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THE EMIR SURVEY OF THE GALACTIC PLANE

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RESUMEN

Cada vez aumentan más las evidencias de que en el interior de la Galaxia hay una barra mayor. La distancia al extremo cercano de la barra de $l = 27°$ fue medida utilizando directamente la aglutinación de gigantes rojas; la extensión de la barra es de $l = 27°$ a $l = -15°$, $|b| < 2°$, que también fue determinada a partir de exploraciones del IR medio y cercano. La siguiente etapa comprende el uso de la capacidad de objetos múltiples tan potente de EMIR para obtener espectros del IR cercano de una selección representativa de las fuentes.

ABSTRACT

There is increasing evidence that there is a major bar in the inner Galaxy. The distance to near end of the bar at $l = 27°$ has been directly measured by using red clump giants, and extent of the bar ($l = 27°$ to $l = -15°$, $|b| < 2°$) has also been determined from near and mid IR surveys. The next stage is to use the powerful multi-object capability of EMIR to obtain near IR spectra of a representative selection of the sources.

Key Words: **GALAXY: BULGE — GALAXY: KINEMATICS AND DYNAMICS**

1. INTRODUCTION

There is now a substantial consensus for there being a bar in the inner Galaxy. This was first suggested by de Vaucouleurs (1964) to explain the radio maps. The first evidence for a bar like distribution in the stars was derived from the asymmetries in the infrared (IR) surface brightness maps (e.g., Blitz & Spergel 1991; Dwek et al. 1995) and in the source counts (Weinberg 1992; Hammersley et al. 1994; Stanek et al. 1994), which both show systematically more stars at positive Galactic longitudes for $|l| < 30°$ close to the Galactic Plane.

The exact morphology of the inner Galaxy, however, is still controversial. Some authors refer to the bar as being a fatter structure, around 2.5 kpc in length with a position angle of 15-30 degrees respect to the Sun - Galactic Center direction (Dwek et al. 1995; Nikolaev & Weinberg 1997; Stanek et al. 1997; Binney et al. 1997; Freudenreich 1998; López-Corredoira et al. 1999; Bissantz & Gerhard 2002; Babusiaux & Gilmore 2005), other researchers suggest that there is a long bar with a half length of 4 kpc and a position angle around 45 degrees. It is noticeable that those authors supporting the 23° bar all examine the region at $|l| < 12°$, whereas those supporting the long bar with the larger angle are trying to explain counts for $30° > l > 10°$ and $-10° > l > -30°$.

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2. EVIDENCE FOR THE LONG BAR

The evidence for the long bar comes from many sources

2.1. *The large scale asymmetry in the star counts*

Hammersley et al. (1994) used the large scale surface brightness maps produced by DIRBE-COBE combined with star counts from the TMGS to explore the distribution of stars in the inner Galaxy. One of the most startling features is the large asymmetry in the counts with longitude (Figure 1). The large excess in star counts between $l = 15°$ and 30° compared with $l = -15°$ to $-10°$ can be clearly seen. In this paper it was shown that extinction, a ring, spiral arms or the exponential disc could not readily explain the features seen, but that a major in plane bar with half-length of about 4 kpc would.

2.2. *The luminosity function*

One of the typical features of a bar is a major star formation region where it is interacts with the disc. Hammersley et al. (1994) shows that the region $l = 21°$ to 27° has a very high number of extremely luminous stars, which was confirmed using spectroscopy of the sources (López-Corredoira et al. 1999). No other nearby region has anything like this density of extremely luminous stars, even $l = 32°$, which is the tangential point to the Scutum spiral arm.

2.3. *The red-clump giants*

The most successful method for determining source distances along a line of sight into the Galac-

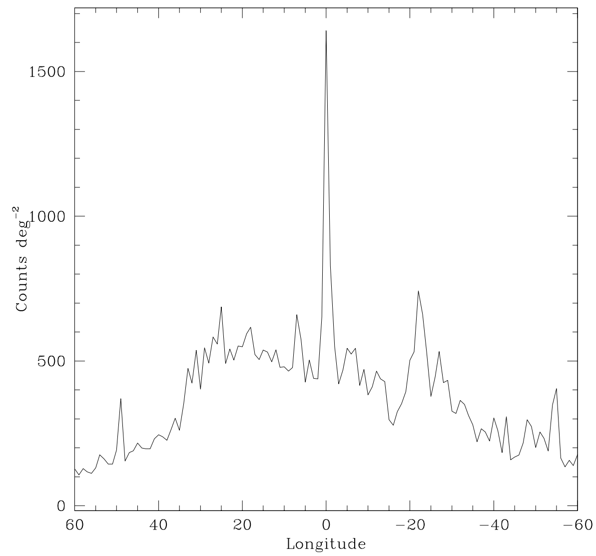

Fig. 1. MSX bands A (8 micron) counts for $|b| < 1°$ which clearly show the asymmetry in the inner Galaxy. This asymmetry is not seen when more than 2 degrees from the plane. As these are 8 micron counts, extinction cannot be the cause.

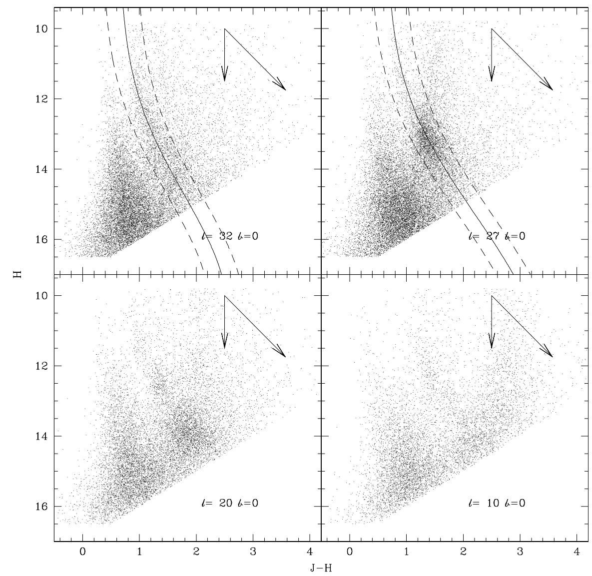

Fig. 2. These are 4 J-H colour magnitude diagrams for various locations along the plane. Notice the clump at $l = 27$ at $J-H = 1.2$ $H = 13.5$. This is not seen at $l = 32$ even though this line of sight is tangential to a spiral arm. This clump is seen, however, at $l = 20$ (but slightly redder) and by $l = 10°$ it merges with the bulge. The arrows show the effect of doubling the distance (vertical) or 10 magnitudes of visible extinction (diagonal).

tic plane is to use the red clump giants as a standard candle. The red clump giants have by far the highest space density of any giants and have a very restricted range of absolute magnitudes, with little dependence on age or matallicity at IR wavelengths. This means that they naturally form an identifiable feature clump on an IR HR diagram. Figure 2 shows J-H vs H diagrams for 4 in-plane regions taken on the 1.5-m TCS (Tenerife). The main sequence stars have relatively low intrinsic luminosities, so only the closer sources are detected and there is little interstellar reddening. They form the the triangular clump at $J - H$=0.5. To the right of the main sequence there is a diagonal curving stripe. This is formed by the red clump giants in the disc with increasing distance from the Sun. The solid line on the $l = 32°$ and 27° plots shows the position of a red clump star on this diagram assuming an exponential extinction law. This means that any position on the red clump stripe can be directly related to a distance from the Sun and extinction to that position i.e. it provides a direct distance scale which is independent of extinction. Furthermore the number of stars at a position along the stripe can be easily related to the density of old stars at a specific distance. Therefore, the red clump stripe can be used as a direct indicator for the old population along the line of sight.

Figure 2 shows the $J - H$ CMD for the on plane regions at $l = 32°$,27°, 20° and 10°. The $l = 32°$ plot clearly shows the red clump stripe from the disc giants. The $l = 27°$ plot also shows the disc giants but there there is a clear very dense cluster at $J - H = 1.2$, $H = 13.5$. This corresponds to a distance of about 6 kpc from the Sun. This dense cluster is also seen at $l = 20°$, butsignificantly redder. At $l = 10°$ the bulge can be seen. In Cabrera-Lavers et al. (2006) we trace the position of this clump of stars Figure 3. This clump is only seen for $28° > l$ within about 1 degree of the plane, and appears to be a feature which runs into the bulge at about $l = 10°$.

3. THE PROPOSED MORPHOLOGY

From the above we suggest that there are two triaxial features in the inner Galaxy:

• The triaxial bulge which is at an angle of 25° to the line joining the Sun and the Galactic Center. This is a shorter structure but extends far from the plane.

• An in plane bar with a half length of some 4 kpc and at an angle of 43° to the Sun-Galactic centre line.

Figure 4 shows shows a schematic of the Galaxy, including the ring and the spiral arms.

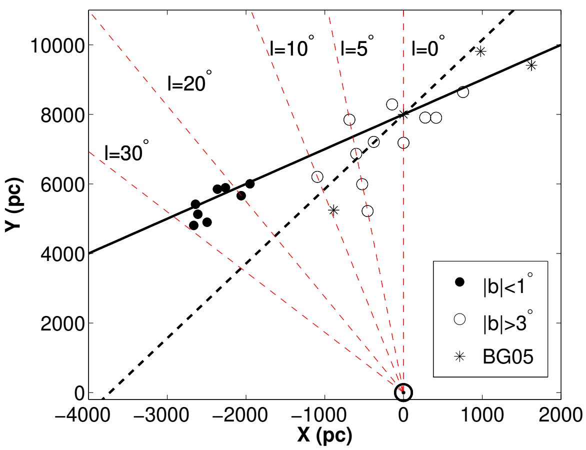

Fig. 3. The position where there is a very dense cluster of stars along various lines of sight. The dots are for on plane regions whilst the open circles are further from the plane. The data is taken from Cabrera-Lavers (2006) and Bausiaux & Gilmore (2005). The Sun is at 0,0 and the Galactic centre at 0,8000. The solid line running through the GC has an angle of 45° and the dense cluster between l=18 and 28 falls on this line. The strong dashed line is at an angle 25° and corresponds to the triaxial bulge.

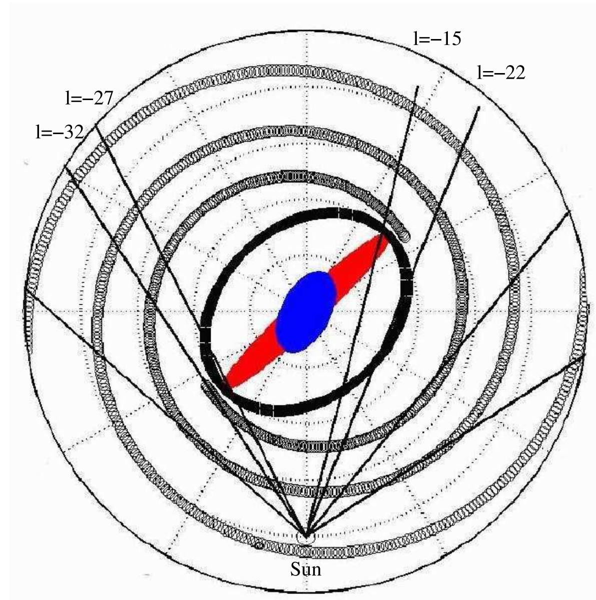

Fig. 4. A schematic of the Inner Galaxy.

4. SPECTROSCOPY

Obtaining spectroscopy is now fundamental to understanding the nature of the bar as this will give indication as to the matallicity and the age. The high extinction in the plane means that visible spectroscopy cannot reach the sources and so H/K spectroscopy is required with a resolution of about 1000 or above. The bar is a large feature and we need to sample sources at a number of locations. Hence in order to obtain a representative sample in each area we ideally need more than 1000 source in total. Attempting such a project is not feasible using a long slit spectrometer as it would take far too long, hence a multi-object instrument is required. Furthermore as the exposure times will be about 10 minutes on a 10m class telescope we need an instrument with a reconfigurable focal plane relatively quickly. EMIR will be the ideal instrument for such a project as it will allow 20 or more sources to be observed at the same time, and its FOV of 4×6 arc minutes will ensure sufficient targets in each field. Hence, in only a few nights it should be possible to complete the project.

5. CONCLUSIONS

There is now increasing evidence that the Galaxy is a double barred spiral, containing both a triaxial bulge and an in plane bar. However, in order to advance the study of this feature further near IR spectroscopy of a representative sample of the bar sources is required. EMIR is the ideal instrument for such a project.

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