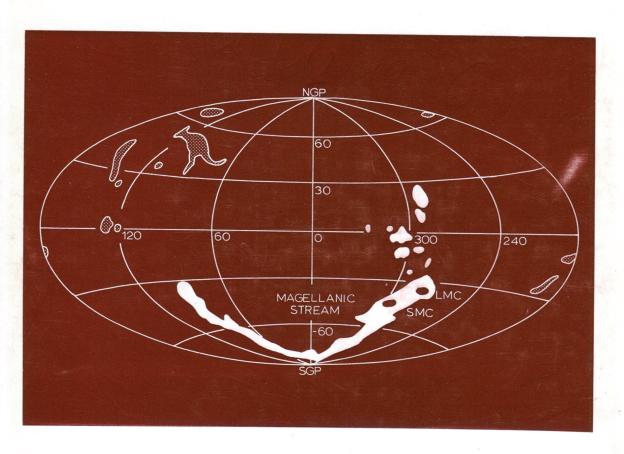
SYMPOSIUM No. 60

GALACTIC RADIO ASTRONOMY

Edited by F. J. KERR and S. C. SIMONSON, III





INTERNATIONAL ASTRONOMICAL UNION
D. REIDEL PUBLISHING COMPANY
DORDRECHT-HOLLAND / BOSTON-U.S.A.

GALACTIC RADIO ASTRONOMY

SYMPOSIUM No. 60

Galactic Radio Astronomy was chosen as the subject of this Symposium, which was held in conjunction with the I.A.U. General Assembly that took place in Sydney in August 1973, largely because it is a very suitable Southern Hemisphere topic. This results in part from the advantages of a southern location in studying the Galaxy and in part from the long association of Australia with radio astronomy. The Symposium was sponsored by Commissions 40, 33, and 34, and was supported financially by the I.A.U., the Australian Academy of Science, the CSIRO Division of Radiophysics, Union Carbide Australia Limited, and the Science Foundation for Physics within the University of Sydney.

Seventy-three papers were presented, with discussion periods following nearly every one. Each session contained one, and in some cases several, review papers. The order of presentation of the sessions in the volume has been changed from that of the Symposium itself, to bring related sessions more closely together. The session on supernova remnants was actually the last one held. The Symposium program arrangement was subject to some constraints which do not apply to the printed version.

As part of the philosophy governing the organization of the Symposium, the Organizing Committee encouraged wide discussion based on the review papers and the small number of short contributed papers. Therefore we have attempted to include almost all of the discussion.

Audience:

Research astronomers, astrophysicists and radio physicists.

D. REIDEL PUBLISHING COMPANY DORDRECHT-HOLLAND / BOSTON-U.S.A.

GALACTIC RADIO ASTRONOMY

INTERNATIONAL ASTRONOMICAL UNION UNION ASTRONOMIQUE INTERNATIONALE

SYMPOSIUM No. 60
HELD AT MAROOCHYDORE, QUEENSLAND, AUSTRALIA,
3-7 SEPTEMBER, 1973

GALACTIC RADIO ASTRONOMY

EDITED BY

F. J. KERR AND S. C. SIMONSON, III University of Maryland, College Park, Md., U.S.A.



D. REIDEL PUBLISHING COMPANY DORDRECHT-HOLLAND/BOSTON-U.S.A. 1974

Published on behalf of the International Astronomical Union by D. Reidel Publishing Company, P.O. Box 17, Dordrecht, Holland

All Rights Reserved
Copyright © 1974 by the International Astronomical Union

Sold and distributed in the U.S.A., Canada, and Mexico by D. Reidel Publishing Company, Inc. 306 Dartmouth Street, Boston, Mass. 02116, U.S.A.

Library of Congress Catalog Card Number 74–81939

Cloth edition: ISBN 90 277 0501 1 Paperback edition: ISBN 90 277 0502 X

No part of this book may be reproduced in any form, by print, photoprint, microfilm, or any other means, without written permission from the publisher

Printed in The Netherlands by D. Reidel, Dordrecht

TABLE OF CONTENTS

PREFACE	IX
LIST OF PARTICIPANTS	XI
PART 1/THE INTERSTELLAR MEDIUM	
V. RADHAKRISHNAN / The Observational Evidence for an Intercloud Medium (Review)	3
CARL HEILES / A Modern Look at 'Interstellar Clouds' (Review)	13
ULRICH J. SCHWARZ and HUGO VAN WOERDEN / Properties of Neutral Hydrogen Clouds	45
M. GUÉLIN / Free Electrons Outside H II Regions (Review)	
EDWARD B. JENKINS / Line Absorption Studies of the Interstellar Gas Near	51
10 ¹⁵ Hz (<i>Review</i>) B. ZUCKERMAN and JOHN A. BALL / On Microwave Recombination Lines	65
from H I Regions (Abstract)	79
F. J. KERR, P. D. JACKSON, G. R. KNAPP, and R. L. BROWN / Two New Recombination-Line Results	81
A. G. LYNE / The Galactic Electron Distribution from a Pulsar Survey	87
MICHAEL GREWING / Heating and Ionization of the Interstellar Medium (Review)	97
DONALD W. GOLDSMITH / Theoretical Calculations of Interstellar Cloud Formation	111
R. SANCISI / Expanding Shells of Neutral Hydrogen as Birthplaces of Stellar Associations	
R. D. BROWN / Interstellar Molecules – Theory (Review)	115
W. M. GOSS, L. E. B. JOHANSSON, J. ELLDÉR, B. HÖGLUND, NGUYEN-Q-RIEU,	129
and A. WINNBERG / Extended OH Emission at 1720 MHz (Summary)	125
B. WHITEOAK / The Observed Characteristics of the Local Magnetic Field	135
(Review)	137
G. WESTERHOUT and D. BECHIS / A High-Resolution Polarization Survey of the North Polar Spur	151
. MAYO GREENBERG and SEUNG-SOO HONG / The Chemical Composition	
and Distribution of Interstellar Grains (Review)	155
F. J. KERR and G. R. KNAPP / The Gas-to-Dust Ratio in the Galaxy	179
P. G. MEZGER, E. B. CHURCHWELL, and L. F. SMITH / Absorption Character-	
istics of Dust in the Lyman Continuum Region (Abstract)	183
. R. SHAKESHAFT / Spectrum of Galactic Background Radiation (Summary)	185

H. HIRABAYASHI / Galactic Background Radiation at 2 cm and Thermal Electrons in the Galaxy	187
PATRICK PALMER / Thermal and Maser Phenomena in Rotationally Excited	10
OH (Abstract)	191
PART 2/GALACTIC HII REGIONS	
E. CHURCHWELL / Recent Radio Observations of Galactic H II Regions	
(Review)	195
JACOB W. M. BAARS and HEINRICH J. WENDKER / High-Resolution Radio	
Observations of a Giant H II Region in Cygnus	219
F. P. ISRAEL and P. C. VAN DER KRUIT / Radio Observations of H II Regions in M33 (Read by H. J. Habing)	227
J. H. SPENCER and B. F. BURKE / The H II Regions of M31	227
NORIO KAIFU, TETSUO IGUCH, and MASAKI MORIMOTO / The Brightness	229
Distribution of Ori A at 4.1 mm in the $1_{01} - 0_{00}$ Line of Para-Formaldehyde	
and in the Continuum	233
W. K. HUCHTMEIER and G. A. DAY / Large-Scale Expansion in the Carina	233
Nebula (Abstract)	239
YERVANT TERZIAN and VERNON PANKONIN / Decimeter-Wavelength	237
Studies of Recombination Lines	241
G. MONNET / Optical Observations of Ionized Gas in External Galaxies	2
(Review)	249
LINDSEY F. SMITH / Distribution of Dust in the Orion Nebula (Abstract)	257
C. G. WYNN-WILLIAMS / Infrared Emission from HII Regions (Review)	259
B. F. BURKE / Maser Sources in HII Regions (Review)	267
R. D. DAVIES / Magnetic Fields in OH Maser Clouds	275
PIERRE KAUFMANN, W. G. FOGARTY, E. SCALISE, JR., and R. E. SCHAAL / On	
the First Southern-Sky H ₂ O Masers Observed at Itapetinga, Brazil	293
T. K. MENON / Time Scales and Masses of OH-Emission Regions (Summary)	299
L. E. B. JOHANSSON, B. HÖGLUND, A. WINNBERG, NGUYEN-Q-RIEU, and	
W. M. GOSS / OH Observations Near the Reflection Nebulae NGC 2068	
and NGC 2071	301
F. D. KAHN / HII Regions: Some Theoretical Developments (Review)	303
PART 3/SUPERNOVA REMNANTS	
B. Y. MILLS / Observational Aspects of Supernova Remnants (Review)	311
F. D. KAHN / Supernova Remnants: Can a Fossil HII Region Be Formed As	311
the Result of a Supernova Explosion?	329
D. K. MILNE and JOHN R. DICKEL / Polarization Observations of Supernova	241
Remnants	335
D. B. SLEE and G. A. DULK / High-Resolution Observations of Galactic Non-	222
thermal Sources at 160 MHz	347

TABLE OF CONTENTS VII

H. HIRABAYASHI / A 160-MHz Map of Cas A	353
R. M. DUIN, R. G. STROM, and H. VAN DER LAAN / Westerbork Observations of the Galactic Supernova Remnants IC 443 and Tycho (Read by H. J.	
Habing)	355
FUMIO SATO / 21-cm Absorption Study of Extended Supernova Remnants	363
A. G. LYNE / The Birthplaces of Pulsars	369
I. S. SHKLOVSKII / New Results on Supernova Remnants (Summary; read by	
Yu. Parijskij)	373
PART 4/STELLAR AND CIRCUMSTELLAR SOURCES	
L. L. E. BRAES / Radio Continuum Observations of Stellar Sources (Summary)	
(Review)	377
HARVEY D. TANANBAUM / Stellar X-Ray Sources (Review)	383
V. A. HUGHES, M. R. VINER, and A. WOODSWORTH / Radio Outbursts from	
Cygnus X-3	401
C. G. WYNN-WILLIAMS / Infrared and X-Ray Variability of Cyg X-3	407
D. K. MILNE and L. H. ALLER / Measurements on Planetary Nebulae	411
YERVANT TERZIAN / Fine Structure in Planetary Nebulae	417
J. L. CASWELL / Radio Observations of IR/OH/H ₂ O Stars (Review)	423
A. R. HYLAND / The Infrared Properties of Circumstellar OH/IR and H ₂ O/IR	
Sources (Review)	439
F. J. KERR and P. F. BOWERS / Some High-Velocity Sources of 1612 MHz OH	
Emission	459
PART 5/THE GALACTIC CENTER	
J. BORGMAN / Infrared Radiation from the Galactic Center (Review)	465
M. A. GORDON / Radio Continuum and Recombination Line Studies of the	
Galactic Center (Review)	477
A. G. LITTLE / The Galactic Center at 408 MHz	491
G. SWARUP, GOPAL-KRISHNA, and N. V. G. SARMA / Occultation Observa-	
tions of the Galactic Center Region at 327 MHz	499
S. CHRISTIAN SIMONSON, III / 21-cm Line Studies of the Galactic Center	
Region (Review)	511
B. J. ROBINSON / Kinematics of Molecules at the Galactic Centre (Review)	521
KENJI AKABANE, MASAKI MORIMOTO, KIYOSHI NAGANE, and NORIO	
KAIFU / Observations of the $J=6$ to 5 Line of OCS in Sgr B2	537
J. H. OORT / The Galactic Centre (Review: Summary and Concluding Remarks)	539
PART 6 / LARGE-SCALE GALACTIC STRUCTURE	
W. B. BURTON / Current Problems in 21 cm Line Studies of the Large-Scale Structure of the Galaxy (Review)	551

HAROLD WEAVER / Some Aspects of Galactic Structure Derived from the	
Berkeley Low Latitude Survey of Neutral Hydrogen (Invited Paper)	573
GART WESTERHOUT / Progress Report on the Maryland-Green Bank Galac-	
tic 21-cm Line Survey	587
CHI YUAN and LANCE WALLACE / A Simple Interpretation of the 'Rolling	
Motions'	591
R. D. DAVIES / High Velocity Neutral Hydrogen Clouds (Review)	599
D. S. MATHEWSON, M. N. CLEARY, and J. D. MURRAY / The Magellanic	
Stream	617
CARL E. HEILES / The Large-Scale Structure of Local HI, Dust, and Galactic	
Radio Continuum (Invited Paper)	625
K. TAKAKUBO / Low- and Intermediate-Velocity Hydrogen at Positive Galac-	
tic Latitudes	631
R. M. PRICE / Continuum Radio Emission and Galactic Structure (Review)	637
C. G. T. HASLAM, W. E. WILSON, D. A. GRAHAM, and G. C. HUNT / The Bonn	
408 MHz Survey	649
AUTHOR INDEX	651
	UJI