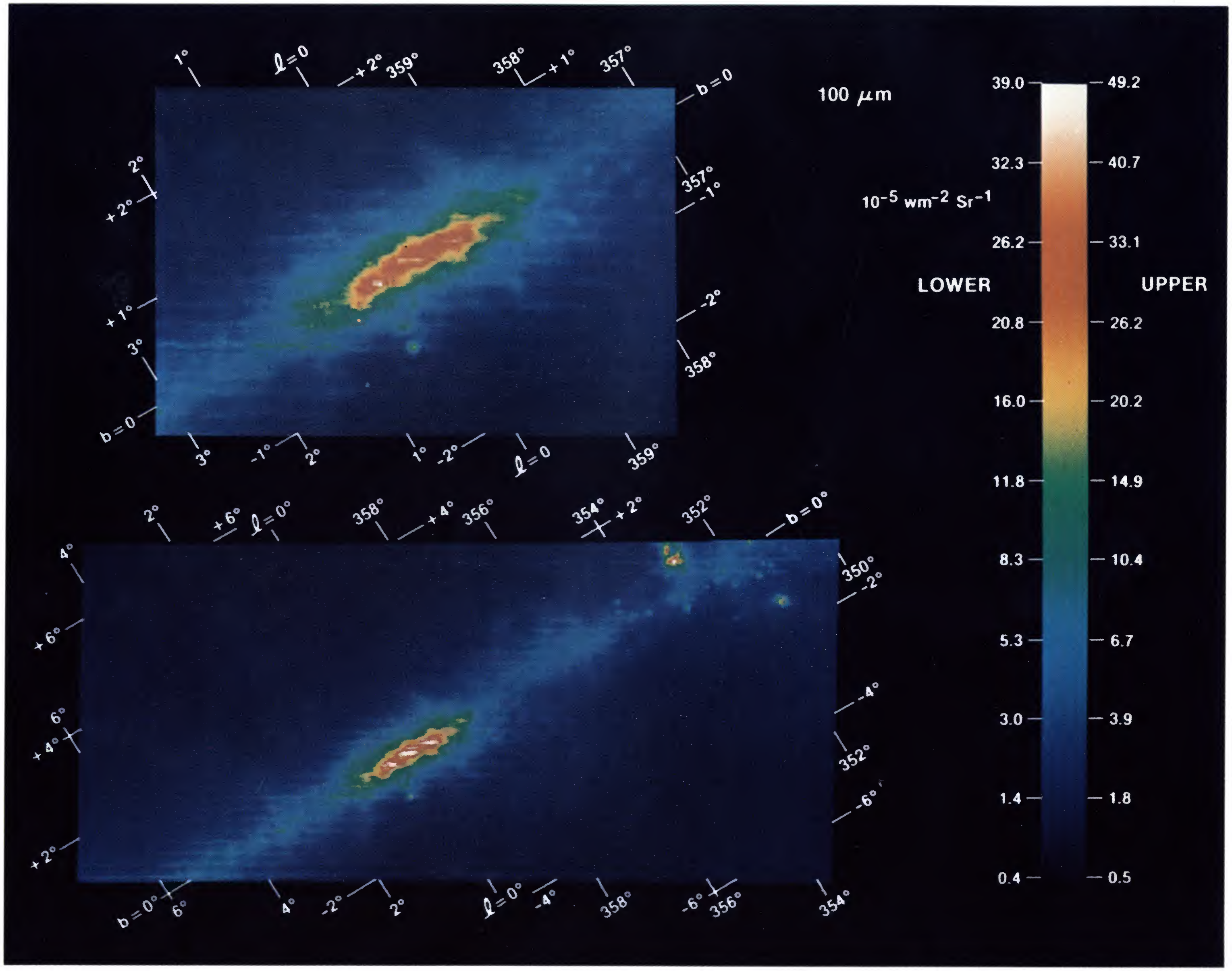

FIG. 4.—False-color intensity image from 100 μm *IRAS* data. Other details same as Fig. 1. Striping caused by incomplete matching of detector responsivities is seen in the brighter parts of the image.

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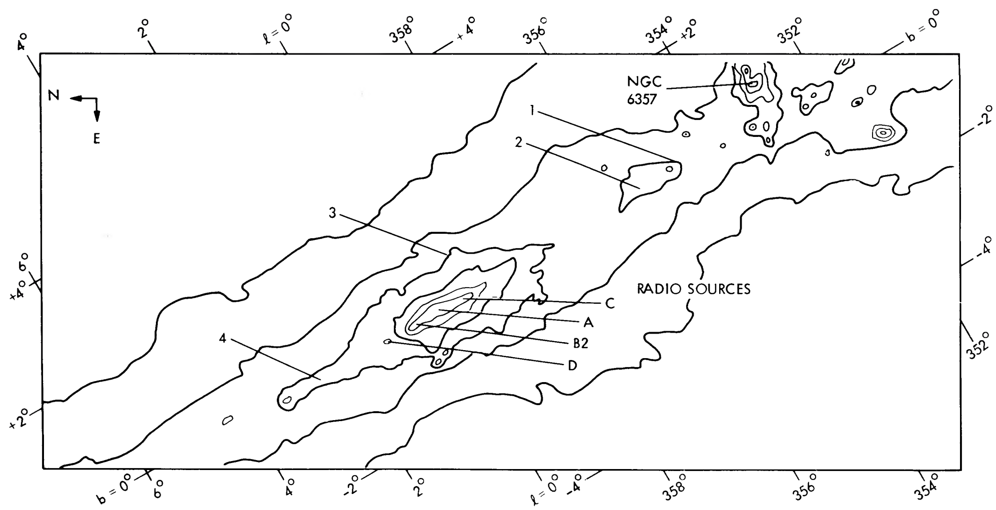

FIG. 5.—A schematic representation of the *IRAS* central Galaxy images, indicating the location of several features in the images and the location of the areas where dust temperatures and column densities were obtained. Four components of the nuclear radio source are indicated.

TABLE 1

PRELIMINARY DUST TEMPERATURES AND COLUMN DENSITIES FOR SELECTED AREAS

Area	l	b	Beam Size (arcmin)	Color Temp. (K)	Dust Temp. (K)	Optical Depth at 100 μm	Dust Column Density (g cm^{-2})
1........	354.82	+0.10	30 × 30[a]	29	25	0.019	0.8×10^{-3}
2........	355.81	+0.12	30 × 30[a]	29	25	0.028	1.2×10^{-3}
3........	359.36	+0.84	2 × 2	31	27	0.014	0.6×10^{-3}
4........	2.53	−0.11	2 × 2	27	24	0.047	2.0×10^{-3}

[a] The 30′ × 30′ beam obtained by averaging over a 15 × 15 pixel square.

color temperature of 220 K between 12 and 60 μm. The ratio of 12 μm to 100 μm flux gives a color temperature of 234 K. There is no indication in the *IRAS* data that this source is extended. Assuming unit emissivity, these fluxes and temperature yield a source diameter of 0″.9. The fixed position of the source over a period of a week makes it unlikely to be within the solar system. This object has not been seen in other infrared surveys because they either did not cover this part of the sky or were not sensitive enough. No indication of the source is seen in the 5 GHz survey of Altenhoff *et al.* (1970).

Temperatures and column densities for four areas labeled A–D in Figure 5 are shown in Table 1. The mass absorption coefficient of the dust grains was assumed, following Hildebrand (1983), to be

$$K_\lambda = 2.4 \times 10^3/\lambda(\mu\text{m})\ \text{cm}^2\ \text{g}^{-1}.$$

The intensity measurements used to derive the quantities in Table 1 are accurate to about 10% (1 σ). This translates to about 1 K accuracy in the temperatures and 10% in the column densities.

We have avoided preliminary analysis of the nucleus itself in the 60 and 100 μm bands and any of the data in the 12 and 25 μm bands. This avoids yet uncalibrated nonlinearities in the very bright regions and the subtraction of 12 and 25 μm emission from interplanetary dust in fainter areas.

IV. SUMMARY

This *Letter* is mainly a showcase for the *IRAS* image of the galactic center. It gives the reader a qualitative view of the central region of the Milky Way and indicates the power of the *IRAS* data.

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