RevMexAA (Serie de Conferencias), **26**, 84–85 (2006)

ARGO AND OTHER TIDAL STRUCTURES AROUND THE MILKY WAY

Helio J. Rocha-Pinto,[1,2] Steve R. Majewski,[2] and Michael F. Skrutskie[2]

RESUMEN

Se realizó una búsqueda de sobredensidades que pudieran estar asociadas con subestructuras en el halo galáctico en bajas latitudes a partir de una muestra de gigantes M de 2MASS. Bajo la hipótesis de que las poblaciones estelares en la Vía Láctea exterior deberían de estar distribuidas de manera más o menos simétrica, se utilizaron dos métodos para identificar asimetrías en la distribución (l, b) de gigantes M de 2MASS que pudieran ser indicios de sobredensidades estelares: (1) la verificación directa de simetría en campos reflejados sobre varios círculos mayores simétricos hipotéticos en la Galaxia; y (2) la extracción de un modelo galáctico simétrico para la distribución de gigantes M a partir de la distribución observada. Si bien podemos confirmar varios de los aspectos reportados previamente de la corriente de marea Monoceros, un hallazgo mayor de nuestro trabajo es que el núcleo aparente del sistema Monoceros no se localiza en Canis Major, como lo han sugerido otras exploraciones, sino con mayor probabilidad a mayor l, en la región de la antigua constelación Argo (actualmente Puppis, Vela y Carina). Además del extenso sistema Monoceros, identificamos varias otras sobredensidades de gigantes M, principalmente a mayores distancias. Algunas de ellas corresponden a sistemas encontrados previamente en Triangulo-Andrómeda y Perseo, mientras que la naturaleza de otros de menor significado permanece incierta o puede ser atribuida a asimetrías de primer plano de estrellas enanas M contaminantes.

ABSTRACT

A sample of 2MASS M giants is used to search for overdensities that may be associated with substructure in the Galactic halo at low latitudes. Under the hypothesis that stellar populations in the outer Milky Way should be more or less symmetrically distributed, two methods were used to identify asymmetries in the (l, b) distribution of 2MASS M giants that may be the signature of stellar overdensities: (1) direct symmetry checking in fields reflected across various hypothesized Galactic symmetric great circles; (2) and extraction of a symmetric Galactic model for the M giant distribution from the observed distribution. While we are able to confirm various previously reported features of the Monoceros tidal stream, a major finding of our work is that the apparent core of the Monoceros system is not in Canis Major, as other surveys have suggested, but more likely at larger l, in the region of the ancient constellation Argo (present-day Puppis, Vela, and Carina). In addition to the large Monoceros system, we identify several other more tenuous overdensities of M giants, primarily at larger distances. Some of these correspond to previously found systems in Triangulum-Andromeda and Perseus, while the nature of others of lesser significance remains uncertain or can be attributed to foreground asymmetries of contaminating M dwarf stars.

Key Words: **GALAXIES: INTERACTIONS — GALAXY: DISK — GALAXY: STRUCTURE**

1. MOTIVATION AND DATA SELECTION

Since the discovery of the Monoceros Stellar Stream (hereafter, MSS) by Newberg et al. (2002), a number of studies have addressed the properties of this system (see Rocha-Pinto et al. 2006, and references therein). While the existence of this stellar stream have been confirmed by several independent groups, the origin and center of the structure are subjected to intense debate. Recently, Martin et al. (2004) claim to have found the core of a satellite galaxy in Canis Major (“CMa”; $l \sim 240°$), which they argue to be the progenitor of the MSS.

In order to study the MSS, we have extracted a giant star candidate sample from the 2MASS point source release as all stars having dereddened $0.85 < J - K_S < 1.5$, $K_S < 13.0$, and that meet a M giant color locus restriction (details about the sample, as well as how the distance of each star was calculated, can be found in Rocha-Pinto et al. 2006). From this sample, we call into question the existence of a “core” overdensity in CMa, and find an apparently more significant giant star overdensity at $l \sim 290°$, which we claim to be a more physical indicator of the MSS center. We name this newly-found stellar overden-

[1]Observatório do Valongo, UFRJ, Rio de Janeiro, RJ 20080-090, Brazil (helio@ov.ufrj.br).

[2]Department of Astronomy, University of Virginia, Charlottesville, VA 22903, USA.

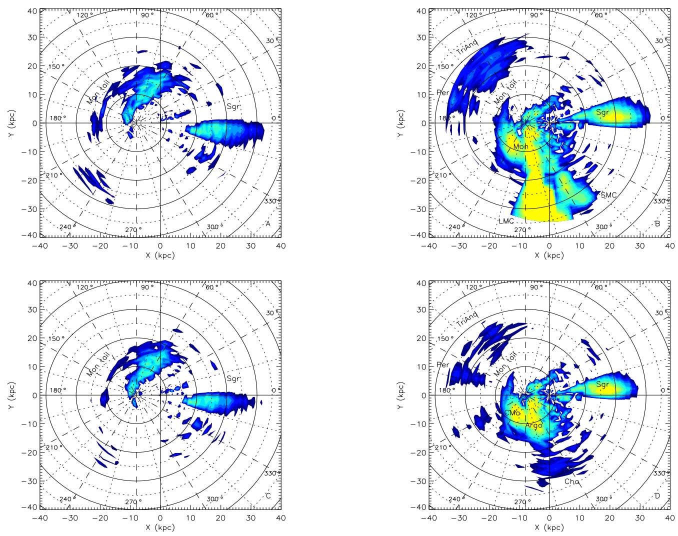

Fig. 1. Asymmetries in the 2MASS M giant candidate distribution with respect to the Galactic plane. The left and right panels show the residual overdensity in the northern and southern hemispheres, respectively. In these plots, the sample was limited to $-25° < b < +25°$, in order to avoid the Magellanic Clouds. The solar position is $X = -8$ kpc, $Y = 0$ kpc. A number of known structures can be seen in these plots: The Monoceros stream, Sagittarius, the TriAnd and Perseus systems (Rocha-Pinto et al. 2004). The large southern hemisphere stellar group from 5 to 15 kpc from the Sun, between $220° < l < 300°$ comprises the presumed center of the Monoceros system. Two main overdensities can be seen in this system: CMa and Argo. We have found that Argo has 2-3 times more stars than CMa.

sity as Argo, from the ancient constellation towards which it has been found.

2. ASYMMETRY MAP

Figure 1 summarizes most of our findings. It shows M giant asymmetry maps projected onto the Galactic plane, for stars having $-25° < b < +25°$. Several features in these maps can be identified with known satellite galaxies, while others are new findings as the TriAnd + Perseus systems (Rocha-Pinto et al. 2004) and Argo. It is apparent that there is a continuity between the Argo and CMa overdensities. We have verified that when these overdensities are projected onto the celestial sphere (Rocha-Pinto et al. 2006), there is a continuous increase in the stellar density from CMa to Argo, except for a blocking reddening feature at $l \sim 265°$, reinforcing our hypothesis that CMa is part of the Argo stellar system.

Among the other stellar structures discovered by our analysis, the Chamaleon stellar overdensity, $[l, b] \sim [300°, -20°]$ at 32 kpc from the Sun, looks like a star 'cloud' similar to TriAnd and Perseus. Moreover, we have found that the stellar feature called 'Structure A' by Martin et al. (2004) corresponds to an arc-like structure that resembles a tidal stream (seen as the thick arc-like overdensity, from 5 to 20 kpc, in the left panel of Figure 1). Observations are still necessary to investigate the origin of these objects.

3. THE WARP HYPOTHESIS

We have compared our stellar asymmetries with the asymmetries in the gas distribution caused by the Galactic disk warp (Rocha-Pinto et al. 2006). We have found that the stellar overdensities are 2-5 kpc closer to the Sun than the maximum H I asymmetries at the lines of sight where the disk warp is larger. Moreover, there is no stellar overdensity counterpart of the northern hemisphere H I warp in our data. From these facts, we conclude that both CMa and Argo overdensities are not signatures of the Galactic disk warp.

REFERENCES

Martin, N. F., Ibata, R. A., Bellazzini, M., Irwin M. J., Lewis, G. F., & Dehnen, W. 2004, MNRAS, 348, 12

Newberg, H. J., Yanny, B., Rockosi, C. M., et al. 2002, ApJ, 569, 245

Rocha-Pinto, H. J., Majewski, S. R., Skrutskie, M. F., & Crane, J. D. 2003, ApJ, 594, L115

Rocha-Pinto, H. J., Majewski, S. R., Skrutskie, M. F., Crane, J. D., & Patterson, R. J. 2004, 615, 732

Rocha-Pinto, H. J., Majewski, S. R., Skrutskie, M. F., Patterson, R. J., Nakanishi, H., Muñoz, R. R., & Sofue, Y. 2006, ApJ, 640, in press