

Report on the Joint USA-USSR Radio Astronomy Symposium
held at Washington and Green Bank, May 15-19, 1961

I. A joint USA-USSR Radio Astronomy Symposium, arranged under Article 7 of the exchange agreement between the Academies of Sciences of the USA and USSR was held at Washington and Green Bank, May 15 through May 19, 1961. The host institution was the National Radio Astronomy Observatory. The Opening Session was held at the National Academy of Sciences, Washington on the afternoon of May 15, when welcoming and introductory addresses were given. Technical Sessions were held at the National Radio Astronomy Observatory, May 16 through 19.

II. Participants in the symposium were as follows:

USSR

G. G. Getmantsev, Radiophysical Institute of Gorky University
P. D. Kalachev, Lebedev Physical Institute
A. D. Kuzmin, Lebedev Physical Institute
V. A. Sanamyan, Byurakan Astrophysical Observatory
R. L. Sorochenko, Lebedev Physical Institute
V. V. Vitkevitch, Lebedev Physical Institute

USA

A. H. Barrett, University of Michigan
A. Blaauw, Vanderbilt University
R. N. Bracewell, Stanford University
G. R. Burbidge, Yerkes Observatory
B. F. Burke, Department of Terrestrial Magnetism, Carnegie Institution
of Washington
F. D. Drake, National Radio Astronomy Observatory
G. B. Field, Princeton University
J. W. Findlay, National Radio Astronomy Observatory
J. W. Firor, Department of Terrestrial Magnetism, Carnegie Institution
of Washington
F. T. Haddock, University of Michigan
D. S. Heeschen, National Radio Astronomy Observatory
F. D. Kahn, National Radio Astronomy Observatory
G. Keller, National Science Foundation
J. D. Kraus, Ohio State University
A. E. Lilley, Harvard University
C. R. Lynds, National Radio Astronomy Observatory
C. H. Mayer, Naval Research Laboratory
E. F. McClain, Naval Research Laboratory
T. K. Menon, National Radio Astronomy Observatory
R. Minkowski, University of Wisconsin
A. R. Sandage, Mount Wilson and Palomar Observatories
C. L. Seeger, Stanford University
G. J. Stanley, California Institute of Technology
O. Struve, National Radio Astronomy Observatory
G. W. Swenson, University of Illinois
C. M. Wade, National Radio Astronomy Observatory
H. F. Weaver, University of California
L. Woltjer, Institute for Advanced Study

The symposium interpreter was Mrs. S. Edmundson, of the USA National Academy of Sciences. Appendix A is a photograph of most of the symposium participants.

III. The Symposium Program.

The Symposium Program was opened by Detlev W. Bronk, President of the U. S. Academy of Sciences, who welcomed the delegates, and by V. V. Vitkevitch, who brought greetings from the Astronomical Council of the Academy of Sciences of the Soviet Union. V. A. Sanamyan presented greetings from Academician Ambartsumian, and O. Struve welcomed the delegates to the National Radio Astronomy Observatory. Introductory papers reviewing the history, present status, and the course of radio astronomy in the United States and in the Soviet Union were then presented by F. D. Drake and V. V. Vitkevitch.

The Technical Program. Below is given a list of the technical papers presented at the symposium, with a brief description of the subject matter of each.

B. F. Burke, J. W. Firor, and M. A. Tuve: Hydrogen Line Studies. A report of cloud structure of interstellar hydrogen at high galactic latitudes, as found with a multi-channel radiometer.

A. Blaauw: 21-cm Evidence on Interstellar Cloud Structure. The results of attempts to portray 21-cm profiles as sums of gaussian components.

C. L. Seeger: 408 mc Observations of the Polarized Component of the Non-thermal Galactic Background Radiation. Excellent evidence for the existence of polarization in the galactic background radiation, with a preliminary map of the orientation and percentage polarization found.

A. D. Kuzmin and A. E. Salomonovich: Radio Emission of Taurus A at a wavelength of 8 mm. Observations of Taurus A at high resolution which give evidence for a second source very close to the Taurus A source.

R. L. Sorochenko: Preliminary Results of Observations at 21-cm of the Milky Way Region with the Center R. A. = $20^{\text{h}} 18^{\text{m}}$ and Dec. = $+42^{\circ} 30'$. 21-cm profiles showing absorption features connected with the source Cygnus X, and indicating its location in the Milky Way.

C. H. Mayer, T. P. McCullough, R. M. Sloanaker. Radio Source Polarization Measurements. Polarization measurements of six sources, of which only Taurus A presently gives clear cut evidence of polarization.

A. H. Barrett: Observations of Radio Sources at 1.8-cm Wavelength. Extension of the spectra of several radio sources to 1.8-cm wavelength.

A. D. Kuzmin: Spectra of Radio Sources Observed with the 22-meter Radio Telescope of the Lebedev Physical Institute. A critical comparison of spectra obtained with the 22-meter telescope with older spectral data.

T. K. Menon: The Density Distribution in Emission Nebulae. The density distribution in the Orion Nebula and NGC 2244, as found from radio observations.

F. D. Kahn: Dynamics of HII regions. A critical discussion of the observational data showing there are violent contradictions in theory which may be resolved only by making extreme assumptions regarding the evolutionary stage of the subject HII regions.

Y. N. Parijsky: On the Connection between Hydrogen Lines Radiation and Radio Emission of Gaseous Nebulae. A means of determining the distance to emission nebulae from optical and radio observations, with the results of the application of the method to 32 nebulae.

A. D. Kuzmin, R. I. Noskova: Identification of Exciting Stars and Determination of Emission Nebulae Parameters on the Basis of Radio Astronomical Data. A proposal of a new method of identifying exciting stars and measuring nebula parameters using radio observations and optical spectral data only. Application to many HII regions gives very encouraging results.

A. D. Kuzmin: Concerning the Discrete Source of Radiation at R. A. $18^h 53^m 7$, Dec. = $+1^\circ 16'$. Data from the 22-meter telescope is given which indicates that the source is a non-thermal source similar to IC443.

A. E. Lilley: Results of the Harvard Hydrogen Line Maser Program. Both negative and positive results of a search for 21-cm line and continuum radiation from galaxies is given.

C. M. Wade: The Structure of Some Bright Radio Galaxies. The double emission regions in Fornax A, Centaurus A, and Cygnus A is emphasized as a significant feature of intrinsically bright radio sources, and the complex low intensity structure of M87 described.

G. J. Stanley: Measurements of Radio Source Diameters at the Owens Valley Observatory. A summary of the statistical data on source brightness distributions found at Owens Valley, which show that a majority of the intrinsically bright radio sources are probably double.

D. S. Heesch: The Spectra of Some Extragalactic Radio Sources. A summary of the extensive observations of source spectra, which show that the normal galaxies and abnormal radio galaxies fall respectively on two well defined sequences in a color magnitude diagram, and that some of the bright sources have distinct curvatures in their spectra.

A. G. Little, D. D. Cudaback, and R. N. Bracewell: Structure of the Central Component of Centaurus A. The central component of Centaurus A is shown to consist of two components of unequal strength, in two possible orientations.

L. Woltjer: Some Remarks on Supernova Remnants: It is suggested that the central star in the Crab Nebula is an extraordinary object which emits much of its energy in the form of energetic particles. The source 3C48 may be an example of an older version of the same object.

G. M. Tovmestan, R. K. Shachbazyan: On the Equality of Cosmic Sources. A statistical analysis of a number of source catalogs was made which indicated that radio sources tend to occur in clusters of galaxies, and they tend to be connected with double galaxies.

R. Minkowski: Radio Sources, Galaxies, and Clusters of Galaxies. A summary of the most recent results obtained from the optical identification of radio sources.

A. R. Sandage: On the Possibility to Choose Between Cosmological World Models from Observations of Distant Radio Clusters of Galaxies. An analysis of the quality of observations needed to distinguish between different cosmological world models.

V. L. Ginzburg: On the Nature of Radio Galaxies. It is shown that large numbers of relativistic electrons could be produced in the early stages of the evolution of a galaxy when high material velocities exist.

G. B. Field: On Shklovsky's Early Picture of the Cygnus A Source. A discrepancy between the positions of the stellar and halo components of the source is shown, which seems to militate strongly against this early picture.

G. R. Burbidge: Recent Ideas Concerning the Origin of the Strong Extragalactic Radio Sources. A suggestion by Hoyle that radio galaxies are the result of an enormous flare phenomenon in the central regions of galaxies is discussed. It is shown that this demands extreme parameters of the radio galaxies. A new idea is presented that radio galaxies are the result of a chain reaction of supernovae in the galactic nucleus.

V. A. Razin: On the Spectra of Nonthermal Radio Emission of the Galaxy and Metagalaxy. It is shown that if the exchange of relativistic particles between the galactic plane and halo is impeded, the spectrum of radio emission from the halo should be steeper than the radiation from the flat subsystem. Extragalactic radiation should have a still steeper spectrum.

G. G. Getmantsev: On the Origin of Non-thermal Galactic Radio Emission and of Primary Cosmic Rays. Arguments are given in favor of the idea that the relativistic particles giving rise to halo emission originate in the halo during the early history of a galaxy. Supernovae are probably a source of relativistic electrons only for the flattened subsystem. The exchange of cosmic rays between the halo and flat subsystem is almost absent.

C. R. Lynds: Application of the Image Orthicon to Astronomical Problems. Observations made with an image orthicon on the 36" Kitt Peak telescope were presented, and the advantages (high quantum efficiency) and the limitations (image distortion) of the image orthicon described.

J. D. Kraus: Design Considerations and Preliminary Performance Data for the Ohio State University 360-foot Radio Telescope. A description of the 360-foot telescope, accompanied by a theoretical analysis of various aspects of telescope performance, and actual measurements which are closely consistent with the theoretical analysis.

G. W. Swenson, Jr.: The University of Illinois Radio Telescope. A description of the design of the telescope, accompanied by a progress report on the construction of the instrument.

J. W. Findlay: The NRAO 300-foot Transit Telescope. A description of the design of the telescope, and demonstration of a model of it.

V. A. Sanamyan: On the Work of the Large Interference Radio Telescope at the Byurakan Observatory. A detailed description of the seven element interferometer at the Byurakan Observatory, with examples of the high quality of observation possible with it.

G. J. Stanley: The Owens Valley Interferometer and its Applications to Problems of Aperture Synthesis. A resume of experience gained from the Owens Valley Interferometer, with some suggestions as to how to extend the instrument so as to increase its observing capabilities.

V. V. Vitkevitch and P. D. Kalachev: The Large Cross Radio Telescope of the Lebedev Physical Institute. Possible Ways to Construct Large Radio Telescopes. A description of the design of the large cross telescope, and the progress made in its construction. Discussion of several novel proposals for the construction of very large reflector type telescopes.

R. N. Bracewell: Guiding Principles Leading to the Design of a Radio Telescope with a One-Minute Beam. A discussion of the philosophy that should guide future designs for large telescopes, with emphasis on resolution limiting and the advantage of building an instrument which can be expanded. A design which meets the criteria, using a number of cylindrical parabolas, was presented.

C. L. Seeger: On the Design of the Giant Benelux Radio Telescope. A resume of the problems encountered in the design of very large cross type telescopes, and a discussion of various approaches which might solve these problems.

F. D. Drake: Some Economical Designs for High-performance Radio Telescopes. A description of several versions of a telescope which combines reflecting elements with the Mills Cross principle to give high performance at low cost.

Informal Discussion. Because of the limited number of papers on the program, and the small number of participants, it was possible to devote much time fruitfully to informal discussion. To aid in this, informal study groups were organized outside the formal symposium program to discuss the following special topics:

- Source Polarization Studies
- 21-cm Line Studies
- Discrete Sources
- Design parameters for Large Telescopes

IV. Social and Sightseeing Activities.

The following social and sightseeing activities were arranged for the symposium:

- 1) A symposium dinner, attended by all delegates.
- 2) Dinner parties in the homes of NRAO staff members for members of the Soviet delegation.
- 3) A visit to some nearby caverns by a portion of the American and Soviet delegations.
- 4) A return trip to Washington by automobile for the Soviet delegation, via a route which included the Shenandoah Valley and the Skyline Drive.
- 5) Sightseeing in Washington, including a visit to the White House and most other points of interest.

V. Other Scientific Visits made by the Soviet Delegation.

Arrangements were made for the Soviet Delegation to visit the Department of Terrestrial Magnetism of the Carnegie Institute of Washington, and the Radio Observatory of the University of Michigan. The Soviet delegation was very pleased that it was possible, on short notice, to make these visits.

VI. Suggestions for future symposia.

As a result of the experience gained from this symposium, we would like to make the following suggestions regarding future Symposia:

1) An interpreter was provided at this conference. This turned out to be very useful, and contributed very significantly to the success of the venture. There is a severe language problem with most delegates, making an interpreter extremely desirable at future symposia.

2) Hotel accommodations provided the Soviet delegates in Washington were below average in quality, and did not reflect well on the U.S. or American hospitality. Better accommodations should be provided in the future.

3) Every effort should be made to determine well in advance of the symposium the places, other than the symposium location, the Soviet delegation wishes to visit while in America. Since many places are closed to Soviet citizens, and arrangements to visit the permitted places take time to make, the Soviet desires need to be known well in advance so that side-trips can be arranged, where possible, in an efficient way.

VII. Evaluation of the Effectiveness of the Symposium.

It is felt that the technical program was well balanced and stimulating, and that its scope and length were very nearly optimum. In the discussions held in connection with the formal program and outside it, there was a free and enthusiastic flow of information between the two delegations. Because of this, major steps were made in gaining a knowledge of the progress made in radio astronomy in the two countries, and the problems now considered important in each. Since the attainment of such mutual understanding was a primary goal of the conference, it is felt that the symposium was highly successful.

At the request of the Director of the National Radio Astronomy Observatory, the undersigned organized the Symposium and prepared this report.



F. D. Drake
Associate Astronomer
July 18, 1961

APPENDIX A

The accompanying photograph shows most of the symposium participants.

Key:

(Left to Right)

First Row (seated): G. G. Getmantsev, F. T. Haddock, M. S. Wade, S. Edmundsen (interpreter), R. Minkowski, V. V. Vitkevitch, O. Struve, R. L. Sorochenko, J. W. Firor, G. Keller, A. D. Kuzmin, R. N. Bracewell, F. D. Drake.

Second Row: C. M. Wade, E. F. McClain, V. A. Sanamyan, P. D. Kalachev, G. J. Stanley, A. H. Barrett, H. F. Weaver, G. W. Swenson, Jr., C. H. Mayer, D. S. Heeschen, J. D. Kraus.

Third Row: G. B. Field, T. K. Menon, C. L. Seeger, L. Woitjer, A. R. Sandage, A. E. Lilley, A. Blaauw, F. D. Kahn, B. F. Burke.

Absent: G. R. Burbidge, J. W. Findlay, C. R. Lynds.