

file

October 19, 1959

Mr. Roland Paine
Press Officer
The National Science Foundation
Washington 25, D. C.

Dear Mr. Paine:

In accordance with our telephone conversation this morning, I am enclosing information on our project "Ozma" which might be used in a press release. As we discussed over the phone, we very much wish to withhold this information from the press until such time as the experiment is successful. Publication now would create a flood of demands for information which would only slow our progress, and would embarrass the NSF and NRAO if the experiment is a failure. However, we appreciate that it might be desirable to release this information if the press should become aware of the project and start concocting stories on the basis of imagination rather than fact, or if another group also embarks on research in this field and tries to capitalize on it publicity-wise.

Sincerely yours,

F. D. Drake

cc: O. Struve
D. S. Heeschen ✓

Encl.

"On Demand" Press Information Regarding NRAO Project Ozma
October 19, 1959

In a limited way, the National Radio Astronomy Observatory has commenced a project, called "Ozma", whose purpose is to detect radio emissions created by intelligent beings on other planets. Astronomers now generally believe (see H. Shapley, Of Stars and Men and S. S. Huang, American Scientist, Sept. 1959 p. 397, for example) that planetary systems like the solar system occur in very large numbers throughout our galaxy and the rest of the universe. It is also believed that a large number of such systems have planets possessing conditions suitable for the flourishing of life forms. Because of the facts that some stars are older than others, and biological evolution probably proceeds at different rates on different planets, it is probable that intelligent civilizations far more advanced than ours, in the same state as ours, and more primitive than ours exist at present. We would expect, then, to find scattered throughout our galaxy planets from which radio transmissions similar to ours, or even more powerful and more numerous than ours, are radiated. The number of such planets can be estimated only very roughly.

The scientific, philosophical, and political impact of the discovery of such transmissions would be extremely great.

In recent years, the development of large antennas and major inventions which greatly increase receiver sensitivity have made it possible to construct a radio telescope which can detect earth-like transmissions at interstellar distances. A search for such transmissions is therefore technically feasible. The NRAO has built a special receiver especially suited to detect them. It will be used with the large NRAO radio telescopes, and will incorporate a high-sensitivity reactance amplifier. It is designed to reject terrestrial signals and the non-intelligent

cosmic radio power normally studied by radio astronomers. The scientist in charge of the project is Dr. F. D. Drake. It is expected that the first observations will be made about January 1, 1960. The first stars to be studied will be the solar-type stars nearest the solar system.

NATIONAL ACADEMY OF SCIENCES
NATIONAL RESEARCH COUNCIL
OF THE UNITED STATES OF AMERICA

SPACE SCIENCE BOARD

20 July 1961

Dr. Otto Struve, Director
National Radio Astronomy Observatory
P. O. Box 2
Green Bank, West Virginia

Dear Dr. Struve:

At its last meeting, the Space Science Board agreed to convene a quiet meeting of scientists qualified to discuss the scientific aspects of establishing radio contact with other planetary systems. Mr. Peckman of the Space Science Board staff has discussed this matter with Dr. Drake of the National Radio Astronomy Observatory and I understand that you are prepared to issue the necessary invitations and to act as host to such a meeting at Green Bank.

We should be grateful if the National Radio Astronomy Observatory could now proceed to convene this meeting on behalf of the Space Science Board along the lines already known to Dr. Drake. Mid-September has been suggested as the time for the meeting which is expected to last for two days. A tentative program of invited contributions and a suggested list of participants is attached.

We hope very much that the discussions at this meeting will provide:

- (i) estimates of limiting values for the probability of existence of planets on which civilized life is likely to have evolved, and from this discussion, a re-evaluation of the assumptions and probabilities that intelligent radio transmissions are likely to be observable;
- (ii) an assessment of the advisability of conducting further investigations with existing equipment. If conclusions from this discussion indicate that the prospects with existing equipment are so marginal that results are

Handwritten notes:
NATHAN
Peckman
Drake
Green Bank

Handwritten notes:
File
Symposium on
OZMA

Dr. Otto Struve

20 July 1961
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extremely unlikely, an assessment of the scale of effort which should be undertaken and prospects of success with improved equipment, including a discussion of the design characteristics for such apparatus;

- (iii) recommendations to the Space Science Board concerning further work in this field.

We believe it is important -- and I understand you concur -- that participants in this meeting be limited to those who can themselves make substantive contributions and that the meeting should be planned and conducted in a scientific atmosphere without publicity. In the matter of travel expenses for participants, it is our usual policy to seek the support of the participant's parent institution insofar as feasible; in cases where this is not possible, the Academy will, of course, make reimbursement. In addition, the Space Science Board will provide all possible assistance to your Observatory in planning and conducting the meeting.

I should like to thank you once again for your help in this matter and express the hope that the meeting will be fruitful.

Sincerely yours,


Hugh Odishaw
Executive Director

cc: O. G. Villard, Jr.

Tentative Program for Symposium on Extraterrestrial Intelligent Life

1. Review of work done and engineering aspects -
Drake and Lilley
2. Statistical aspects - Hoerner preferred or perhaps Huang
3. Biological considerations - Lederberg
4. The beacon problem - Townes
5. The search frequency problems - Morrison
6. Other methods of communication or manifestations of
communication - Bracewell or Dyson or both.

List of Participants

- Dr. Dana Atchley, Jr., Microwave Associates, Inc., Burlington, Massachusetts
- Dr. Ronald W. Bracewell, Director, Radio Astronomy Institute,
Stanford University, Palo Alto, California
- Dr. Frank D. Drake, National Radio Astronomy Observatory,
P. O. Box 2, Green Bank, West Virginia
- Dr. F. J. Dyson, Institute for Advanced Study, Princeton, New Jersey
- Dr. M. J. E. Golay, Perkin Elmer Corporation, 116 Ridge Road,
Rumson, New Jersey
- Dr. Thomas Gold, Cornell University, Ithaca, New York
- Mr. Su Shu Huang, NASA, Goddard Space Flight Center, Greenbelt, Maryland
- Dr. Joshua Lederberg, Department of Genetics, School of Medicine,
Stanford University, Palo Alto, California
- Dr. J. G. Lilly, 3605 Poinciana Ave., Coconut Grove, Miami 33, Florida
- Dr. G. C. McVittie, Department of Astronomy, University of Illinois,
Urbana, Illinois
- Dr. B. M. Oliver, Hewlett-Packard Company, 275 Page Mill Road,
Palo Alto, California
- Dr. Edward M. Purcell, Lyman Laboratory of Physics, Harvard University,
Cambridge 38, Massachusetts
- Dr. Carl Sagan, Department of Astronomy, University of California,
Berkeley 4, California
- Dr. Otto Struve, Director, National Radio Astronomy Observatory,
P. O. Box 2, Green Bank, West Virginia
- Dr. G. H. Townes, Massachusetts Institute of Technology, Cambridge, Massachusetts
- Dr. Harold C. Urey, University of California, La Jolla, California
- Dr. O. G. Villard, Jr., Department of Engineering, Stanford University,
Stanford, California
- Dr. S. von Hoerner, Astronomisches Rechen-Institut, Münchhofstrasse 12-14,
Heidelberg, Germany
- J. F. T. Fearman, Space Science Board, National Academy of Sciences,
2101 Constitution Avenue, Washington 25, D. C.

List of Participants

- * Dr. Dana Atchley, Jr., Microwave Associates, Inc., Burlington, Massachusetts
- * Dr. Ronald W. Bracewell, Director, Radio Astronomy Institute, Stanford University, Palo Alto, California
- Dr. F. D. Drake, National Radio Astronomy Observatory, P. O. Box 2, Green Bank, West Virginia
- Dr. F. J. Dyson, Institute for Advanced Study, Princeton, New Jersey
- Dr. M. J. E. Golay, Perkin Elmer Corporation, 116 Ridge Road, Rumson, N. J.
- * Dr. Thomas Gold, Cornell University, Ithaca, New York
- * Mr. Su Shu Huang, NASA, Goddard Space Flight Center, Greenbelt, Maryland
- * Dr. Joshua Lederberg, Dept. of Genetics, School of Medicine, Stanford University, Palo Alto, California
- * Dr. J. C. Lilly, ^{3908 Main Highway} ~~3605 Poinciana Ave.~~, Coconut Grove, Miami 33, Florida
also, (Communication Research Institute, St. Thomas, Virgin Islands)
- * Prof. P. M. Morrison, Dept. of Physics, Cornell University, Ithaca, New York
- * Dr. B. M. Oliver, Hewlett-Packard Company, 275 Page Mill Road, Palo Alto, Calif.
- Dr. Edward M. Purcell, Lyman Laboratory of Physics, Harvard University, Cambridge 38, Massachusetts
- Dr. Carl Sagan, Dept. of Astronomy, University of California, Berkeley 4, Calif.
- Dr. Otto Struve, Director, National Radio Astronomy Observatory, P. O. Box 2, Green Bank, West Virginia
- * Dr. C. H. Townes, Massachusetts Institute of Technology, Cambridge, Massachusetts
- Dr. Harold C. Urey, University of California, La Jolla, California
- Dr. O. G. Villard, Jr., Dept. of Engineering, Stanford University, Stanford, California
- J. P. T. Pearman, Space Science Board, National Academy of Sciences, 2101 Constitution Avenue, Washington 25, D. C.
- Dr. Melvin Calvin, Dept. of Chemistry, University of California, Berkeley, Calif.
- * Prof. G. Cocconi, Dept. of Physics, Cornell University, Ithaca, New York
- * Prof. Martin Schwarzschild, Princeton University Observatory, Princeton, N. J.
- Dr. J. R. Pierce, Bell Telephone Laboratories, Inc., Murray Hill, N. J.

NATIONAL RADIO ASTRONOMY OBSERVATORY
POST OFFICE BOX 2
GREEN BANK, WEST VIRGINIA
TELEPHONE MARLINTON 292

September 18, 1961

Under the sponsorship of the Space Science Board of the National Academy of Sciences, a Conference on Extraterrestrial Intelligent Life will be held November 1 and 2, 1961, at the National Radio Astronomy Observatory, Green Bank, West Virginia. On behalf of the Space Science Board, I cordially invite you to attend this conference.

If you are able to attend, we request that you provide your own travel expenses. However, the National Academy of Sciences has agreed to provide travel expenses, in those cases where it is necessary to make possible attendance at the Conference. Room and board will be provided free of charge at the Observatory while invitees are in residence at the Conference.

A detailed agenda will be sent to those invitees who are able to attend the conference. However, it is presently anticipated that subjects to be discussed will include:

- 1) Experimental work already performed in efforts to detect other intelligent species.
- 2) Biological considerations bearing on the evolution and incidence of intelligent life.
- 3) Statistical discussions of the incidence of intelligent life, including astronomical and biological factors.
- 4) Techniques by which civilizations may "mark" themselves.
- 5) The most efficient means of interstellar communication, technological factors affecting the efficiency of these means, and technological requirements for further experimental searches.
- 6) Manifestations of intelligent life or means of communication other than electromagnetic radiation.

It is hoped that about twenty people active in this field will attend. The conference will be conducted privately, without publicity or press coverage, and it is requested that invitees cooperate to make this possible.

An enclosure to this letter outlines the preferred means of transportation to Green Bank. Invitees should make their own transportation arrangements.

If you plan to attend this conference, please notify us of this and your travel plans at your earliest convenience. Please notify us of the title and approximate length of any paper you would like to present at this conference, and of any subjects you would specifically like to see discussed.

I hope very much that you will be able to attend the Conference.

Sincerely yours,

O. Struve
Director

Encl.

TRANSPORTATION TO GREEN BANK

- 1) AIRLINES: Lake Central Airlines makes several flights daily between Elkins, W. Va. (the nearest airport) and Charleston, W. Va., Washington and Pittsburgh. Observatory vehicles will transport any travelers between Elkins and Green Bank.

- 2) RAILROAD: The Chesapeake and Ohio railroad (and New York Central from Chicago) offers overnight Pullman service between White Sulphur Springs, W. Va. (nearest rail station) and Chicago, Cincinnati, New York, Washington, and Detroit. Observatory cars will transport any travelers between White Sulphur Springs and Green Bank. This is the most reliable means of travel to Green Bank.

- 3) AUTOMOBILE: The Observatory is about a five hour drive from Washington or Pittsburgh, about three hours from Charleston, W. Va. and Charlottesville, Va., and about 2 hours from Staunton, Va. Detailed routings are desirable, and may be obtained from the Observatory in advance. Road conditions should be checked before starting during the winter months (December through April).

NATIONAL RADIO ASTRONOMY OBSERVATORY

POST OFFICE BOX 2

GREEN BANK, WEST VIRGINIA

TELEPHONE ARBOVALE 456-2011

October 25, 1961

TO: Invitees,
Conference on Extraterrestrial Intelligent Life

1. We are pleased at the large number of you that will be able to attend the conference on November 1 and 2. We intend to start the program at about 10:30 A.M. on November 1, to allow time for those coming on the morning trains to reach Green Bank.
2. The scientists we now expect to attend the conference are as follows:

D. W. Atchley, Jr., Microwave Associates
M. Calvin, University of California
G. Cocconi, Cornell University
F. D. Drake, National Radio Astronomy Observatory
S. S. Huang, NASA
J. Lederberg, Stanford University
J. C. Lilly, Communications Research Institute
P. M. Morrison, Cornell University
B. M. Oliver, Hewlett-Packard Corporation
J. P. T. Pearman, National Academy of Sciences
C. Sagan, University of California
O. Struve, National Radio Astronomy Observatory

Replies have not yet been received from all invitees.

3. Invitees have been somewhat reluctant to commit themselves to formal papers. However, some titles that have been received are:

Latest Developments in Optical Masers (Oliver)

Bimodal Weight Distribution and Evolution of Life (Morrison)

Recent Research on the "Language" of the Bottlenose Dolphin (Lilly)

The Range of Electromagnetic Communication Systems as a Function of Wavelength (Drake)

Use of Cross-correlation to Increase the Probability of Detecting Civilizations (Drake).

The program will follow the outline of subjects given in our original

letter of invitation.

4. We are looking forward to having you with us at the conference.

Sincerely yours,

Otto Struve

O. Struve

PROGRAM

Extraterrestrial Intelligent Life Conference, National Radio Astronomy
Observatory, November 1 and 2, 1961.

Below is given the proposed program for the conference, to be adjusted as the participants see fit. The names listed in connection with various parts of the program are meant as suggestions as to who we hope will play a leading role in the discussion, or present a paper, at that time. Pleas of ignorance will be accepted.

November 1, A.M. - P.M.

Tour of NRAO for early comers.

Early lunch, 12:00 noon.

About 1 P.M., commencement of conference.

- 1) Welcome to Conference by Prof. Struve and Dr. Pearman.
- 2) Introductory remarks and adjustments to program. Drake.
- 3) Experimental work already performed. Calvin, Lilly, Drake.
- 4) Biochemical and Biological considerations in incidence of intelligent life, humanoid and other. Calvin, Lilly, Morrison, Sagan.
- 5) Astronomical Statistics bearing on the subject. Huang, Sagan, Struve.
- 6) Longevity factor.

November 2, 9:00 A.M.

- 7) General discussion of incidence of communicative intelligent civilizations, based on data of November 1.
- 8) Brief discussion of marking techniques. Cocconi, Morrison, Sagan, Drake.
- 9) Most efficient means of interstellar communication (rocketry, electromagnetic waves). Morrison.
- 10) Approaches to electromagnetic communication. Atchley, Cocconi, Morrison, Oliver, Drake.

November 2, 1:30 P.M.

- 10) Continued.
- 11) Conclusions as to what research should be supported and emphasized, and what by-products might be expected. Recommendations to Space Science Board. Pearman, Struve.

ORDER OF THE DOLPHIN

2 November 1961

CHARTER MEMBERS:

X Melvin Calvin
Professor of Chemistry
University of California
Berkeley 4, California

Dane W. Atchley, Jr., President (Home: South Lincoln Road, Lincoln, Mass.)
Microwaves Associates

G. Cocconi
Cornell University
Ithaca, New York

F. D. Drake
National Radio Astronomy Observatory
Green Bank, West Virginia

S. S. Huang Goddard Space Flight Center
National Aeronautics and Space Administration
Washington, D.C. Greenbelt, Maryland

John C. Lilly, Director
Communication Research Institute
3908 Main Highway
Miami 33, Florida

P. M. Morrison
Department of Physics
Cornell University
Ithaca, New York

Bernard M. Oliver, Vice President
Hewlett-Packard Corporation
Palo Alto, California

J. P. T. Pasman
National Academy of Sciences
Washington, D. C.

Carl Sagan
~~Department of Astronomy~~ Department of Astronomy
~~University of California~~ Harvard University
~~Berkeley, California~~ Cambridge 38, Massachusetts

~~Otto Struve~~
~~National Radio Astronomy Observatory~~ Department of Astronomy
~~Green Bank, West Virginia~~ California Institute of Technology
Pasadena 4, California

*Mr. Morris Handelsman
27 Tyson Lane
Princeton, New Jersey*

- 2 -

ORDER OF THE DOLPHIN

MEMBERS

5 November 1961

Professor A. K. Solomon
Department of Biophysics
Harvard University
Cambridge, Massachusetts

5 November 1961

Elected by rump session consisting of
Melvin Calvin
John C. Lilly
D. W. Atchley

Mrs. Doris Woodward
24 Fenmore Road
Belmont, Massachusetts

Dr. Britton Chance, Director
Johnson Foundation
University of Pennsylvania
Medical School
Philadelphia, Pennsylvania

28 April 1962

Elected at Table 21, dinner of
American Philosophical Society by
Melvin Calvin
John C. Lilly

Mrs. Elizabeth S. Lilly
Communication Research Institute
3906 Main Highway
Miami 33, Florida

28 April 1962

Elected at Table 21, dinner of
American Philosophical Society by
Melvin Calvin
Britton Chance
John C. Lilly

Memorandum

To: Members, Order of the Dolphins

~~From: F. D. Drake~~

first

~~Enclosed~~ is an imitation/message from another communicative civilization I made up recently for use at some public lectures. I thought perhaps you might enjoy trying to solve it during some long winter evenings. It employs only principles one might actually expect to find used in space, and its message content is a serious effort guess as to what would be best to tell in a first message, although I left out a few important things to keep the puzzle from being too long. I think you will be surprised at how much insight into the other civilization can be obtained from so few bits.

I will be glad to give hints, if the key to the solution does not hit you immediately. Good luck!

Seasons Greetings,

F. D. Drake

Send to: O Struve

✓ P. M. Morrison

✓ G. Cocconi

✓ D. Athbley, Jr.

✓ M. Calvin

✓ C. Sagan

✓ B. M. Oliver

✓ J. P. T. Pearman

✓ S. S. Huang

✓ J. C. Lilly

Solution to the 551 Character Imitation Message From Another Civilization

The first step in the solution to the message is to determine, if possible, the number of dimensions in which the message is written. If one dimensional, it will be similar to an ordinary telegram; if two dimensional, it will be similar to a conventional TV picture, although other than cartesian coordinates might be employed, etc. We would not expect the number of dimensions to be large, simply because ease of decipherment calls for few dimensions. To make headway in this, one may see what factors may be divided into 551. This test reveals that 551 is the product of only two factors, 19 and 29, both prime, of course. This is a good indication that the message is two dimensional. Trial and error with cartesian coordinates shows that breaking the message into groups of 19 characters, and arranging these as in a conventional TV raster, gives a clearcut picture, which is obviously the correct decipherment of the message.

The interpretation of the picture is as follows:

- 1) The figure of the man-like creature at the bottom of the picture is obviously a drawing of the being sending the message. We see that it is a primate, with a heavier abdomen than we have, and that it carries its legs more widespread than we do. Its head is also more pointed than ours. One may speculate from this physiognomy that the gravitational acceleration is greater on the home planet of this creature than it is on earth.
- 2) The large square in the upper left-hand corner, accompanied by nine smaller objects strung along the left-hand margin, is a sketch of the planetary system of the creature. We see that there are four minor planets, a larger planet, two large planets, another intermediate planet, and one last minor planet. The system thus resembles our own in basic morphology.
- 3) The two groups in the upper right hand corner may be recognized as schematic drawings of the carbon and oxygen atoms. We deduce from this that the creature's biochemistry is based on the carbon atom, as ours is, and that the oxidizer used in the chemistry is oxygen, also as with terrestrial animals.
- 4) A key group of symbols are those occurring just to the right of the four minor planets and the fifth planet. Inspection of these symbols shows that they are simply a modified binary representation of 1, 2, 3, 4, 5, written in sequence alongside the first five planets. The modification made to the basic binary numbers is the addition to the ends of the numbers of parity bits, where necessary, so that the number of 1's in every binary number is odd. This is similar to computer practice on earth. It is apparently not used here as a check on transmission, but rather to designate a symbol as a number. In future communications, symbols will certainly also be used for words of language. We may deduce from the creature's careful setting down of the binary number system that he will use this, with parity bits, for numbers henceforth. It follows that we may expect words of language to have even numbers of 1's. In this way, the creature has established a number system, and has enabled us to recognize words of language.
- 5) Knowing this, the portions of the message located above the creature and below the atoms may be interpreted. We note that there are three groups of characters all having an odd number of 1's. These are then numbers. The lower group is connected to the creature by a diagonal line, signifying that it has something to do with him. We further note that the arrangement of these groups are mutually consistent only if no parity bits are present. The lower group, which

was too long to place on one line, is about $7(10^9)$ in decimal. The next is about 3000, and the upper group is 11. Noting that these groups are connected to the creature, and written alongside planets 2, 3, and 4, we reach the apparent interpretation that these numbers are the population of the creature on those planets. There are about 7 billion creatures on planet 4, evidently the home planet. There are about 3000 on planet 3, from which we can deduce the fact that astronautics is more developed than on earth, and there is a sizeable colony on planet 3. Lastly, there are 11 of the creatures on planet 2, evidently a small scientific or exploratory group.

6) The figure to the right of the creature contains one binary number, and a symmetric configuration of symbols of even parity, probably not words, and certainly not numbers. One symbol is level with the top of the creature's head, and the other his feet. This is apparently telling us the size of the creature -- it is 31 somethings tall. The only unit of length our two civilizations have in common is the wavelength at which the message was sent, so we conclude that the creature is 31 wavelengths tall.

7) Lastly, there is a symbol of even parity, with four 1's, underneath the creature. This is evidently an effort by the creature to use up all the "words" allotted him in his message. We may suspect, in keeping with the discussion in (4), that this is a word of language, and is very likely the symbol that the creature will use for himself in future messages. This behavior would seem to reinforce the conclusions of (4), but we will have to wait for future messages for proof that this conclusion is correct.

A few remarks:

The content of the message was designed to contain the data we would first like to know about another civilization, at least in the opinion of many scientists who have thought about this problem.

In preparing the message, an attempt was made to place it at a level of difficulty such that a group of high quality terrestrial scientists of many disciplines could interpret the message in a time less than a day. Any easier message would mean that we are not sending as much information as possible over the transmission facilities, and any harder might result in a failure to communicate. In trying this puzzle on scientists, it has been true so far that scientists have understood the parts of the message connected with their own discipline, but have usually not understood the rest. This is consistent with the philosophy behind the message.

The use of two dimensions has made possible the transmission of a great deal of information with few bits. This is because it is possible to arrange the symbols of the message in positions relative to one another such that even the arrangement carries information, when we employ logic and our existing knowledge of what may possibly occur in another planetary system. Thus the 551 bits are equivalent to approximately 25 English words, but the information content of the message appears much greater than that. This is because much of the message tells us, by the placement of a single symbol, which of several complicated possibilities is the one that has occurred in the other planetary system, without using bits to spell out precisely the possibility that has occurred.

COMMUNICATION RESEARCH INSTITUTE

3908 MAIN HIGHWAY
COCONUT GROVE
MIAMI 33, FLORIDA

File

3
July
1962

F. D. Drake
National Radio Astronomy Observatory
Green Bank, West Virginia

Dear Honorary Dolphin,

Enclosed is the current list of the members of the
Order of the Dolphin with historical notations,
which I am sending to you at the suggestion of
Melvin Calvin.

Sincerely,

Elisabeth B. Lilly

Elisabeth B. Lilly *ms*

ORDER OF THE DOLPHIN

2 November 1961

CHARTER MEMBERS:

Melvin Calvin
Professor of Chemistry
University of California
Berkeley 4, California

Dana W. Atchley, Jr., President (Home: South Lincoln Road, Lincoln, Mass.)
Microwave Associates

~~G. Cocconi
Cornell University
Ithaca, New York~~ N.P. Division
CERN
Geneva, Switzerland

F. D. Drake
National Radio Astronomy Observatory
Green Bank, West Virginia

S. S. Huang
National Aeronautics and Space Administration
Washington, D. C.

John C. Lilly, Director
Communication Research Institute
3908 Main Highway
Miami 33, Florida

P. M. Morrison
Department of Physics
Cornell University
Ithaca, New York

Barnard M. Oliver, Vice President
Hewlett-Packard Corporation
Palo Alto, California

J. P. T. Pearman
National Academy of Sciences
Washington, D. C.

Carl Sagan
Department of Astronomy
University of California
Berkeley, California

→ Dept. of Genetics 10 Oct - Feb. 1, 1963
~~Stanford U. Medical School
Palo Alto, California~~ Dept. of Astronomy
Harvard University
Cambridge 38, Mass.

Otto Struve
National Radio Astronomy Observatory
Green Bank, West Virginia

ORDER OF THE DOLPHIN

MEMBERS

5 November 1961

Professor A. K. Solomon
Department of Biophysics
Harvard University
Cambridge, Massachusetts

Mrs. Doxie Woodward
24 Kenmore Road
Belmont, Massachusetts

Dr. Britton Chance, Director
Johnson Foundation
University of Pennsylvania
Medical School
Philadelphia, Pennsylvania

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