Publ. Astron. Soc. Aust., 1999, 16, 38–41

Blind H I Survey in the Great Attractor Region

S. Juraszek

School of Physics, University of Sydney, NSW 2006, Australia
s.juraszek@physics.usyd.edu.au
Australia Telescope National Facility, CSIRO, PO Box 76, Epping, NSW 2121, Australia
Sebastian.Juraszek@atnf.csiro.au

Received 1998 November 9, accepted 1999 January 28

Abstract: Optically, the Zone of Avoidance (ZOA) can only be explored to within a few degrees of the Galactic Equator. This restriction does not apply to radio wavelengths where we are able to detect galaxies at great distances behind the Galactic Plane. Using the Parkes 21 cm multibeam instrument we have detected neutral hydrogen (H I) in 42 galaxies in the region of the Great Attractor. We have been able to identify nine galaxies and make positional associations with a further six from existing optical catalogues, which makes at least 60% of these galaxies new discoveries.

Keywords: surveys—galaxies: distances and redshifts—galaxies: fundamental parameters—radio lines: galaxies

1 Introduction

Visual identification of galaxies is possible down to Galactic latitudes as low as 5° (e.g. Kraan-Korteweg et al. 1994, 1997). However, within 5° of the Galactic equator, observations at all infrared and optical wavelengths become very difficult and ultimately confusion-limited (Lu et al. 1990). In this latitude range, neutral hydrogen (H I) observations at λ 21 cm have been used with considerable success. The two main limitations in detecting galaxies using this method come from the H I and continuum emission from our Galaxy. The local H I emission covers a narrow velocity range of −100 to +100 km s^{-1} and in this range extragalactic H I may be masked. While continuum sources cover the entire velocity range of the observation and mask galaxies by reducing sensitivity, in general they only cover very small areas of sky.

The new Parkes 21 cm multibeam receiver (Staveley-Smith 1997) has an array of 13 feed horns (each having two receivers with orthogonal linear polarisations) mounted hexagonally in the prime focus of the Parkes* 64 m telescope. The system has a beamwidth of 14·3′ (FWHP). The Parkes H I multibeam instrument is ideal for surveying large areas in a relatively short time with a sensitivity previously unavailable.

We present some of the first results of a blind H I survey for galaxies in the direction of the Great Attractor. The surveyed region covers Galactic longitudes 308° to 332° and Galactic latitude $|b| \leq 5°$ with a velocity range of −1200 to +12700 km s^{-1}. This survey has detected H I in 42 galaxies.

2 Data Analysis and Results

This blind H I survey comprises data from three standard ZOA fields. Each standard field is 8° × 10° in size and has been scanned four times (when the ZOA Survey is completed this region will have been observed 25 times hence the data presented here are only 16% of the final ZOA Survey). These data have then been gridded together using specially developed aips++ routines (Barnes 1998). The data are Nyquist sampled (Staveley-Smith et al. 1998). The final data cube has an rms noise of 20 mJy beam^{-1}, a gridded beam size of 15·5′ and pixel size of 4′×4′, with a velocity resolution of 18 km s^{-1}.

The data cube was searched visually three times in different orientations to confirm identification and classification of candidate H I sources. After careful application of flux limits and selection criteria, we have a final catalogue of 42 H I detections. For all the detections we have found that the profiles exhibit either the classical double horn profile of an edge-on spiral galaxy (Figure 1) or a Gaussian profile of a face-on or irregular galaxy (Figure 2). We have found no H I galaxies in this region with negative velocities, indicating motion towards the Local Standard of Rest.

We have attempted to identify these sources using various other catalogues. In our search, we have

* The Australia Telescope is funded by the Commonwealth of Australia for operation as a National Facility managed by CSIRO—see Frater & Brooks (1992).

 1323-3580/99/010038$05.00

https://doi.org/10.1071/AS99038 Published online by Cambridge University Press

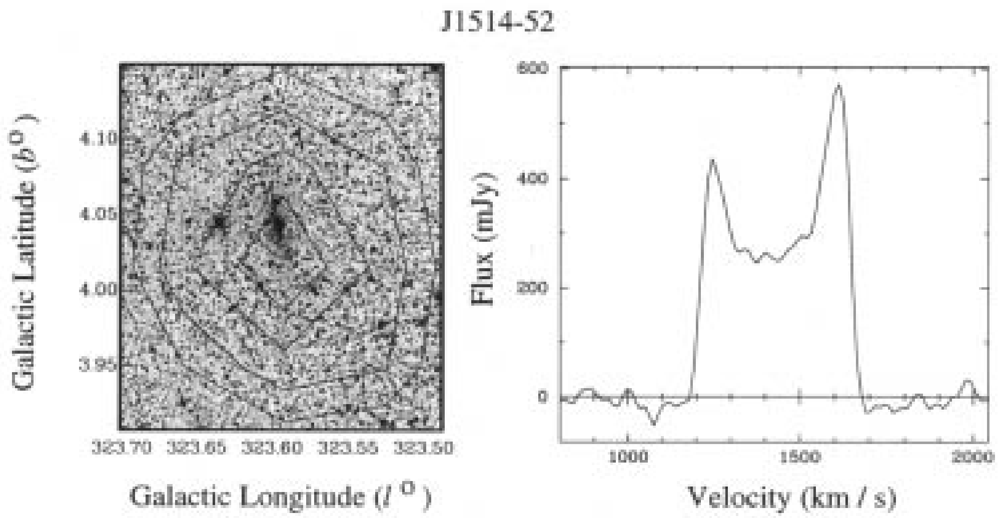

Figure 1—(*Left*) The Parkes multibeam HI contours are shown overlayed on the Digitized Sky Survey (DSS) image of a previously identified galaxy J1514 −52 (ZOAG G323·59− 04·04). (*Right*) The line profile of J1514 −52 shows the classical double horn profile expected for a nearby HI rich edge-on spiral galaxy.

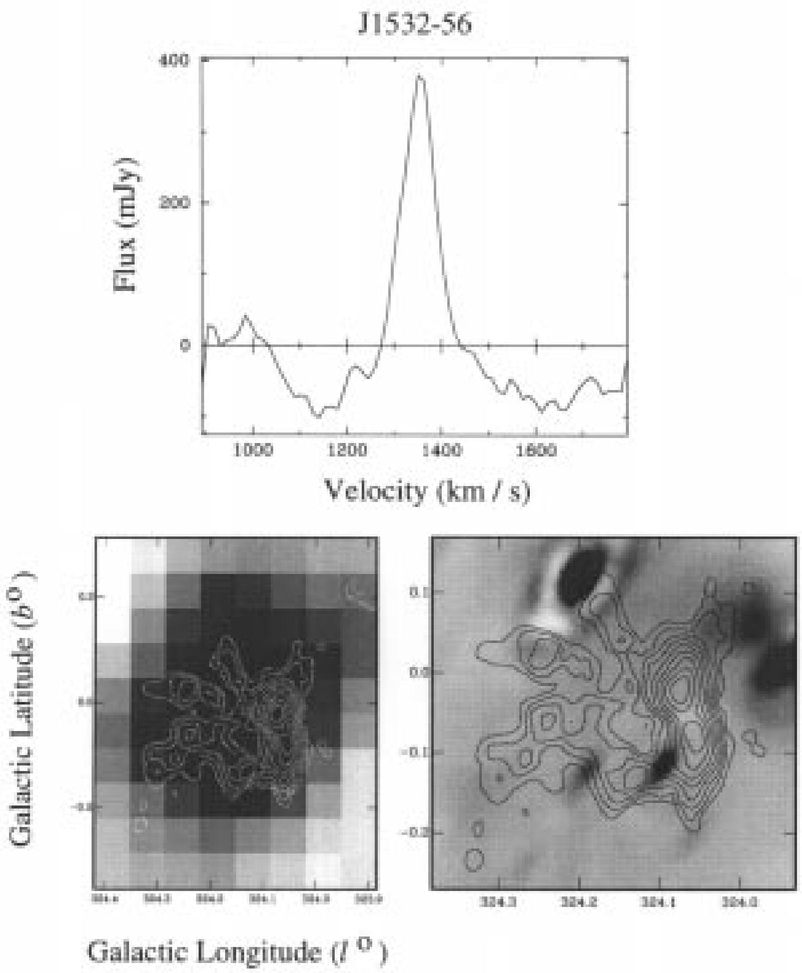

Figure 2—(*Top*) A narrow, single-peak, velocity profile of galaxy J1532−56, which is at approximately the same distance as J1514−52. The HI profile appears more like that expected for a face-on or an irregular galaxy. This galaxy has not been detected previously. The optical image of this region shows only foreground stars. (*Below Left*) The HI contours from the Australia Telescope Compact Array (ATCA) follow-up observations (Staveley-Smith et al. 1998) are plotted on a column density image from the Parkes multibeam. The ATCA shows unexpected amounts of structure suggesting it is an interacting system of two galaxies. (*Below Right*) The HI contours have been plotted on an IRAS Galaxy Atlas (IGA) image at 60 μm (Cao et al. 1997). These IRAS data have been super-resolved to 1–2 arcmin resolution.

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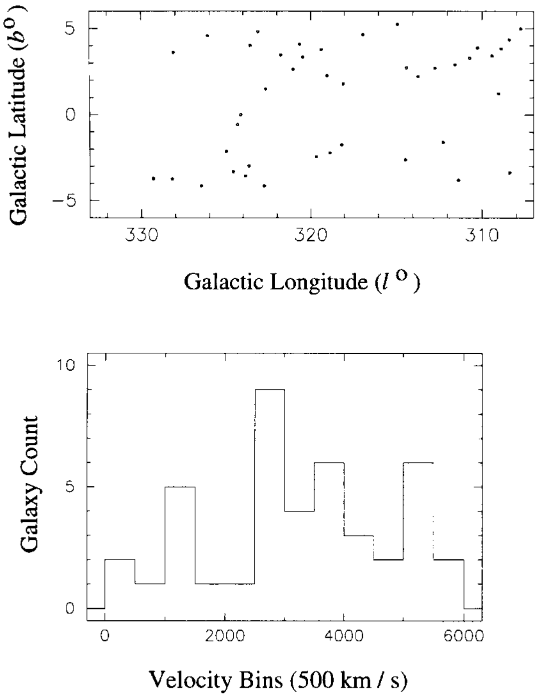

Figure 3—(*Top*) The distribution on the sky of the 42 HI detected galaxies. (*Bottom*) The velocity distribution histogram with a bin size of 500 km s^{-1}. The velocities (cz) calculated have been corrected for Local Group Motion.

used both position and velocity information, to make galaxy identification. The two main catalogues that we have used in the process are KKWH (Kraan-Korteweg et al. 1997) and the IRAS Point Source Catalog (Version 2, 1998, hereafter PSC). With a search radius of $6'$ we identified 15 galaxies, of which six have no redshift information, so their association is tentative. No further associations or identifications were found using NED.† Conservatively at least 60% of the galaxies that we find in the ZOA are new discoveries; this value will increase with the full sensitivity survey.

The KKWH catalogue allows us to comment on the morphology of some of the HI detected galaxies in our sample. We have been able to associate the following morphologies with our HI detections: 24% spirals; 10% barred spirals; and 5% ellipticals or spiral bulges. This leaves at least 60% with no observable Hubble morphology. Morphology classification in the ZOA is difficult due to the varying levels of extinction caused by our Galaxy. Foreground absorption may obscure the outer parts of spiral galaxies leaving only the bulge distinct.

The IRAS PSC together with the IRAS Galaxy Atlas (Cao et al. 1999) was used to obtain infrared flux densities (not colour-corrected) and further

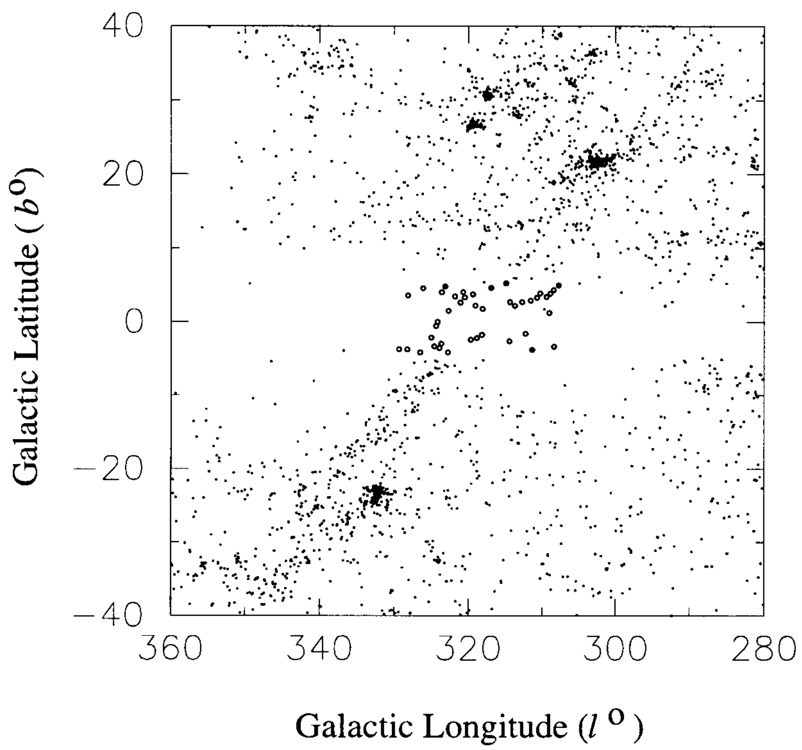

Figure 4—HI detected galaxies (°) are plotted over a distribution of optically identified galaxies (·) with velocities in the range 0 to 6000 km s^{-1} (Durand et al. 1994). The large area of sky shows the connection of the detected galaxies to the large scale structure. Filled circles denote galaxies with optical counterparts from the above database.

† The NASA/IPAC Extragalactic Database (NED) is operated by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

https://doi.org/10.1071/AS99038 Published online by Cambridge University Press

associations. A total of 12% of the HI galaxies were associated with IRAS sources which have no optical counterparts in the KKWH catalogue. We have used selection criteria to minimise the possibility of chance alignment between a HI galaxy and a Galactic IRAS source.

The Parkes telescope beam at 21 cm resolved four of the galaxies for which we have calculated HI diameters, measured at the 50% peak brightness level. The HI diameters are in the range 50 to 110 kpc. Using this result, an indicative total mass was calculated ranging from 2×10^{10} to 2×10^{11} $M_\odot$.

The range in velocity within which we found galaxies is 100 to 6000 km s^{-1}. Although this reflects the sensitivity limit of the data, it does show that there are no unusually HI-rich galaxies within the fiducial velocity range of the Great Attractor. The range of HI masses is $\sim5\times10^7$ to 2×10^{10} $M_\odot$, where we have used $H_0 = 75$ km s^{-1} Mpc^{-1}. Figure 3 shows the distribution of our 42 galaxies in Galactic coordinates and in velocity. We do detect an over-density at 3000 to 4000 km s^{-1}. Further observations are required to determine the precise over-density of the region. We also show the HI detected galaxies on a plot of optically identified galaxies (Durand et al. 1994) to show the connectivity of large scale structures in the local universe (Figure 4). For the first time we have a clear view of the continuation of this large scale structure across the ZOA.

3 Discussion

The HI galaxies detected in the Parkes multibeam ZOA Survey are usually all undetectable in the optical. Considering that we are only looking at 16% of the final survey data for this region and are rejecting sources below 3σ rms noise, we have detected a significant number of galaxies. Preliminary results from the first full sensitivity ZOA Survey data cube in this region suggests that we can detect one galaxy per square degree.

Multibeam HI observations are proving to be an efficient way to discover previously unknown galaxies. Once detected, we also obtain redshift, distance, HI mass and, in some cases, HI diameter information at the same time. The derived properties (HI mass, diameter, total mass) for the 42 galaxies detected in this region are comparable to those of nearby optically-selected samples of spiral galaxies. The infrared properties are also representative of a nearby, optically selected sample.

Acknowledgments

I would like to acknowledge the support of the ZOA Survey Team, and the assistance of Lister Staveley-Smith and Reneé Kraan-Korteweg is greatly appreciated.

References

Barnes, D. G. 1998, in ADASS VII (San Francisco: ASP), p. 32
Cao, Y., Terebey, S., Prince, T. A., & Beichman, C. A. 1997, ApJ, Suppl., 111, 387
Durand, N., Bottinelli, L., Gouguenheim, L., Paturel, G., Gamier, R., Marthinet, M. C., & Petit, C. 1994, in Unveiling Large-scale Structures behind the Milky Way, ASP Conf Ser. 67, eds C. Balkowski & R. C. Kraan-Korteweg (San Francisco: ASP), p. 257
Frater, R. H., & Brooks, J. W. 1992, J. Electr. Electron. Eng. Aust. (special issue), 12, no. 2, June
IRAS Point Source Catalogue 1998, Version 2, Joint IRAS Science Working Group (Washington: GPO)
Kraan-Korteweg, R. C. 1996, Nature, 379, 519
Kraan-Korteweg, R. C., Loan, A. J., Burton, W. B., Lahav, O., Ferguson, H. C., Henning, P. A., & Lynden-Bell, D. 1994, Nature, 372, 77
Kraan-Korteweg, R. C., Woudt, P. A., & Henning, P. A. 1997, PASA, 14, 15
Lu, N. Y., Dow, M. W., Houck, J. R., Salpeter, E. E., & Lewis, B. M. 1990, ApJ, 357, 388
Staveley-Smith, L. 1997, PASA, 14, 111
Staveley-Smith, L., Juraszek, S., Koribalski, B. S., Ekers, R. D., Green, A. J., Haynes, R. F., Henning, P. A., Kesteven, M. J., Kraan-Korteweg, R. C., Price, R. M., & Sadler, E. M. 1998, AJ, 116, 2717

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