THE DETERMINATION OF GALACTIC ARMS FROM THE BRIGHTNESS DISTRIBUTION OF FAR INFRARED SOURCES

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ABSTRACT. From the *IRAS* catalogue we selected 10,001 young infrared (IR) sources which lie within the galactic plane. Their IR flux integrated over ±5° in latitude shows maxima at galactic longitudes l = 80°, 60°, 50°, 35°, –27°, –54°, and –74°, which directions are interpreted as tangents to the spiral arms. The resulting spiral arm pattern is nearly identical with the arms derived from observations of O and B stars.

1. INTRODUCTION

The spiral arm structure of the Galaxy is still an unsolved problem. Bright O and B stars determine only that part of the spiral arms which is near the sun. Using radio observations to determine the spiral arm structure has quite a few uncertain factors; therefore, it does not lead to unique conclusions. Applying infrared sources to find the galactic spiral arm structure is what we suggest. Our new approach complements the earlier methods.

Earlier, S. Hayakawa (1977) used the data of 2.4 μm infrared flux obtained by balloon observations to discover peak values of infrared flux at galactic longitudes l = 30° and 50°. This showed that th roman ere were two infrared-bright bands at radius r=5 kpc and 7.4 kpc from the center of the Galaxy. Anauth and Nagaraja (1981), using the "IRC" and "CRL" catalogs, found a maximum of infrared brightness at l=30°, which they considered to correspond to a spiral arm at R=5 kpc. Our paper is based on new IR source data, which makes it possible to explore the galactic spiral arm structure in more detail. Our method rests on the idea that young IR sources should be concentrated in spiral arms, and therefore the direction of maximum flux corresponds to tangents to the spiral arms.

2. APPROACH

Because the spiral arms are in the galactic plane, we need statistics only for IR sources within this plane within the range of galactic longitude l = ±84° and of galactic latitude b = ± 5°, divided into longitude intervals of 2°.

The most important problem is what kind of IR sources should be selected, because only the youngest IR sources undoubtedly reside in spiral arms. According to Honck (1984), the *IRAS* fluxes at λ = 25 μm, 60 μm, and 100 μm can be used to construct a color-color diagram of [log (S_{60}/S_{25}) − log (S_{100}/S_{60})], which has the young IR sources on the upper right part of the diagram. Therefore we can take $S_{100} > S_{60} > S_{25}$ as a condition for choosing young IR sources.

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3. RESULTS

From the *IRAS* catalogue, 10,001 IR sources within the galactic plane were selected on the basis of the above conditions. We then obtained the sum of IR flux S_{100} in each $2° \times 10°$ longitude and drew the diagram of IR surface brightness as a function of longitude (Figures 1 and 2). We can see that on top of a slowly varying base, indicated by the parallel bars, there are several brightness peaks: –74°, –54°, –27°, 35°, 50°, 60°, and 80°.

We think that these maximum flux directions should be tangent to the spiral arms, which we assumed to be logarithmic spirals, $\Lambda \ln r - 2\Theta = C$. A least-squares fit gives $\Lambda = 16.83$ and $C = 24.87$. The two curves nearly coincide with the Persei arm and Sagittarii arm at $R = 12.3$ kpc and $R = 8.7$ kpc from the galactic center as determined by bright O and B type stars. But there is also some difference because the bright stars have started to break away from the position where they formed. Although the direction $l = 80°$ is not tangent to the spiral line, it is through the Orion Arm, which is probably our local arm. We cannot explain the maximum at $l = 50°$, which is not tangent to the spiral arm we have observed. It may be due to a specially large IR source cluster splitting from the spiral arm.

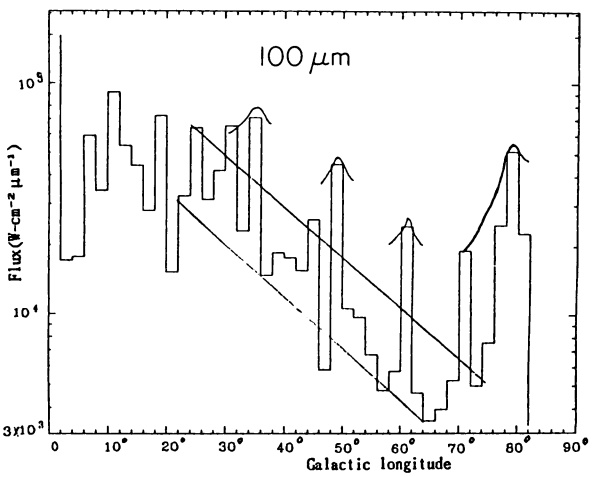

Figure 1. The IR surface brightness distribution at galactic longitudes $l = 0°$–$84°$.

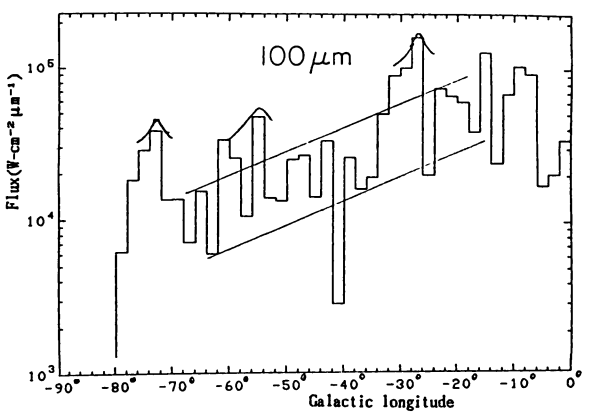

Figure 2. The IR surface brightness distribution at galactic longitudes $l = -84°$–$0°$.

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