Rediscovering our Galaxy
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Structure in the Milky Way

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Abstract. The morphological and chemical structure of the Milky Way today is an important constraint on models of the formation and evolution of the Galaxy. We use H II regions, the sites of recent massive star formation, to probe both the Galactic spiral structure and the Galactic metallicity structure. H II regions are the brightest objects in the Galaxy at radio wavelengths and are detected across the entire Galactic disk. We derive the distances to H II regions using parallax measurements or by deriving kinematic distances. Here we summarize ongoing work to assess the accuracy of kinematic distances and to complete the census of Galactic H II regions in the Southern sky.

Keywords. Galaxy: structure, ISM: H II regions, radio lines: ISM

1. Background

Until recently, the census of Galactic H II regions was vastly incomplete. These sites of massive star formation are the archetypical tracer of Galactic structure and can be found across the entire Galactic disk at radio wavelengths. We are using the most sensitive radio telescopes in the world to complete the Galactic H II region census and to probe both the morphological structure and metallicity structure of the Galaxy.

In the Green Bank Telescope (GBT) H II Region Discovery Survey (HRDS) we identify H II region candidates based on their coincident 24 μm (MIPSGAL), 8.0 μm (GLIMPSE) and 20 cm (VGPS) continuum emission. We use the GBT to search for hydrogen radio recombination line (RRL) emission to determine if the candidate is a *bonafide* H II region. With a 95% detection rate, we discovered 448 new H II regions – more than doubling the number of known H II regions in the surveyed zone ($343° < \ell < 67°$, $|b| < 1°$) (Bania *et al.* 2010; Anderson *et al.* 2011)

2. Southern H II Region Discovery Survey (SHRDS)

The Southern sky census of Galactic H II Regions is incomplete due to a lack of sensitive radio surveys. We are using the Australia Telescope Compact Array (ATCA) to search for RRL emission from *WISE* Catalog candidate H II regions in the Southern sky (Brown *et al.* 2017). This 600+ hour project began in 2015 and is ongoing. Based on a preliminary inspection of our first 200 hours of data, we have already discovered at least 150 new Southern sky H II regions, and we expect to find at least 150 more once the project is complete (Wenger *et al.*, in prep.).

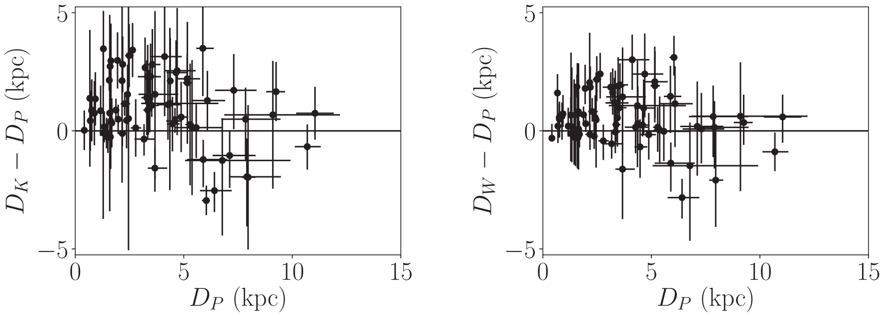

Figure 1. Left: difference between the kinematic and parallax distance using the "traditional" kinematic distance method and the Brand & Blitz (1993) rotation curve. Right: the same but using our new kinematic distance method and the Reid *et al.* (2014) rotation curve. The new method produces kinematic distances with smaller uncertainties and in better agreement with the parallax distances.

3. Kinematic Distances

Distances to Galactic H II regions are derived in two ways: by measuring the parallax of a molecular maser associated with the high mass star forming region (HMSFR), or by assuming a model of Galactic rotation and determining the kinematic distance. The "traditional" kinematic distance method assumes a model of Galactic rotation and determines an object's distance based on the best match between the object's velocity and the rotation model. Our new method uses the same principles, but we Monte Carlo re-sample the rotation model and other parameters within their uncertainties to determine the probability distribution function (PDF) of the kinematic distance. This PDF allows us to determine both the most likely kinematic distance as well as the range of possible kinematic distances (i.e. the kinematic distance uncertainty). By comparing the kinematic distances and parallax distances for 75 HMSFRs, we find this new kinematic distance method is both more accurate and produces more reasonable kinematic distance uncertainties than the "traditional" kinematic distance method (Wenger *et al.*, in prep; see Figure 1). The mean difference between the parallax and "traditional" kinematic distances is 48% (1.03 kpc) whereas with our new method the mean difference is 24% (0.54 kpc).

4. Summary and Future Work

We are completing the census of Galactic H II regions and using this census to probe the morphological and metallicity structure of the Galaxy. With our new kinematic distance method we will derive more accurate distances and distance uncertainties to these nebulae which will allow us to construct the most accurate face-on view of Galactic morphological and metallicity structure.

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