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Woodruff T. Sullivan

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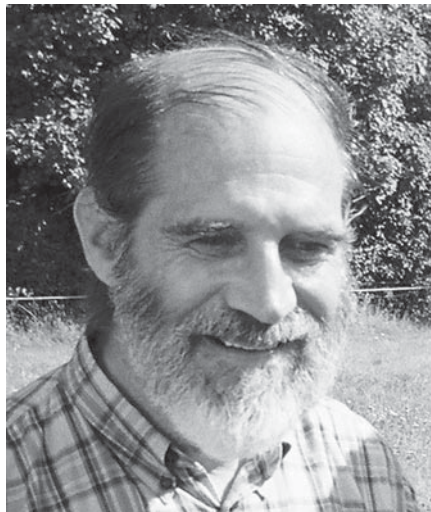
## Cosmic Noise

### A History of Early Radio Astronomy

Providing a definitive history of the formative years of radio astronomy, this book is invaluable for historians of science, scientists and engineers. The whole of worldwide radio and radar astronomy is covered, beginning with the discoveries by Jansky and Reber of cosmic noise before World War II, through the wartime detections of solar noise, the discovery of radio stars, lunar and meteor radar experiments, the detection of the hydrogen spectral line, to the discoveries of Hey, Ryle, Lovell, Pawsey and others in the decade following the war, revealing an entirely different sky from that of visual astronomy.

Using contemporary literature, correspondence and photographs, the book tells the story of the people who shaped the intellectual, technical, and social aspects of the field now known as radio astronomy. The book features quotes from over 100 interviews with pioneering radio astronomers, giving fascinating insights into the development of radio astronomy.

WOODRUFF T. SULLIVAN III is Professor of Astronomy and Adjunct Professor of History at the University of Washington, Seattle. Trained as a radio astronomer, his research has included studies of the interstellar medium in our own and other galaxies, the search for extraterrestrial intelligence, and astrobiology.



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# Cosmic Noise

## A History of Early Radio Astronomy

Woodruff T. Sullivan, III

*University of Washington*



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**For Barbara,**

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almost as long as to me*

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I had the opportunity only yesterday of watching Sagittarius rise in broad daylight on the needle of a millivoltmeter ... It is certainly gratifying to see gunlaying radar apparatus put to such uses!

Alan Hunter<sup>1</sup>

---

<sup>1</sup> A. Hunter (Royal Greenwich Observatory): J. L. Greenstein, 8 October 1946, box 39, GRE.

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## Foreword

Not long ago, before the birth of radio astronomy, the starry sky was observed by astronomers looking through telescopes, using their eyes and photography. Now we call them optical astronomers, using optical telescopes, admitting their new colleagues who detect radio, X-rays, and gamma-rays. The radio astronomers were the first of these, and their radio telescopes have developed over half a century into complex and sophisticated instruments that reveal a new universe. This has been no less than a revolution in both astronomy and its instruments: as in all revolutions, it has a history whose early beginnings are at least as interesting as the explosive growth in which we are now immersed.

Woody Sullivan's history takes the subject up to 1953. This is perhaps the latest date for which a comprehensive history can be contained in a single volume, but it is a good date to mark the emergence of radio astronomy as an integral part of modern astronomy. There was by this time a basic understanding of the origin of cosmic radio waves, and the techniques of radio telescopes, spectrometers, and interferometers. Funding for large projects was becoming available, and research groups were consolidating. The following half century saw the extension of the visible spectrum into the ultraviolet and infrared, and the exploitation of the new windows of radio, X-rays, and gamma-rays, with many discoveries which changed our view of every aspect of the universe. In more recent years we have

seen the scale of radio telescopes expand to international proportions, both physically and in cooperation between many observing groups. Nevertheless, the elements were all there in 1953; furthermore there was extensive documentation of the early steps (notably in Australia), and even where the written record was patchy most of the original players were available for interview when this history was undertaken.

As an experienced radio astronomer Sullivan is well placed to relate the history of the technical advances of the early years. He is also gifted with an understanding and interest in people that enables him to give a balanced account of some difficult relationships between the ambitious, enthusiastic, and sometimes competitive research groups of the time. His study and his interpretations will be of interest not only to the participants, many of whom are still alive, but to historians of science and sociologists, who will doubtless argue whether or not this was, in their terms, a revolution. In my terms it certainly was, and Sullivan has done us a service in writing this excellent historical account of it.

F. Graham Smith FRS

Sir Francis Graham Smith is Emeritus Professor at Jodrell Bank Observatory, where he was Director (1981–88). He also served as Director of the Royal Greenwich Observatory (1976–81), and as the 13th Astronomer Royal (1982–91).

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## Preface

Freshly minted as a Ph.D. in astronomy, I began this project in 1971 with the observation that almost all of the pioneers of radio astronomy, including my advisor (Frank Kerr<sup>†</sup>), were still available as sources for a book on the worldwide history of radio astronomy. World War II, during which radio astronomy and I were both born, had ended only a quarter-century before and memories were relatively fresh. Armed with a cassette tape-recorder, I naively began interviewing “old-timers.” But when I learned more about doing history and about interviewing, I eventually repeated those early interviews, added many more (see Appendix B), and became serious about archival research (Appendix C). Guided by Urania and Clio, I gathered data from around the world as I could, mostly during 1972–88. The bulk of the initial writing followed in 1984–89, but then the mostly-finished book stalled as other projects intervened. Scattered efforts were sometimes possible, but in the end it took a sabbatical year in 2006 to resurrect the book and finally bring it to completion. The 24 year span of writing triples the 1945–53 period that the book mainly covers, and also far surpasses the stewing period of nine years for writing that the Roman poet Horace famously advised. As another measure of the time that has passed, 60% of the interviewees whose materials have been used for the present volume have now passed away.

Along the way I did produce two other books (still in print) that I consider handmaidens to the present volume: *Classics in Radio Astronomy* (Sullivan 1982) and *The Early Years of Radio Astronomy* (Sullivan 1984). The former is a collection of reprints, with extensive commentary, of 37 seminal papers in radio astronomy and the latter a collection of 21 articles discussing the pre-1960 period by early radio astronomers and

historians. Furthermore, over the years portions of the present book appeared in the form of articles, abstracts, and talks; the principal contributions among these can be found in the list of references.

In 1984 I signed a contract with Cambridge University Press to produce this book in two years. Although that contract expired in the last millennium, I am delighted that the Press nevertheless has been willing to publish this opus. Simon Mitton has been encouraging all along and I also thank Richard Ziemacki, Helen Wheeler, and Vince Higgs for their support and advice.

The book is a monograph designed to appeal to astronomers and historians of science, as well as to others with some background in the physical sciences who have a serious interest in the development of twentieth-century science. I cover the entirety of worldwide radio and radar astronomy through the year 1953. By the word “cover” I mean the best story I can assemble about the intellectual, technical, and social aspects that shaped early radio astronomy. This story has been based on (1) the published literature of the time (including lab reports), (2) correspondence and other items found during archival research, (3) over 115 interviews with the early radio astronomers themselves, and (4) photographs of the time (about one-half of the book’s 180 figures). Quotations from the interviews are an important feature of the book – they create liveliness and provide insights, although I am well aware of the pitfalls of memory. I thank interviewees, publishers, and photographers for permissions to use their materials.

The first chapter sets out the structure and organization of the book and the conventions that I have used. Unusually for a history book, I have strived to make indexes and cross-references such that the volume acts as an efficient reference book. The first chapter also sets this volume in the context of other studies and discusses my approach to doing history. Section 1.2.3

<sup>†</sup> The superscript <sup>†</sup> after a name in the Preface indicates that the person is known to have died.

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gives a précis of the book's narrative and Section 1.3.3 summarizes the main historical themes.

This enterprise has had a large supporting cast. I thank sincerely my history of science colleagues at the University of Washington (UW) and the University of Puget Sound whose friendship, mentoring, and criticisms over the decades have been fundamental to my education in history of science. Chief among these have been Keith Benson, Jim Evans, Mott Greene, Tom Hankins, Bruce Hevly, Karl Hufbauer, and Jody Yoder. Further afield in the history of science community, I have profited tremendously in general or in terms of specific reviews of chapters by David DeVorkin, Steve Dick, David Edge<sup>†</sup>, Paul Forman, Peter Galison, Stewart Gillmor, Owen Gingerich, Rod Home, Michael Hoskin, Wayne Orchiston, Simon Shaffer, Robert Smith, and Spencer Weart. I am truly sorry that David Edge, who died in 2003, will not see this work. David, a radio astronomer turned sociologist of science, was a good friend and fellow lover of cricket and baseball. From the start, he was supportive of my efforts and generous with advice even though I was hornning in on his own research that eventually resulted in *Astronomy Transformed* (Edge and Mulkey 1976) (see Section 1.3.1). Through the years we had a marvellous correspondence that greatly enriched the present study.

The cooperation and advice of the community of radio astronomers (and related researchers) has been indispensable to this project. I am thankful for the willingness of many to be interviewed (see Appendix B for the full list), to review draft chapters, to answer myriad follow-up questions, and to supply copies of archival materials, photographs, and reprints. It is perhaps odious to pick out those who have been the most generous with their time, but the following indeed went the extra mile: John Baldwin, John Bolton<sup>†</sup>, Taffy Bowen<sup>†</sup>, Ron Bracewell<sup>†</sup>, Arthur Covington<sup>†</sup>, Chris Christiansen<sup>†</sup>, John DeWitt<sup>†</sup>, Bruce Elsmore, Harold "Doc" Ewen, Vitaly Ginzburg, Jesse Greenstein<sup>†</sup>, Robert Hanbury Brown<sup>†</sup>, Gerald Hawkins<sup>†</sup>, Denis Heightman<sup>†</sup>, Stanley Hey<sup>†</sup>, Roger Jennison<sup>†</sup>, Ken Kellermann, Frank Kerr<sup>†</sup>, Bernard Lovell, Ken Machin<sup>†</sup>, Bernie Mills, Harry Minnett<sup>†</sup>, Lex Muller<sup>†</sup>, Jan Oort<sup>†</sup>, James Phillips, Grote Reber<sup>†</sup>, Alexander Salomonovich<sup>†</sup>, Peter Scheuer<sup>†</sup>, John Shakeshaft, Bruce Slee, Graham Smith, Gordon Stanley<sup>†</sup>, Henk Van de Hulst<sup>†</sup>, Gart Westerhout, and Paul Wild<sup>†</sup>.

In addition I similarly thank the following people most heartily for their cooperation and information: Mary Almond, Zoltán Bay<sup>†</sup>, Emile-Jacques Blum, Henry Booker, M. K. Das Gupta<sup>†</sup>, John Dickey, John Findlay<sup>†</sup>, Kurt Fränzl<sup>†</sup>, Frank Gardner<sup>†</sup>, Tommy Gold<sup>†</sup>, Cyril Hazard, Tony Hewish, Jim Hindman<sup>†</sup>, Vic Hughes<sup>†</sup>, George Hutchinson, Nik Kardashev, John Kraus<sup>†</sup>, Laurence Manning, Connie Mayer<sup>†</sup>, Ed McClain<sup>†</sup>, Kenichi Miya, Fumio Moriyama, George Mueller, Vivian Phillips, Jack Piddington<sup>†</sup>, John Pierce, Wolfgang Priester, Ed Purcell<sup>†</sup>, J. J. Riihimaa, Jim Roberts, Peter Robertson, Olof Rydbeck<sup>†</sup>, Boris Schedvin, Jean-Louis Steinberg, Gordon Stewart, King Stodola, Tatsuo Takakura, Charlie Townes, James Trexler<sup>†</sup>, Derek Vonberg, Kevin Westfold<sup>†</sup>, Fred Whipple<sup>†</sup>, and Don Yabsley<sup>†</sup>.

One contemporary of mine who has played a huge role in improving this book and bringing it to fruition is Miller Goss, who carefully reviewed the entire manuscript and raised many issues both of detail and broader impact. I thank him for his labors and wish him well on his own forays into the history of radio astronomy.

I have enjoyed significant institutional support over the years, starting with the Kapteyn Laboratory of the University of Groningen for a postdoc, then the UW Department of Astronomy since 1973, supplemented by sabbatical stays at the Institute of Astronomy, Cambridge University and the Observatoire de Meudon near Paris. I am grateful to the directors of these institutions for backing my historical pursuits. I also especially thank Arthur Whiteley and his eponymous Center for establishing a marvellous scholarly retreat in the San Juan Islands where for the past five years major portions of this book have been written and rewritten.

Financial support, primarily in the form of partial summer salary, has come from the Dudley Observatory (thrice), the UW Graduate Student Research Fund (once), and the National Science Foundation (eight times). NSF's Program in History and Philosophy of Science, headed by Ron Overmann, also awarded a major grant in 1976–79, which allowed, for instance, a three-week visit to the Radiophysics Laboratory in Sydney for archival and oral history research. In 1980 I also was privileged to visit the main Soviet radio astronomy sites and groups on an exchange sponsored by the US National Academy of Sciences. And I would

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be remiss if I did not mention my first-ever “grant” to do history: a 100-guilder gift in 1973 from my colleagues at the Kapteyn Lab – I have never forgotten this endorsement of my fledgeling efforts.

Processing the interviews has been a laborious task. I thank NSF and the Center for History of Physics (American Institute of Physics.) for funding transcriptions. In particular, the skill and attention to detail of transcribers Bonnie Jacobs and Pamela Jernigan is acknowledged. Furthermore, during the early 1990s Karen Fisher provided excellent secretarial services.

Librarians have often worked wonders for me, whether via Interlibrary Loan, locating obscure reports and journals, or allowing special access after hours. I also thank those who have made the NASA Astrophysics Data System a powerful and vital bibliographic tool for the historian of astronomy.

This history would be impoverished and stale without access to well-organized archives, or sometimes to a person’s papers before placement in an official archive. For the latter privilege I thank in particular Lady Rowena Ryle (widow of Martin Ryle), as well as

Alice Jansky<sup>†</sup> and David B. Jansky (widow and son of Karl Jansky). A special, huge thanks goes to Sally Atkinson, longtime chief administrative assistant of the Radiophysics Division in Sydney, and unofficial archivist after her retirement. Sally was tireless in fulfilling my requests and providing access to everything from scrapbooks to photographs to official correspondence in the rich Division records. Other archivists too, from around the world (Appendix C), have rendered superior service.

I have been aided in translations over the decades by Helga Byhre, Karl-Heinz Böhm, Tom Hankins, Larry Sandler<sup>†</sup>, Jim Naiden<sup>†</sup>, Vlad Chaloupka, Bob Schommer<sup>†</sup>, Julian Barbour, Dave Jenner, and Joke Huizinga<sup>†</sup>.

My family has sustained this project in many ways, for instance helping with bibliographic and archival tasks, tolerating warped holiday trips, and encouraging me to stick with it. Daughters Rachel and Sarah grew up with “The Book” ever present and my wife Barbara’s support has been continuous for decades. To her I dedicate this volume.

## Acknowledgments for figures

The author thanks the following persons, publications and institutions for the use in this book of the indicated figures from their publications or collections. I apologize if I have unwittingly, despite my efforts, omitted any required permissions.

- American Astronomical Society (*Astrophysical J.*): 4.5, 4.6, 4.7, 10.3, 10.6, 11.3, 11.10, 14.4, 14.13, 14.14
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