OBSERVATIONS OF THE NEAR INFRARED SURVACE BRIGHTNESS DISTRIBUTION OF THE GALAXY

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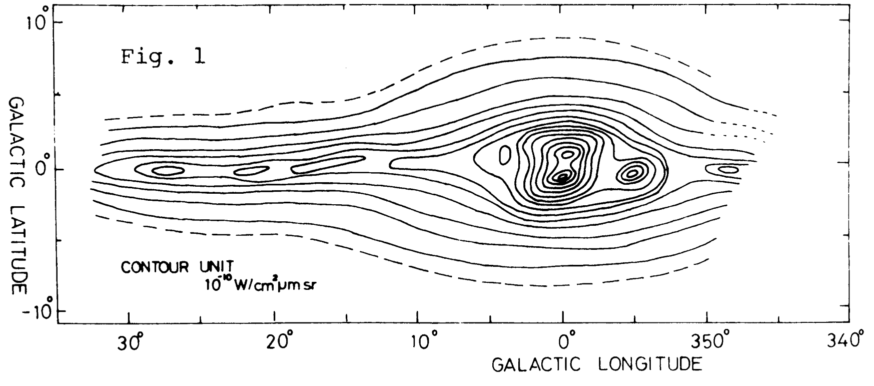
Studies of the stellar distribution in the inner region of our Galaxy have been seriously hampered at optical wavelengths by strong interstellar extinction. The extinction decreases considerably at infrared wavelengths, allowing us to look deep into the Galaxy. Motivated by this, we have tried to observe the near infrared brightness distribution of the central region of the Galaxy (Okuda et al.,1977, Maihara et al.,1978, Oda et al.,1978). Similar observations have been carried out by Hayakawa et al.,(1976), Ito et al.,(1977), and Hofmann et al.,(1977). These observations have provided valuable information on the distributions of stars and dust in the inner Galaxy (Hayakawa et al., 1977, Maihara et al., 1978, Oda et al., 1978).

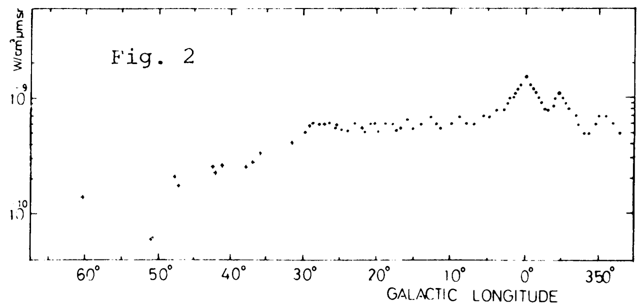
OBSERVATIONS AND RESULTS

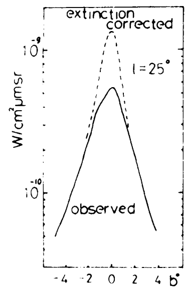
The observations were made four times since 1971, using balloon borne telescopes at altitudes near 25 km. The observed wavelength range was limited to a narrow gap in the OH airglow centered at 2.4μm. The field of view adopted in the flights in 1975 and 1976 was 1°x1°; this was improved to 0°.6x0°.6 in the flight of 1977 in order to resolve the fine structure near the galactic center.



W. B. Burton (ed.), The Large-Scale Characteristics of the Galaxy, 377 380.

The brightness distribution derived from the 1977 flight and partly supplemented by the 1976 data is drawn in Figure 1. The longitudinal dependence of the ridge intensity and the cross-sectional distribution at l=25° are displayed in Figures 2 and 3.



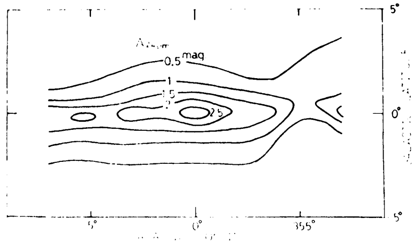


STARS AND DUST IN THE INNER GALAXY

a) Distribution of Dust

The split of the brightness contours close to the galactic center evidently indicates the presence of extremely large interstellar extinction along the galactic plane. Although it is not straightforward to estimate the effect of the extinction from the single-band observations, we have tried to decompose the magnitude of the extinction by assuming that the intrinsic brightness distribution of the bulge is similar to that of M31. The validity of this assumption will be discussed elsewhere.

Magnitudes of the extinction thus derived are shown in Figure 4. Most of the extinction ($A_{2.4}$=1.7 mag, corresponding to 21 mag of visual extinction) is distributed independently of galactic longitude. It may be associated predominantly with the 5-kpc ring of the molecular clouds which has been delineated from CO emission measurements (Scoville and Solomon 1975, Gordon and Burton 1976). In fact, the column density of total hydrogen gas (atomic and molecular), $3\times10^{22}/cm^2$ (Burton 1976) is consistent with the extinction, if the relations of $N(H)/E_{B-V}=5\times10^{21}$ atoms cm^{-2} mag^{-1} (Savage and Jenkins 1972) and $Av/E_{B-V}=3$ are adopted. The width of the extinction is about 2° in FWHM, or 200pc if the extinction originates in the 5 kpc ring. This is almost comparable to the situation in the solar neighborhood.



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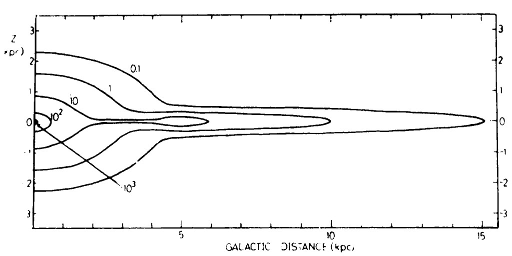
A slight concentration of the extinction ($A_{2.4}$=0.8 mag) toward the galactic center suggests existence of a dust layer in the innermost region of the Galaxy. The distribution corresponds with that of the far infrared emission detected by Hoffmann and Frederick (1969) and Soifer and Houck (1973). The total amount of dust required for the extinction is about 10^5 $M_\odot$, in good agreement with that estimated from the far infrared observations. The dust layer may have something to do with the large CO-clouds in the galactic center (Bania, 1977).

b) Distribution of Stars

The central bulge extends in a spheroid of ±15 in longitude by ±7°.5 in latitude, or ±2.5 kpc by 1.3 kpc in linear scale. The total luminosity corrected for extinction amounts to 2×10^{10} $L_\odot$, if 4000 K is assumed for the effective temperature of the constituent stars. This is comparable to the situation in M31.

The most conspicuous feature of the ridge component is its flatness between l=10°and 30°, which suggests an annular distribution of the emitter as proposed for the CO clouds distribution (Burton, 1977). It is also remarkable that the ridge is extremely narrow; its FWHM is about 3°.5. This would become much narrower, at most 2° as shown in Figure 3, if we correct the interstellar extinction derived above. The corresponding linear thickness is 300 pc in FWHM, if the annulus is located at a distance of 5 kpc from the galactic center. This would mean that the emitters are extreme Pop. I type objects such as protostars, O or B stars, or late supergiants.

Taking the interstellar extinction into account, a model distribution of volume emissivity of the 2.4 μm radiation is calculated so as to reproduce the observed brightness distribution. That is shown in Figure 5. The radial dependence of the volume emissivity is shown in Figure 6, together with that of the nucleus derived by Becklin and



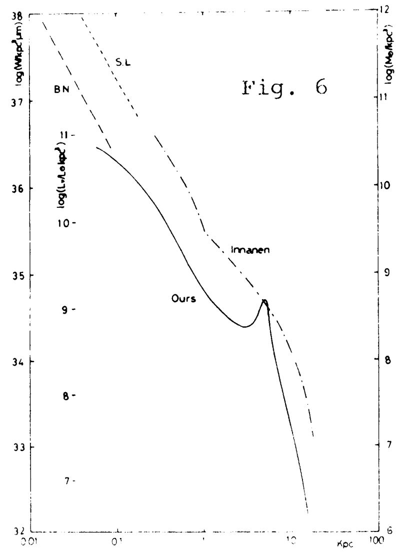


Fig. 6

Neugebauer (1968). They are compared with the mass density distribution estimated from the rotation curve of the Galaxy by Sanders and Lowinger (1972) and by Innanen (1973) in the same figure. They are almost parallel to the infrared emissivity distribution, except for an extraordinary enhancement of the latter around 5 kpc. If we assume 4000 K for an effective temperature of the constituent stars, the ratio M/L_{bol} becomes ~2 in the inner Galaxy, while 0.4 in the 5 kpc ring. The relatively small value of the first ratio suggests that giant type stars contribute to the luminosity of the bulge, while much more luminous objects should supply the luminosity in the 5 kpc ring. In this regard, it is worth remarking that CO clouds, thermal radio sources, HII regions, and OH/IR sources cluster in the same region (e.g. Burton 1976). They all indicate that the region is very active in star formation and rich in young generation objects.

Finally, a few words should be added about the anomalous enhancement at l=355°, b=-0°.7, which has no known identification with any optical or radio sources. The total flux of the excess intensity amounts to 3.5×10^{-10} W/cm^2 μm, or K=-1.5 mag. From the presently available data, it cannot be concluded whether the anomaly is due to a local decrement in the interstellar extinction or to some unknown source hidden from optical detection by the strong interstellar extinction. It is interesting to note, however, that the flux and the size are compatible to those of M32 (Penston 1973), if M32 were put at a distance of 40 kpc.

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