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OH/IR SOURCES NEAR THE GALACTIC CENTER

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ABSTRACT

We have carried out a 1612 MHz search for OH/IR stars near the galactic center with the 100 m telescope in Effelsberg. The survey covers a 2°.5 wide strip along the galactic equator between $l = 358°$ and $l = 15°$. In this *Letter* we briefly discuss the distribution in galactic coordinates and radial velocity of the strongest sources found. Our survey covers the tail of the "disk component" ($l > 5°$) known from earlier studies. In addition we find a strong "nuclear bulge" with a high source density at $|l| < 2°$. This is especially marked for sources with relatively small peak separations, which indicates either that the star-formation rate near the galactic center has decreased, or that stars with low masses form in relatively large numbers near the galactic center. The present sample shows no evidence for rotation in the nuclear bulge. The radial velocity distribution appears to be broader for the sources with smaller peak separations.
Subject headings: galaxies: Milky Way — masers — stars: late-type

I. INTRODUCTION

Since the discovery of OH maser emission at 1612 MHz from Mira variables and M supergiants by Wilson and Barrett (1972), several searches on regular coordinate grids have been undertaken (Caswell and Haynes 1975; Johansson *et al.* 1977; Bowers 1978*a*; Baud *et al.* 1979*b*). More than 200 maser sources have been discovered that show the double-peaked emission profile characteristic of Miras and M supergiants. These sources, known as OH/IR stars, are strongly concentrated toward the galactic plane ($\langle|b|\rangle \lesssim 1°$), and the longitude distribution shows a maximum near $l = 25°$.

We have searched for 1612 MHz OH sources close to the galactic center using the 100 m telescope in Effelsberg. The results of the first part of this so-called strip survey ($358° \leq l \leq 15°$; $|b| \leq 0°.5$) have been published by Baud *et al.* (1979*a*). Recently, we have extended the latitude coverage to $|b| \leq 1°.25$. In this *Letter* we present the results of a first inspection of the data now available.

II. OBSERVATIONS

The 100 m telescope has a half-power beamwidth of 8′ at 1612 MHz and an aperture efficiency of 0.49. The survey area was observed on a rectangular grid having a spacing of 7′.5 in both l and b. The cooled dual-channel 18 cm receiver system with two orthogonally polarized feeds had a system temperature on cold sky of 60 K in 1975 and 50 K in 1979. The 384 channel autocorrelator was split into two sections each with a bandwidth of 2.5 MHz and centered at a velocity of 0 km s^{-1} relative to the local standard of rest. Later, the spectra from both sections were added. The useful velocity range was 400 km s^{-1} and the resolution 2.9 km s^{-1} (uniform weighting). The observations were made in total-power mode with an integration time of 1 minute at each position, and averages of spectra free of features were used as off-line references.

The sensitivity of the survey is not uniform over the whole area owing to varying galactic background and ground radiation (the observations were made at elevations between 9° and 15°). The 3 σ level varies from 0.3 K at the highest longitudes to about 1 K close to the galactic center. An antenna temperature of 1 K corresponds to 0.72 Jy.

A full account of the observations and the reduction will be given when the complete results of the survey are published.

III. RESULTS

In this *Letter* we will consider all sources in the survey area with double-peaked emission profiles for which both peaks are stronger than 0.6 K (0.4 Jy). Peaks of this strength stand out clearly above the noise over the whole region with the exception of a small area around the galactic center (359° < l < 1°, $|b|$ < 0°.2). There, the detection of 0.6 K peaks is very difficult not only because of the high noise level but also because of the presence of sharp and strong absorption features at radial velocities between −200 and +100 km s^{-1}.

A total of 57 sources was found; of these, one is VX Sgr, 26 have been reported in Baud *et al.* (1979*a*, *b*), and the remaining 30 are new detections. We estimate that our final source list will contain about 120 double-peaked sources. The positions and radial velocities of the 57 strong sources found are plotted in Figure 1. Each position refers to the grid point where the peaks are strongest. Many sources are visible at more than one grid point so that eventually more accurate positions can be derived. The radial velocities given are the averages of the velocities of the two peaks. According to Baud *et al.* (1981*a*) and Baud, Habing, and Oort (1979) the separation of the peaks, ΔV, is a measure of the stellar population type, i.e., with increasing ΔV there is a decrease in the velocity dispersion with respect to galactic rotation and a decrease in latitude extent. Therefore, we have divided the sources into two groups of approximately equal size: filled circles in Figure 1 indicate sources with $\Delta V > 30$ km s^{-1} and open circles $\Delta V \leq 30$ km s^{-1}. For both groups the density is highest around $l = 0°$ (nuclear bulge), decreases toward higher longitudes, and rises again from $l = 10°$ to 15°. It should be stressed that this longitude distribution is not affected by the variable sensitivity over the survey area because of the fairly high cutoff limit of 0.6 K. Only the number of sources in the center of the nuclear bulge may have been underestimated.

Following the convention used by Baud *et al.* (1981*b*) we will distinguish between sources in the disk at $l > 5°$ and in the nuclear bulge at $l < 5°$. The radial velocities of most sources in the disk component are consistent with differential galactic rotation. The few sources with negative velocities indicate a fairly large velocity dispersion in the radial direction ($\sigma_\pi \sim 35$ km s^{-1}), as suggested by Baud *et al.* (1981*a*). The velocity distribution of the sources in the nuclear bulge is symmetrical around $V = 0$ km s^{-1} and shows no indication for rotation. However, a rotation velocity as high as 150 km s^{-1} would be masked by the velocity dispersion at a distance of 1° from the galactic center. The distribution of the low-ΔV sources is much broader than that of the large-ΔV sources, $\langle|V|\rangle \sim 90$ and 40 km s^{-1}, respectively. Apparently, the velocity coverage of the strip survey (±200 km s^{-1}) has been insufficient. In fact, we have made another survey, the "deep survey," confined to a circular area having a radius of 1° around the galactic center and a velocity range of ±400 km s^{-1}. Of the 32 double-peaked sources found, eight sources fall outside the velocity range covered by the strip survey.

The number of sources in the present sample and the latitude coverage of the survey are too small to draw firm conclusions about the latitude distribution. The sources in the disk component are symmetrically distributed around $b = 0°$ with some concentration toward the equator ($\langle|b|\rangle \sim 0°.4$). The low-$\Delta V$ sources in the nuclear bulge lie predominantly at positive latitudes, whereas the large-ΔV sources lie symmetrically around $b = 0°$. The distribution of the sources in the nuclear bulge appears to be flattened with an axial ratio (l/b) of about three. However, a smaller axial ratio cannot be excluded until the latitude coverage of the survey is extended.

The longitude distribution between $l = 10°$ and 15° agrees very well with the distribution found by Baud

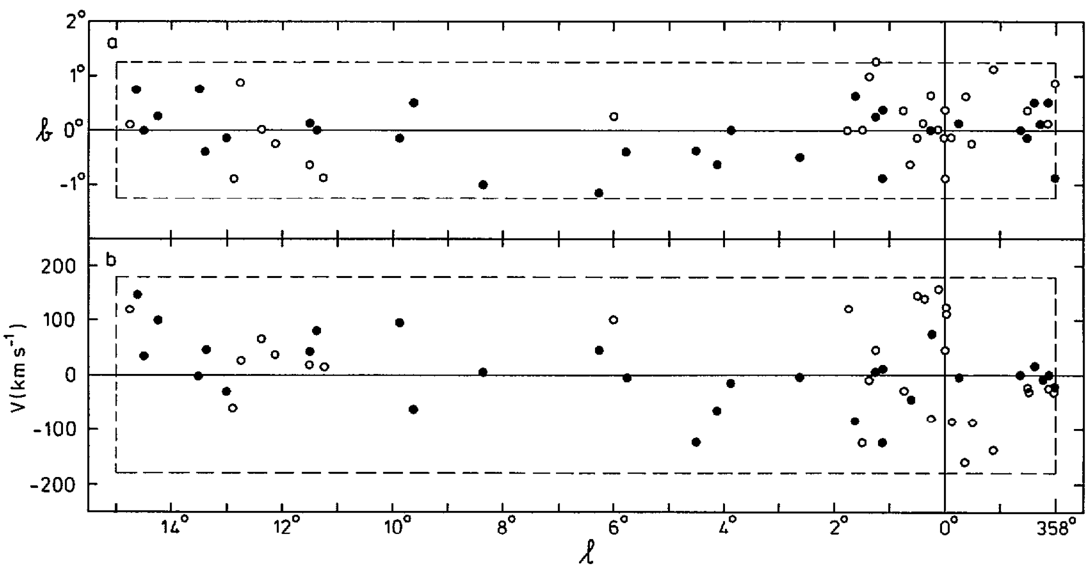

FIG. 1.—Distribution of OH/IR sources in galactic coordinates (*a*), and radial velocity (*b*) as a function of longitude. The dashed lines indicate the survey limits. Open circles refer to sources with peak separation $\Delta V \leq 30$ km s^{-1}, and filled circles to those with $\Delta V > 30$ km s^{-1}.

et al. (1981*a*) in a survey with the Dwingeloo telescope. The histograms in Figure 2 give the number of sources per 2° longitude interval in the Dwingeloo survey (restricted to $|b| \leq 1°25$) and the strip survey. The original histograms with bin sizes of 2° and 1°, respectively, have been smoothed with the function $(\frac{1}{4}, \frac{1}{2}, \frac{1}{4})$ to resolutions of 4° and 2°. The numbers of the strip survey have been divided by 3 in order to account for the

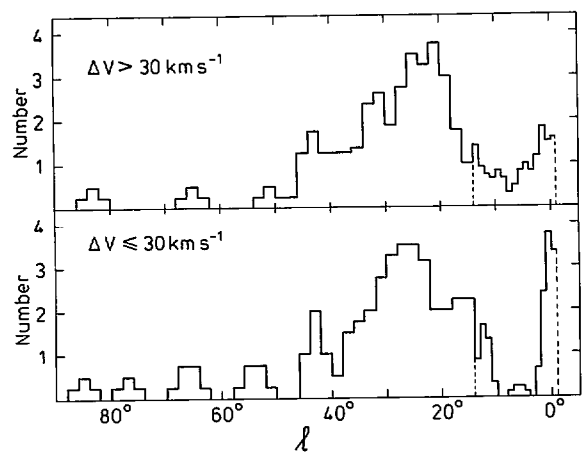

FIG. 2.—The number of OH/IR sources per 2° longitude interval in a 2°5 wide strip along the galactic equator, divided into two groups by peak separation. The data within the dashed lines are taken from the strip survey, those at $l > 14°$ from a survey with the Dwingeloo telescope. The numbers from the strip survey have been corrected in order to account for the higher sensitivity.

higher sensitivity (in the overlap interval $10° < l < 15°$ we found 15 sources in the strip survey, whereas five sources were found in the Dwingeloo survey).

Figure 2 clearly shows the presence of two components in the density distribution: the disk at $l > 5°$ and the nuclear bulge at $l < 5°$. According to Bowers (1978*b*) and Baud *et al.* (1981*a*) the maximum at $l \sim 25°$ is caused by a sharp maximum of the space density at 4.5 kpc galactocentric distance. From here the space density decreases very rapidly toward the galactic center. The present results indicate that the density rises again at about 1 kpc from the center. Baud *et al.* (1981*b*) did not find evidence for a strong nuclear bulge, mainly because their latitude coverage was so small that the results were strongly affected by the various selection effects discussed in their paper. Our new results agree with the distribution of the Mira variables by Feast, Robertson, and Black (1980).

It is remarkable that the nuclear bulge is much more prominent for the low-ΔV sources than for the large-ΔV sources since in the disk component there is no statistically significant difference between the longitude distributions of both groups. This result may have important implications. Baud *et al.* (1981*a*) concluded that the large-ΔV sources in the disk are on the average more massive and younger ($\sim 10^7$ yr, $\sim 10\ M_\odot$) than the low-ΔV sources ($\sim 10^9$ yr, $\sim 3\ M_\odot$). If the sources in the nuclear bulge are similar to those in the disk, the present result indicates either that the birthrate of stars near the galactic center has decreased since about 10^9 yr ago, or that the initial mass function near the galactic center is steeper than in the disk.

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