

A Radio Study of Selected Regions in the Magellanic Clouds

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Statement of Originality

This thesis is the result of work undertaken between 1989 and 2000 in the Department of Astrophysics and the Research Centre for Theoretical Astrophysics at the University of Sydney.

The data from the Molonglo Observatory Synthesis Telescope were extracted from the Astrophysics Department data archive, the cumulative effort of staff and students over the last two decades.

The software used for the reduction and analysis of radio astronomical data comprised mainly standard software packages (e.g. *AIPS* and *MIRIAD*). The software used for the reduction of MOST data was based on the original code by Dr John Reynolds, further developed by the staff and students of the Astrophysics Department. Major enhancements were undertaken by me for processing the data used in this thesis (e.g. precession to J2000.0 equinox and the original routines to output the synthesized map and corresponding beam in FITS format).

The systematic method of source classification introduced in Chapter 5 was developed during discussions with Prof. Lawrence Cram. Dr Lewis Ball assisted in the interpretation of the images of supernova remnant, 1E 0102.2–7219, presented in Chapter 6. The preliminary ATCA image and associated interpretation was published in a joint paper by Amy & Ball (1993). Chapter 7 presents the results of a collaboration in which I had a major involvement, particularly in the Australia Telescope observing programme and subsequent analysis and interpretation of the radio data. The text is reproduced here in the form in which it was published by Ye et al. (1995), a paper of which I am second author.

With the above exceptions, this thesis contains no material which has been presented for another degree at this or any other university and, to the best of my knowledge and belief, contains no copy or paraphrase of work published by another person, except where duly acknowledged in the text.

Shaun W. Amy
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During much of my candidature, I have been employed as a computer and network systems administrator for the CSIRO. Many CSIRO staff have encouraged me to continue my studies and various managers over the years have been flexible in allowing paid employment and my research work to continue in parallel. This has been particularly true in the last 18 months, when I have been allowed to work part-time despite staff shortages.

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The presentation of this thesis was made possible through the use of \LaTeX 2 ϵ .

List of Publications

Much of the material in this thesis is based on work presented in the following publications.

- **A Technique for Reducing the Grating Lobes of the Molonglo Observatory Synthesis Telescope**, Amy, S.W., & Large, M.I. 1990, Proc. Astron. Soc. Australia, 8, 308.
- **The Molonglo 843 MHz Survey of the Magellanic Clouds**, Turtle, A.J., & Amy, S.W. 1991, in The Magellanic Clouds, IAU Symposium No. 148, ed. R.F. Haynes & D.K. Milne (Dordrecht: Reidel), 114.
- **A Search for Non-Thermal Emission in the H II Regions of the Magellanic Clouds**, Amy, S.W. 1991, in The Magellanic Clouds, IAU Symposium No. 148, ed. R.F. Haynes & D.K. Milne (Dordrecht: Reidel), 195.
- **User Guide to Computing and Data Reduction Software for the Molonglo Observatory Synthesis Telescope**, Amy, S.W., Cram, L.E., Crawford, D.F., Gray, A.D., Harnett, J.I., Reynolds, J.E., & Robertson, J.G. 1991, Version 1.0, (School of Physics, University of Sydney).
- **A Simple Microstrip Phase Shifter**, Amy, S.W., & Large, M.I. 1992, Australian J. Phys., 45, 105.
- **New Radio Observations of Supernova Remnant 1E 0102.2–7219 in the Small Magellanic Cloud**, Amy, S.W., & Ball, L.T. 1993, ApJ, 411, 761.
- **SNR 1E 0102.2–7219 in the Small Magellanic Cloud**, Amy, S.W. 1994, Proc. Astron. Soc. Australia, 11, 83.
- **The Australia Telescope Survey of 21 cm Absorption in the Magellanic System**, Dickey, J.M., Mebold, U., Marx, M., Amy, S.W., Haynes, R.F., & Wilson, W.E. 1994, A&A, 289, 357.
- **SNR 0101–7226 - A Shell-Type Supernova Remnant in the Small Magellanic Cloud with No X-Ray Emission**, Ye, T.S., Amy, S.W., Wang, Q.D., Ball, L., & Dickel, J. 1995, MNRAS, 275, 1218.

- **A Radio Survey of the SMC at 843 MHz with the MOST: I. The Survey**, Turtle, A.J., Ye, T., Amy, S.W., & Nicholls, J. 1998, Proc. Astron. Soc. Australia, 15, 280.

The following publications are the result of work conducted during my Ph.D. candidature, but not presented in this thesis.

- **Nova MUSCAE 1991**, Kesteven, M.J., Turtle, A.J., Amy, S.W., Burgess, A., Campbell-Wilson, D., & Webb, J.D. 1991, IAU Circular 5181.
- **Radio Observations of the Low-mass X-ray Binary 2S 0921-630**, Zwarthoed, G.A.A., Stewart, R., Penninx, W., van Paradijs, J., van der Klis, M., Roy, A.L., & Amy, S.W. 1993, A&A, 267, 101.
- **Centaurus A, The Core of the Problem**, Tingay, S.J., Jauncey, D.L., Preston, R.A., Reynolds, J.E., Meier, D.L., Tzioumis, A.K., Jones, D.L., King, E.A., Amy, S.W., & Biggs, J.D. 1994, Australian J. Phys., 47, 619.
- **Supernova Remnants in the Southwestern Part of the Small Magellanic Cloud**, Dickel, J.R., Williams, R., Carter, L.M., Milne, D.K., Petre, R., & Amy, S.W. 2000, submitted January 2001 to AJ.

Abstract

The Magellanic Clouds have long provided a rich celestial laboratory for many astrophysical research programmes. Their location relatively close to the Earth and away from the plane of our Galaxy has made them a natural target for Southern Hemisphere ground-based instrumentation. Likewise, the continuing quest for images of the Clouds with higher dynamic range and improved angular resolution has driven a continual improvement in instrumentation across a range of wavelength bands.

The cornerstone of this thesis is a study of selected sources in the Magellanic Clouds. The sample was chosen from the 843 MHz Molonglo Observatory Synthesis Telescope survey of the Clouds, based on the existing knowledge of each source, its flux density and angular extent. This sample was used to explore observational and analysis techniques with the Australia Telescope Compact Array in order to better determine the nature of these objects and to identify those sources worthy of further study. This work highlights many pertinent issues associated with the correct classification of sources when only a limited amount of data is available. These issues led directly to the development of a more systematic approach in the classification of the Large Magellanic Cloud source sample, detailed for the first time in this thesis.

Two supernova remnants in the Small Magellanic Cloud were studied in detail. The Australia Telescope images of 1E 0102.2–7219 revealed, for the first time, the radio structure of this young oxygen-rich supernova remnant, and allowed a detailed comparison with existing optical and X-ray data to be undertaken. The comparisons presented in this thesis and in an earlier publication have prompted exciting new X-ray observations at unprecedented angular resolution. The second, 0101–7226, studied as part of an international collaboration, has a shell morphology at radio wavelengths but no associated X-ray emission and is therefore something of an enigma.

Contents

List of Tables	xiii
List of Figures	xv
1 Introduction	1
1.1 Overview	1
1.2 A Brief History of Magellanic Cloud Surveys	2
1.2.1 Supernova Remnant Surveys	4
1.2.2 X-ray Studies	5
1.2.3 Further Optical and Radio Observations	5
1.3 This Work and Contemporaneous Studies	6
1.4 Thesis Outline	7
2 Instrumentation and Analysis Techniques	9
2.1 Introduction	9
2.2 The Molonglo Observatory Synthesis Telescope	9
2.2.1 A Radio Schmidt	11
2.2.2 Some Special Characteristics of the MOST	11
2.3 The Australia Telescope	18
2.3.1 Why was it Built?	18
2.3.2 What Is and Where Is the Australia Telescope?	19
2.3.3 ATCA Observing Techniques	21
2.3.4 Calibration and Polarimetry at the ATCA	23
2.4 Summary	28
3 A Survey of Selected Magellanic Cloud Sources	29
3.1 Introduction	29
3.2 Choosing the Sources	30
3.2.1 Astrophysical Considerations	30
3.2.2 Instrumental Considerations	31
3.3 Observing and Data Reduction Strategy	31
3.3.1 Data Reduction	36
3.3.2 Derived Parameters and Source Classification	37
3.3.3 Radio Source Counts	38

3.4	Summary	40
4	Selected Sources in the Small Magellanic Cloud	41
4.1	Introduction	41
4.2	Observations of Selected SMC Sources	41
4.2.1	The “BKGS” X-ray Sources	41
4.2.2	The H II Regions SMC N83/N84 and SMC N90	46
4.2.3	Other Compact Sources in the Direction of the SMC	51
4.3	Source Categorization	70
4.3.1	Source Statistics	70
4.3.2	Radio Spectral Index	71
4.4	Summary	74
5	Selected Sources in the Large Magellanic Cloud	75
5.1	Introduction	75
5.2	A Systematic Method of Classifying Sources	75
5.3	A Catalogue of Selected LMC Sources	79
5.4	Classification of the LMC Sources	173
5.5	Source Statistics	174
5.6	Summary	177
6	Supernova Remnant 1E 0102.2–7219 in the Small Magellanic Cloud	179
6.1	Introduction	179
6.1.1	Classification of Supernova Remnants	179
6.2	Previous Studies of SNR 1E 0102.2–7219	181
6.3	Radio Observations	182
6.3.1	The MOST 843 MHz Image	182
6.3.2	A Preliminary ATCA Image at 4790 MHz	182
6.4	A High-Resolution Multi-Frequency Study with the ATCA	187
6.4.1	Observing Strategy and Data Reduction	187
6.4.2	Total Intensity Images	192
6.4.3	Polarimetry	196
6.5	The Radio Spectrum	196
6.6	Discussion	199
6.6.1	The Radio Data	199
6.6.2	Comparison with Data at Other Wavelengths	203
6.7	Summary	207
7	SNR 0101–7226: A Shell-type Supernova Remnant in the SMC with No X-ray Emission	209
7.1	Preface	209
7.2	Abstract	209
7.3	Introduction	210
7.4	Observations and Results	211

7.4.1	The Radio Continuum	211
7.4.2	Pulsed Radio Emission	212
7.4.3	X-ray Emission	213
7.5	Discussion	214
7.5.1	Radio Structure	214
7.5.2	Why No Diffuse X-ray Emission?	216
7.5.3	The Point-like X-ray Source	217
7.6	Conclusions	218
7.7	Acknowledgments	218
8	Conclusions and Future Prospects	219
	Bibliography	223

List of Tables

3.1	Details of the ATCA 4790 MHz observations of the selected SMC sources	33
3.2	Details of the ATCA 4790 MHz observations of the selected LMC sources	34
4.1	Comparison of the MOST, ATCA and Parkes observations of the BKGS X-ray sources in the SMC	42
4.2	Comparison of the MOST, ATCA, Parkes and X-ray observations of two compact H II regions in the SMC	49
4.3	Comparison of the MOST, ATCA, Parkes and X-ray observations of compact sources in the SMC	68
4.4	A comparison of integrated flux densities across a range of frequencies for the sources in the SMC	72
5.1	Comparison of the MOST, ATCA, Parkes and X-ray observations of sources in the LMC	166
5.2	The integrated flux densities, spectral index and classification of sources in the LMC	175
6.1	Details of the preliminary ATCA 4790 MHz observations of SNR 1E 0102.2–7219 in the SMC	184
6.2	Details of the ATCA multi-frequency observations of SNR 1E 0102.2–7219 in the SMC	187
6.3	Integrated flux densities of SNR 1E 0102.2–7219 in the SMC at the four observed frequencies	199
7.1	Summary of the ATCA and MOST observations of SNR 0101–7226 in the SMC	213

List of Figures

2.1	Two images of the Molonglo Observatory Synthesis Telescope	10
2.2	The East-West response of the MOST	14
2.3	The “dirty” and CLEANed MOST images of the SMC field 0104–724	16
2.4	Images of the Australia Telescope at Parkes and Narrabri	20
3.1	Spatial frequency coverage obtained from the ATCA observations of SMC N83/N84	35
4.1	MOST 843 MHz image of the field containing BKGS 7 and 0050–727 in the SMC	43
4.2	ATCA 4790 MHz image of BKGS 24 in the SMC	44
4.3	MOST 843 MHz and ATCA 4790 MHz images of BKGS 32 in the SMC	45
4.4	MOST 843 MHz and ATCA 4790 MHz images of BKGS 33 in the SMC	46
4.5	MOST 843 MHz image of the field 0119–731 in the SMC	47
4.6	ATCA 4790 MHz images of the SMC N83/N84 region	48
4.7	MOST 843 MHz and ATCA 4790 MHz images of SMC N90	51
4.8	MOST 843 MHz image of the field 0021–742 in the SMC	52
4.9	ATCA 4790 MHz images of 0021–742 in the SMC	53
4.10	MOST 843 MHz image of the field 0032–738 in the SMC	54
4.11	ATCA 4790 MHz images of 0032–738 in the SMC	56
4.12	MOST 843 MHz and ATCA 4790 MHz images of 0036–746 in the SMC	57
4.13	MOST 843 MHz image of the ATCA fields 0037–719 and 0038–720 in the SMC	57
4.14	ATCA 4790 MHz image of the field 0037–719 in the SMC	58
4.15	ATCA 4790 MHz image of 0038–720 in the SMC	59
4.16	MOST 843 MHz and ATCA 4790 MHz images of 0041–709 in the SMC	60
4.17	ATCA 4790 MHz image of 0050–727 in the SMC	61
4.18	MOST 843 MHz and ATCA 4790 MHz images of 0054–713 in the SMC	62
4.19	MOST 843 MHz and ATCA 4790 MHz images of 0055–744 in the SMC	63
4.20	MOST 843 MHz and ATCA 4790 MHz images of 0058–719 in the SMC	63
4.21	MOST 843 MHz and ATCA 4790 MHz images of 0107–718 in the SMC	64
4.22	MOST 843 MHz and ATCA 4790 MHz images of 0109–727 in the SMC	65
4.23	MOST 843 MHz and ATCA 4790 MHz images of 0109–735 in the SMC	66
4.24	MOST 843 MHz and ATCA 4790 MHz images of 0131–729 in the SMC	67

5.1	The “Decision Tree” used to classify the LMC sources	77
5.2	MOST 843 MHz and ATCA 4790 MHz images of 0440–665 in the LMC	83
5.3	Radio spectrum of 0440–665 in the LMC	83
5.4	MOST 843 MHz and ATCA 4790 MHz images of 0449–709 in the LMC	85
5.5	Radio spectrum of 0449–709 in the LMC	85
5.6	MOST 843 MHz and ATCA 4790 MHz images of 0451–696 in the LMC	87
5.7	Radio spectrum of 0451–696 in the LMC	87
5.8	MOST 843 MHz and ATCA 4790 MHz images of 0454–649 in the LMC	89
5.9	Radio spectrum of 0454–649 in the LMC	89
5.10	MOST 843 MHz and ATCA 4790 MHz images of 0456–703 in the LMC	91
5.11	Radio spectrum of 0456–703 in the LMC	91
5.12	MOST 843 MHz and ATCA 4790 MHz images of 0458–720 in the LMC	93
5.13	Radio spectrum of 0458–720 in the LMC	93
5.14	MOST 843 MHz and ATCA 4790 MHz images of 0502–696 in the LMC	95
5.15	Radio spectrum of 0502–696 in the LMC	95
5.16	MOST 843 MHz and ATCA 4790 MHz images of 0503–680 in the LMC	97
5.17	Radio spectrum of 0503–680 in the LMC	97
5.18	MOST 843 MHz and ATCA 4790 MHz images of 0504–668 in the LMC	99
5.19	Radio spectrum of 0504–668 in the LMC	99
5.20	MOST 843 MHz and ATCA 4790 MHz images of 0505–681 in the LMC	101
5.21	Radio spectrum of 0505–681 in the LMC	101
5.22	MOST 843 MHz and ATCA 4790 MHz images of 0510–689 in the LMC	103
5.23	Radio spectrum of 0510–689 in the LMC	103
5.24	MOST 843 MHz and ATCA 4790 MHz images of 0513–692 in the LMC	105
5.25	Radio spectrum of 0513–692 in the LMC	105
5.26	MOST 843 MHz and ATCA 4790 MHz images of 0514–676 in the LMC	107
5.27	Radio spectrum of 0514–676 in the LMC	107
5.28	MOST 843 MHz and ATCA 4790 MHz images of 0515–660 in the LMC	109
5.29	Radio spectrum of 0515–660 in the LMC	109
5.30	MOST 843 MHz and ATCA 4790 MHz images of 0515–674 in the LMC	111
5.31	Radio spectrum of 0515–674 in the LMC	111
5.32	MOST 843 MHz and ATCA 4790 MHz images of 0517–718 in the LMC	113
5.33	Radio spectrum of 0517–718 in the LMC	113
5.34	MOST 843 MHz and ATCA 4790 MHz images of 0518–679 in the LMC	115
5.35	Radio spectrum of 0518–679 in the LMC	115
5.36	MOST 843 MHz and ATCA 4790 MHz images of 0518–696 in the LMC	117
5.37	Radio spectrum of 0518–696 in the LMC	117
5.38	MOST 843 MHz and ATCA 4790 MHz images of 0524–708 in the LMC	119
5.39	Radio spectrum of 0524–708 in the LMC	120
5.40	MOST 843 MHz and ATCA 4790 MHz images of 0526–658 in the LMC	123
5.41	Radio spectrum of 0526–658 in the LMC	123
5.42	MOST 843 MHz and ATCA 4790 MHz images of 0526–659 in the LMC	125
5.43	Radio spectrum of 0526–659 in the LMC	125
5.44	MOST 843 MHz and ATCA 4790 MHz images of 0527–651 in the LMC	127

5.45	Radio spectrum of 0527–651 in the LMC	127
5.46	MOST 843 MHz and ATCA 4790 MHz images of 0528–692 in the LMC	129
5.47	Radio spectrum of 0528–692 in the LMC	129
5.48	MOST 843 MHz and ATCA 4790 MHz images of 0530–678 in the LMC	131
5.49	Radio spectrum of 0530–678 in the LMC	131
5.50	MOST 843 MHz and ATCA 4790 MHz images of 0532–675 in the LMC	133
5.51	Radio spectrum of 0532–675 in the LMC	133
5.52	MOST 843 MHz and ATCA 4790 MHz images of 0533–725 in the LMC	135
5.53	Radio spectrum of 0533–725 in the LMC	135
5.54	MOST 843 MHz and ATCA 4790 MHz images of 0534–720 in the LMC	137
5.55	Radio spectrum of 0534–720 in the LMC	137
5.56	MOST 843 MHz and ATCA 4790 MHz images of 0535–676 in the LMC	139
5.57	Radio spectrum of 0535–676 in the LMC	139
5.58	MOST 843 MHz and ATCA 4790 MHz images of 0537–692 in the LMC	141
5.59	Radio spectrum of 0537–692 in the LMC	141
5.60	MOST 843 MHz and ATCA 4790 MHz images of 0540–696 in the LMC	143
5.61	Radio spectrum of 0540–696 in the LMC	143
5.62	MOST 843 MHz and ATCA 4790 MHz images of 0541–670 in the LMC	145
5.63	Radio spectrum of 0541–670 in the LMC	145
5.64	MOST 843 MHz and ATCA 4790 MHz images of 0543–681 in the LMC	147
5.65	Radio spectrum of 0543–681 in the LMC	147
5.66	MOST 843 MHz and ATCA 4790 MHz images of 0543–710 in the LMC	149
5.67	Radio spectrum of 0543–710 in the LMC	149
5.68	MOST 843 MHz and ATCA 4790 MHz images of 0545–649 in the LMC	151
5.69	Radio spectrum of 0545–649 in the LMC	151
5.70	MOST 843 MHz and ATCA 4790 MHz images of 0545–719 in the LMC	153
5.71	Radio spectrum of 0545–719 in the LMC	153
5.72	MOST 843 MHz and ATCA 4790 MHz images of 0547–677 in the LMC	155
5.73	Radio spectrum of 0547–677 in the LMC	155
5.74	MOST 843 MHz and ATCA 4790 MHz images of 0547–704 in the LMC	157
5.75	Radio spectrum of 0547–704 in the LMC	157
5.76	MOST 843 MHz and ATCA 4790 MHz images of 0550–684 in the LMC	159
5.77	Radio spectrum of 0550–684 in the LMC	159
5.78	MOST 843 MHz and ATCA 4790 MHz images of 0552–682 in the LMC	161
5.79	Radio spectrum of 0552–682 in the LMC	161
5.80	MOST 843 MHz and ATCA 4790 MHz images of 0552–703 in the LMC	163
5.81	Radio spectrum of 0552–703 in the LMC	163
5.82	MOST 843 MHz and ATCA 4790 MHz images of 0600–706 in the LMC	165
5.83	Radio spectrum of 0600–706 in the LMC	165
6.1	MOST 843 MHz image of SNR 1E 0102.2–7219 in the SMC	183
6.2	Preliminary ATCA 4790 MHz image of SNR 1E 0102.2–7219 in the SMC	185
6.3	Preliminary ATCA 4790 MHz image of SNR 1E 0102.2–7219 in the SMC displayed as surface plot	186

6.4	One-dimensional slices taken through the preliminary ATCA image of SNR 1E 0102.2–7219 in the SMC	188
6.5	ATCA image of SNR 1E 0102.2–7219 in the SMC at 1472 MHz	192
6.6	ATCA image of SNR 1E 0102.2–7219 in the SMC at 2368 MHz	193
6.7	ATCA image of SNR 1E 0102.2–7219 in the SMC at 4790 MHz	194
6.8	ATCA image of SNR 1E 0102.2–7219 in the SMC at 8640 MHz	195
6.9	ATCA images of SNR 1E 0102.2–7219 in the SMC smoothed to the resolution of the 1472 MHz image	197
6.10	Total-intensity ATCA images of SNR 1E 0102.2–7219 in the SMC with overlaid electric-field vectors	198
6.11	Radio spectrum of SNR 1E 0102.2–7219 in the SMC	200
6.12	Combined optical image of SNR 1E 0101.2–7219 in the SMC	204
6.13	<i>Einstein</i> HRI X-ray image of SNR 1E 0101.2–7219 in the SMC	205
6.14	<i>ROSAT</i> HRI X-ray image of SNR 1E 0101.2–7219 in the SMC	206
7.1	ATCA images of SNR 0101–7226 in the SMC	211
7.2	MOST 843 MHz image of SNR 0101–7226 in the SMC	213
7.3	<i>ROSAT</i> HRI X-ray contour image plot superimposed on a grey-scale map of the ATCA 1378 MHz observations of SNR 0101–7226 in the SMC	215
7.4	<i>Einstein</i> IPC X-ray count rate versus diameter of SNRs in the Magellanic Clouds	216