**AUSTRALIA TELESCOPE OBSERVING APPLICATION**

PKS

yr,term: 2001MAY

ATNF use
ident:
rcvd:

# PARKES TELESCOPE

SEND TO: Director, ATNF, P.O. Box 76, Epping, NSW 2121, Australia

For ATNF information see : http://www.atnf.csiro.au

**1. Title of proposal:**

A Northern and Bulge Extension to the ZOA survey

| **2. Authors** Principal investigator on line 1 | **Institution/Country** | **for Ph.D. thesis ?** | **Present at Parkes ?** |
|---|---|---|---|
| L.Staveley-Smith, B.Koribalski | ATNF | | Y |
| P. Henning, R. M. Price | Univ. New Mexico (USA) | | Y, Y |
| R. Kraan-Korteweg | Univ. Guanajuato (Mexico) | | Y |
| E. Sadler, A. Green | Univ. Sydney | | Y Y |
| A. Schroeder, I. Stewart | Nice (France), Univ. Leicester (UK) | | Y Y |

**3. Contact author and mailing address:** L.Staveley-Smith
ATNF

phone: 02 9372 4271 FAX: 02 9372 4310 e-mail: Lister.Staveley-Smith@atnf.csiro.au

**4. Continuation or resubmission of previous proposal?** Y **Previous proposal no:** P357

**Related ATNF proposal numbers (if any):**

**5. Scientific categories:** ☐ Solar System ☐ Stellar ☐ Galactic ☐ Mag. Clouds ☒ Extragalactic

**6. Type of observation:** ☐ Continuum ☒ Spectral line ☐ Point source ☒ Mapping
☐ Monitoring ☐ Time binning ☐ High time resol. ☒ Survey
☒ Lin pol ☐ Cir pol ☐ Solar ☒ Multibeam

**7. Receiver(s):** Multibeam

**8. Sidereal time range (please state):** 14 - 22

**9. Requested time this Term (hours):** $25 \times 8$ h Minimum useful time (hr): $10 \times 8$ h

Estimated time to complete this project (hr) : 770 Time allocated so far (hr): 200
(including above)

**10. Number of publications to date from this proposal?** – **(List separately)**

**11. Short summary of proposal (∼150 words, minimum font size 8 point):**

The southern ZOA survey has been successful in finding previously unknown galaxies and quantifying the distribution of galaxies in the vicinity of the Local Void and the ‘Great Attractor’, both of which lie in regions of high optical obscuration. We wish to extend this survey to the declination limit permissible with the Parkes telescope. We also propose to test the feasibility of extending our survey further around the Galactic bulge.



*This LaTeX form was generated on February 15, 2001*

**Title of Proposal:** A Northern and Bulge Extension to the ZOA survey **PKS**

**12. Please indicate the amount of additional help required:**

[×] None [ ] Consultation [ ] Friend (Epping: initial assistance with data reduction)
[ ] Observing assistance [ ] Staff Collaborator

| **13. Spectroscopy only:** | Line 1 | Line 2 | Line 3 |
|---|---|---|---|
| transitions to be observed | HI | | |
| velocity range (km $s^{-1}$) | -1200 to 12700 | | |
| number of channels per spectrum | 1024 | | |
| approx observing frequency | 1394.5 MHz | | |
| number of simultaneous spectra | 2 | | |
| total bandwidth [MHz] | 64 | | |
| receiver tuning range | 1362.5 - 1426.5 | | |

**14. Back End System:** multibeam correlator

**15. Feed(s):** multibeam

**16. Focal plane/vertex arrangements:**

**17. Computer programs:** multibeam

**18. Consumables (eg mag tape):** cdroms

**19. Number of sources:** 2 [If more than 6 sources, please attach list. If more than 30 give only selection criteria and LST range(s)]

| **20. Name [order of priority]** | **Coordinates (J2000)** | | **Band** | **Intensity (cont)** | | **rms noise required (mJy)** | **Cal. size (Jy)** | **Possible LST range h ⇒ h** | **Time requested (hr)** |
|---|---|---|---|---|---|---|---|---|---|
| | **RA (h,m)** | **DEC ($\pm°,'$)** | **(cm)** | **total (Jy)** | **peak (mJy)** | | | | |
| Galactic bulge | 18h | $-30°$ | 21 | | | 5 | | 14 – 22 | 100 |
| Northern ZOA | 19h | $2° - 20°$ | 21 | | | 5 | | 16.5 - 21 | 100 |
| | | | | | | | | | |
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| | | | | | | | | | |

**21. Special hardware, software or operating requirements:** Prefer to be co-scheduled with P248

**22. Non-standard equipment supplied by user:** *(by arrangement, OIC, Parkes Observatory)*

**23. Preferred range of dates for scheduling:** May – July

**24. Unsuitable dates:**

**25. Attach a scientific justification. Maximum length 3 pages (incl. figures). Minimum font size 10 point.**

pks_applic.tex

# A Northern and Bulge extension to the Zone of Avoidance Survey

*A. J. Green (Univ. Sydney), P. Henning (UNM), B. Koribalski (ATNF),
R. Kraan-Korteweg (Guanajuato), R. M. Price (UNM), E. Sadler, (U.Sydney), A. Schröder (Nice),
L. Staveley-Smith (ATNF, PI), I. Stewart (Univ. Leicester)*

## 1. Introduction

The obscuration due to dust and the high stellar density in our Galaxy varies from place to place within the Milky Way. Overall, it blocks our optical view of the extragalactic Universe over ~20% of the sky, somewhat less in the infrared. This "Zone of Avoidance" (ZOA) was recognized even before the nature of the spiral nebulae themselves was understood. This sky coverage limitation does not pose a problem for the study of galaxies themselves, as there is no reason to believe that the population of obscured galaxies should differ from those in optically unobscured regions. However, to understand the Local Group's motion requires mapping the surrounding mass inhomogeneity, measured in practice by galaxy over- and under-densities, across the entire sky. In particular, the lack of a full census of nearby, hidden galaxies is troublesome, since the local galaxies play a significant role in the Milky Way's motion with respect to the microwave background (Kraan-Korteweg 1993). In their dynamical model of the local Universe, Shaya, Tully & Pierce (1992) point out the importance of correctly sampling the low-latitude extragalactic population. Even with a conservative obscuration correction, the low-latitude IC 342/Maffei group has the greatest gravitational influence on the Local Group.

Early searches for galaxies obscured by the Galactic Plane were motivated by the possibility of finding a nearby, obscured M31 (see review of Kerr 1994). Several massive nearby galaxies have already been found – e.g. Maffei 1 and 2: Maffei (1968); Circinus A: Freeman et al. (1977); Sagittarius dw: Ibata, Gilmore & Irwin (1994); Dwingeloo-1: Kraan-Korteweg et al. (1994). Of the eight apparently brightest galaxies, five lie within the ZOA (Centaurus A, IC 342, Maffei 1 and 2 and NGC 4945) (Kraan-Korteweg 1993).

A deep HI survey of the southern ZOA has recently been completed (see Fig.1 and Staveley-Smith et al. 1998, Juraszek et al. 2000, Henning et al. 2000). No very massive, nearby galaxies were found. Nevertheless, several hundred (ultimately $\sim$ 2000) new galaxies have been catalogued. The two H I brightest galaxies found in the shallow southern ZOA survey (Henning et al. 2000 – see Fig.1) are HIZSS 32 ($cz = 961$ km s$^{-1}$ ) and HIZSS 96 ($cz = 1457$ km s$^{-1}$ ) (Staveley-Smith et al. 1998), both with H I masses close to $10^{10}$ M$_\odot$. The more distant galaxies are being used to quantify structure in the ZOA, and its relationship with previously known structure. In the region of the Great Attractor, for example, no over-mass $> 2 \times 10^{15} \Omega_\circ$ M$_\odot$ has thus far been found.

An extension of the ZOA survey into the northern hemisphere and the Galactic Bulge has some clear benefits. Except for the Dwingeloo ZOA survey in the north, little is known about the distribution of galaxies at low latitudes except in regions where the extinction is fortuitously low. Near the Bulge, there are regions with extinction $A_B > 3$ mag even at latitudes of 20 deg (see Fig.2). The Bulge also suffers from the serious problem of stellar crowding which interferes with the process of galaxy identification in the optical. The extent and location of the Local Void, in particular, can be well-addressed by mapping the galaxy distribution in the northern ZOA and around the Bulge. The Local Void, which is approximately centred on the Sagittarius region, is believed by some authors (e.g. Faber & Burstein 1988) to explain the discrepancy between the position of maximum CMB temperature, in the Local Group frame, and the putative 'Great Attractor' position.

## 2. Scientific Goals

Galaxies in the latitude range $5° \leq |b| \leq 10°$ suffer high extinction in optical bands. However, away from the Bulge, DENIS, the $2\mu$m all-sky survey (2MASS) (Huchra et al. 1994), and the PSC-z extension, based on IR imaging of IRAS galaxy candidates (Saunders et al. 1994) will, in the long term, probably be able to detect many of the higher luminosity galaxies in the velocity range accessible to the Parkes multibeam receiver. However, $|b| \leq 5°$ ($|b| \leq 10°$ near the Galactic Centre - see Fig.2) roughly corresponds to a Galactic H I column density of $5 \times 10^{21}$ cm$^{-2}$ and an extinction of $A_B = 5$ mag. Below this latitude, the extinction and confusion problem is too severe for any optical or IR-based survey. Apart from the shallow Dwingeloo survey, there is no other survey we know if which will usefully be able to consistently detect galaxies in this latitude range.

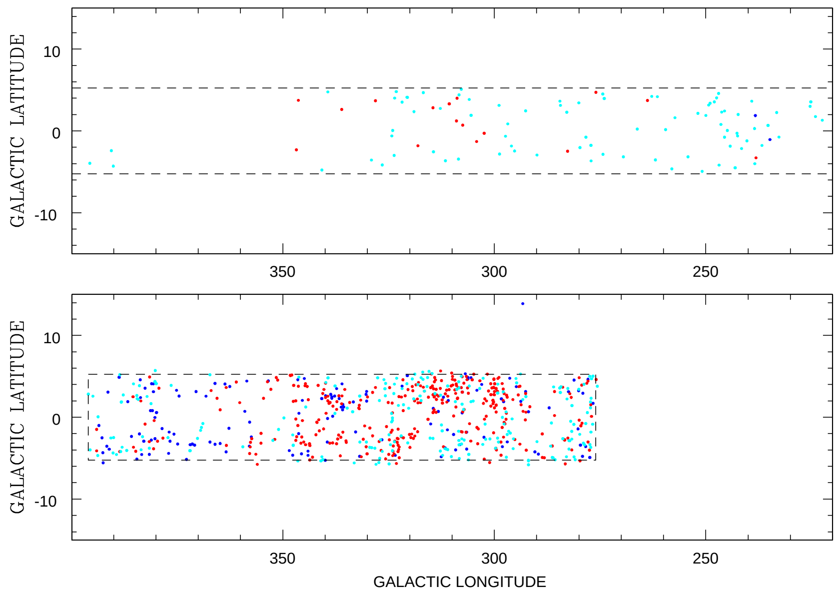


Figure 1: (Top) Galaxies found in the southern ZOA shallow survey (Henning et al. 2000); (Bottom) galaxies so far catalogued in the full-sensitivity deep ZOA survey.

## 3. Survey Parameters

We propose an effective integration time of 0.5 hr/beam and, for the northern ZOA extension, we propose to observe between Galactic longitudes $\ell = 36°$ to $52°$ , $|b| \leq 5°$ ($\ell = 196°$ to $212°$ will be finished by 2001MAY). A full survey of the Bulge region to an equivalent $A_B$ extinction level may eventually require mapping the region $330° < \ell < 40°$, $5° < |b| < 10°$ and $350° < \ell < 20°$, $10° < b < 20°$ (see Fig.2). However, at this stage we wish to concentrate on the lower latitude and longitude regions, and ensure that sidelobes from Sag A do not unduly affect the data. To obtain the proposed integration time, a total observing time of 770 hrs is required for the full northern and Bulge extensions. For the coming term, we request 200 hrs, 110 hrs of which is to complete the northern extension. We request the LST range 14 – 22 hr and to be scheduled alongside P248.

## References

Faber, S.M. & Burstein, D. 1988, in Proc. Vatican Study Week: Large Scale Motions in the Universe, eds Rubin, V.C. & Coyne, G.V. (Princeton University Press) p.116

Fairall, A. 1998, Large-Scale Structures in the Universe (Chichester: John Wiley)

Freeman, K.C., Karlsson, B., Lynga, G., Burrell, J.F., Van Woerden, H., Goss, W.M., & Mebold, U., 1977. AA, 55, 445.

Henning, P.A., Staveley-Smith, L., Ekers, R.D., Green, A.J., Haynes, R.F., Juraszek, S., Kesteven,

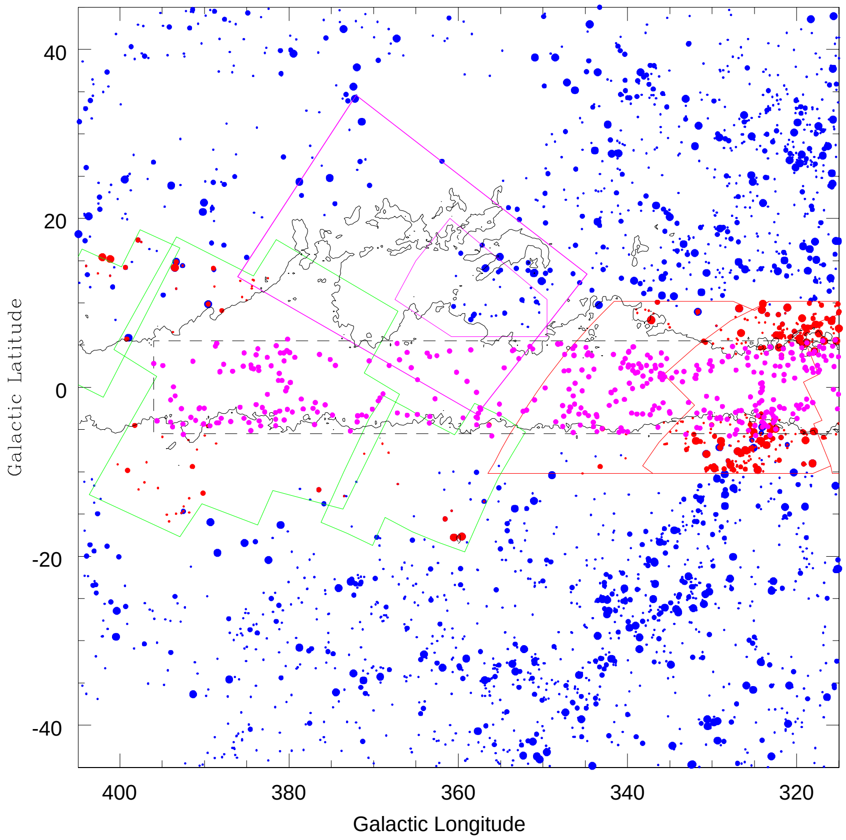


Figure 2: Blue and red dots: galaxies with extinction-corrected diameters larger than $D \geq 1.3'$ and $A_B > 3.0$ mag, coded with size; Boxes: regions searched using deep optical plates; Contour: DIRBE extinction contour of $A_B = 3.0$ mag; Pink dots: galaxies so far catalogued in the deep ZOA survey (preliminary results only).


M.J., Koribalski, B., Kraan-Korteweg, R.C., Price, R.M., Sadler, E.M. & Schroeder, A. 2000, AJ, 119, 2686

Huchra, J. et al. 1994. In Unveiling Large-Scale Structure behind the Milky Way, PASP conf. series, Volume 67, eds. Balkowski, C. & Kraan-Korteweg, R.C., p.41 (ASP:San Francisco).

Ibata, R., Golmore, G., & Irwin, M., 1994, Nature, 370, 194.

Juraszek, S.J., Staveley-Smith, L., Kraan-Korteweg, R.C., Green, A.J., Ekers, R.D., Henning, P.A., Kesteven, M.J., Koribalski, B., Sadler E.M., & Schroder, A. 2000, AJ, 119, 1627

Kahn, F.D., & Woltjer, L., 1959, ApJ, 130, 705.

Kerr, F.J., 1994. In Unveiling Large-Scale Structure behind the Milky Way, PASP conf. series, Volume 67, eds. Balkowski, C. & Kraan-Korteweg, R.C., p.3 (ASP:San Francisco).

Kraan-Korteweg, R., 1993. In Second DAEC meeting on the Distribution of Matter in the Universe, ed. Mamon, G., & Gerbal, D., p.202 (Meudon).

Kraan-Korteweg, R. et al., 1994, Nature, 372, 77.

Maffei, P., 1968, PASP, 80, 618.

Peebles, P.J.E. 1994. ApJ, 429, 43.

Saunders, W. et al. 1994. In Unveiling Large-Scale Structure behind the Milky Way, PASP conf. series, Volume 67, eds. Balkowski, C. & Kraan-Korteweg, R.C., p.257 (ASP:San Francisco).

Shaya, E.J., Tully, R.B. & Pierce, M.J. 1992, ApJ, 391, 16

Staveley-Smith L., Juraszek S., Koribalski B., Ekers R.D., Green A., Haynes R.F., Henning P., Kesteven M., Kraan-Korteweg R., Price M. & Sadler E. 1998, AJ, 116, 2717