THE SPIRAL STRUCTURE OF OUR GALAXY

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ABSTRACT

The study of the structure of our Galaxy requires to determine the distance of young objects (especially O and B stars). We review the method used and the main results of our study of the large scale structure of our Galaxy before presenting the potential improvements of the Gaia data.

Key words: Galaxy: structure; Young stars.

1. INTRODUCTION

The tracing of the spiral structure of our Galaxy requires to identify and determine the position of the star-forming complexes. Each complex can be seen as a parental molecular cloud with associated ionised hydrogen, young stars and young clusters. The analysis of the ionised gas at Hα wavelength is essential to associate the radio sources to their molecular parental cloud, using velocity and spatial similarity. In parallel, the exciting stars of the ionised gas make the link between the velocity of the complex and the stellar distance.

In this framework we have performed a Hα survey of the southern Milky Way (with a scanning Fabry-Perot interferometer). Coupled with multi-wavelength data, this allowed us to establish a star-forming complexes catalogue from which we traced the spiral structure and study the kinematic of our Galaxy (Russeil 2003). But, such a study depends on the distance of HII region exciting stars. Still today a lot of exciting stars have no known or very uncertain spectro-photometric distance.

The Gaia project is a great opportunity to determine precisely the distance of the exciting stars of HII regions.

2. THE TRACERS OF THE SPIRAL STRUCTURE

Star-forming complexes are the main tracers of the spiral structure. Each complex can be seen as a parental molecular cloud with associated ionised hydrogen (HII regions and diffuse emission) and young stars (O, B stars, young open clusters, OB associations). The drawing of the structure is very difficult because of the superimposed information along the line of sight. Hence the strategy to find the structure of our Galaxy follows two steps:

1. Complex delimitation and listing (grouping young objects)
2. Distance determination (stellar and/or kinematic distance).

In this framework we performed a Hα survey of the southern Galactic plane (4th Quadrant). The observations used a Scanning Fabry-Perot inteferometer (free spectral range: 115 km s^{-1}; sampling step: 5 km s^{-1}) and a photon counting detector attached to the 36 cm telescope (Field of view: $39'2$; pixel size: $9''$) installed at La-Silla Observatory. This gives the velocity information all over the observed field in the direction of star-forming complexes. Thanks to this survey a large number of HII regions were optically detected (+ Hα velocity determination) and the diffuse Hα emission (Warm Interstellar Medium) appears to be always detected, even in ‘empty fields’, with similar velocity as the discrete HII regions. Sometimes it is the only arm tracer (e.g., $l = 298°$).

With the help of additional multi-wavelength (molecular, radio recombination and absorption lines) information (from the literature), we delimitated the star-forming complexes (by grouping the young objects), determined their systemic velocity (taking into account the HII regions internal motions and the kinematic spread of objects belonging to the same complex) and solved the distance ambiguity problem.

3. THE DISTANCE DETERMINATION

Our study is based on stellar distance (when exciting star(s) of HII region is identified) and/or kinematic distance determination. The stellar distance is the spectrophotometric distance (adopting a mean calibration system, see Russeil (2003)) while the kinematic distance is obtained adopting the rotation curve of Brand & Blitz (1993) .

The stellar distance uncertainty on an individual star is $\sim$25% (e.g., Brand & Wouterloot 1988; Reed 1996).

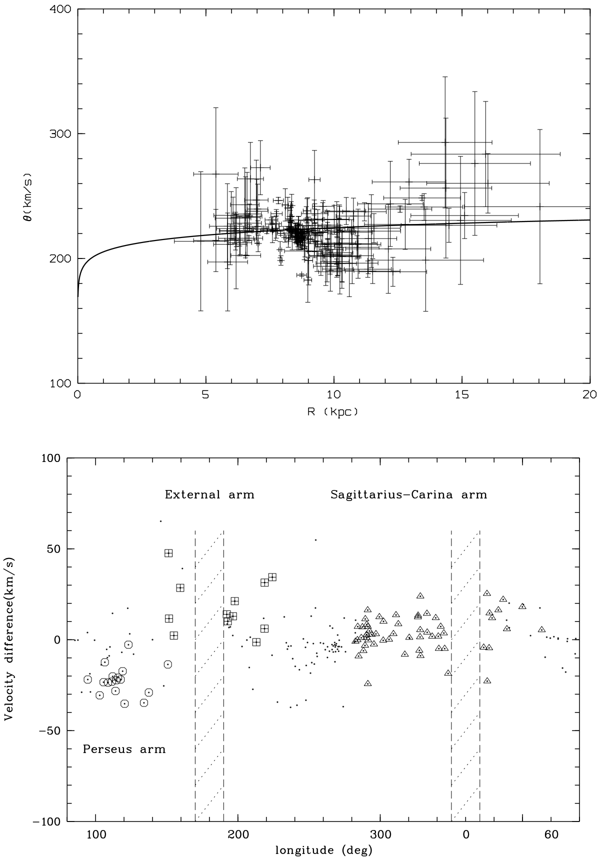

Figure 1. Rotation curve (top) and velocity departures (bottom) obtained from our star-forming complexes catalogue (Russeil 2003)

This uncertainty comes from uncertainties on the spectral type determination and the M_V–spectral type relationship. The interstellar extinction makes the determination of stellar distance only local ($<$ 6 kpc) while the Galaxy extends up to 20 kpc. This implies an incomplete coverage of the rotation curve as well as its dependance on the stellar distance uncertainty (large scatter and error bars).

We expect the Gaia data to measure the distance of the exciting stars of local and distant HII regions.

4. THE GALAXY KINEMATIC

From complexes with stellar distance we extracted kinematic information (adopting $R_\odot = 8.5$ kpc and $\theta_\odot = 220$ km s^{-1}): rotation curve and velocity departures (Figure 1).

The rotation curve shows a large scatter altogether with large error bars. The mean rotation curve is used to determine the kinematic distance of star-forming complexes. Velocity departures are observed with slightly different values from arm to arm. Let us note that we are limited to close arm structure.

The Gaia data should help us to measure the rotation curve, a key data, for the study of our Galaxy kinematic and structure as well as to follow and measure the velocity departures along longer arm sections.

5. CONCLUSION

Because stellar distances are the first step of the study of our Galaxy (Figure 2), the conclusions exposed here concerning the spiral structure and kinematic of our Galaxy could be drastically changed or greatly improved due to the new data from Gaia.

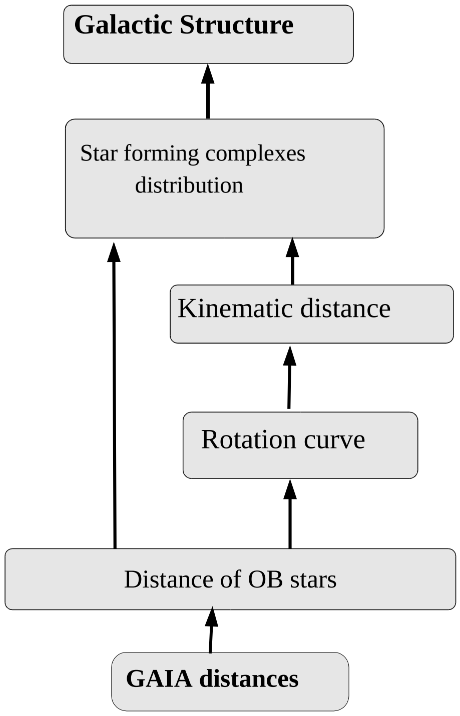

Figure 2. Summarized method for the study of our Galaxy.

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