von Neumann
Air Force Prize
(own folder)

347 Vista de la Playa
La Jolla, California
December 6, 1958

Dr. J. R. Oppenheimer
Director's Office
Institute for Advanced Study
Princeton, New Jersey

Dear Robert:

Many thanks for your very prompt answer to my little headache. In the meantime, I have also heard from the Air Force. I have written to them; I have written to Mr. Leidesdorf, and I hope that I will never have to pester you with this again.

We were very pleased and delighted to be able to participate in Freeman's wedding preparation and wedding. They seem to be delightfully happy and enjoying the new settled life very much.

With many more thanks and best wishes, in which Carl joins me, for the approaching holidays.

Sincerely,

Klari

Klari Eckart

Fac. von Neumann

CLASS OF SERVICE
This is a fast message unless its deferred character is indicated by the proper symbol.

WESTERN UNION
TELEGRAM

1201

W. P. MARSHALL, PRESIDENT

SYMBOLS
DL = Day Letter
NL = Night Letter
LT = International Letter Telegram

The filing time shown in the date line on domestic telegrams is STANDARD TIME at point of origin. Time of receipt is STANDARD TIME at point of destination

sent 11/17/58

Mrs. C. Eckhart
347 Vista de la Playa
La Jolla, California

Leidesdorf has made gift to Air Force Academy. Gift has been acknowledged. All greetings

Robert Oppenheimer

THE COMPANY WILL APPRECIATE SUGGESTIONS FROM ITS PATRONS CONCERNING ITS SERVICE

Former Fac von Neumann

20 October 1958

Dear Mrs. Eckhart:

Dr. Oppenheimer has asked me to return to you the enclosed letter to you from Col. Hogan, with its attachments; and to let you know that all copies of this letter and of your drafted reply of October 15th have been destroyed.

Sincerely yours,

(Mrs. Wilder Hobson)
Secretary to the Director

Mrs. C. Eckhart
347 Vista de la Playa
La Jolla, California

enclosure

* Air Force.
prefer to be given
in name of Prof von Neumann

1. Pergamon Press undertakes to publish THE COLLECTED WORKS OF DR. JOHN VON NEUMANN at its own risk and expense.

2. The Editor of the work shall be Professor A.H. TAUB, who will be assisted by members of the Honorary Editorial Advisory Board. The Editor shall have full and complete control over the contents of the work and the Publisher shall publish nothingabout the work that has not had the prior approval of the Editor.

3. The Publisher undertakes to produce the work to the highest technical quality and to the same standards as, for instance, the works of Dr. T. von Karman and Paul Ehrlich.

4. The Publisher undertakes to keep the published price of the work at a reasonable level and to settle the published price in consultation with the Editor and Dr. R. Oppenheimer.

5. The Publisher agrees to handle and process promptly all requests for permission to quote passages from the Collected Works, and the Publisher further agrees not to refuse any such requests without first obtaining the written approval and consent of the Editor.

6. The Publisher will submit to the Editor for approval and consent copy for all jackets and advertisements relating to each of the books.

7. The Publisher will reimburse the Editor for his out-of-pocket and travelling expenses in connection with his duties and for the time spent by him on the project.

8. The Publisher agrees to supply 12 complimentary sets of the Collected Works to Mrs. Klara von Neumann and one free set to those members of the Honorary Editorial Advisory Board who actively assist in the production of the work.

---

von Neumann

IRM/bh

10th March 1958

Mrs. Klara von Neumann,
1526 32nd Street, N.W.,
Washington D.C.,
U.S.A.

Dear Mrs. von Neumann,

The Collected Works of Dr. John von Neumann

I enclose herewith, in draft, the obligations of the Pergamon Press, in respect of the Collected Works of your late husband. I should very much appreciate it if you would consult with your friends and advise me whether this is satisfactory.

I hope to be in Washington early in April and very much look forward to seeing you.

With best wishes,

Yours sincerely,

I. R. Maxwell.

c.c.Dr. R. Oppenheimer,
Professor Taub.

Fac von Neumann

THE INSTITUTE FOR ADVANCED STUDY

PRINCETON, NEW JERSEY

February 11, 1958

Mr. Gordon C. Godejahn, Manager
Advertising and Sales Promotion
Central Scientific Company
1700 Irving Park Road
Chicago 13, Illinois

Dear Mr. Godejahn:

Your letter of February 7 addressed to the Director has been referred to me. We are happy to be of help to you in your portrayal of the late John von Neumann for Cenco News Chats. Enclosed you will find the biography of Professor von Neumann, and a glossy print which is the only picture we have of him.

If we can be of further assistance, please let us know.

Sincerely yours,

(Mrs.) Elizabeth S. Gorman
Secretary

Enclosures
cc: Dr. R. Oppenheimer

CENTRAL SCIENTIFIC COMPANY

February 7, 1958

Director
Institute for Advanced Studies
Princeton University
Princeton, New Jersey

Dear Professor:

In each issue of our publication, Cenco News Chats, is featured a portrait and biographical sketch of a deceased scientist who has done outstanding work in a scientific field.

We should like to portray Dr. John von Neumann in an early issue and, in this respect, ask for your kind help in securing the basic facts of his life and work and several photographs which will guide our artist in the portrait drawing. Any reference material you can send us in this respect will be deeply appreciated and full credit will be given, if desired.

Cenco News Chats has a circulation of about 64,000 reaching technical people in all phases of science throughout the nation and we believe these readers will be genuinely interested in Dr. von Neumann. Several copies are being mailed to you to give you an idea of what has been featured in the past.

We await your reply and thank you for your consideration.

Sincerely yours,

CENTRAL SCIENTIFIC COMPANY

Gordon C. Godejahn, Manager
Advertising and Sales Promotion

GCG/tc
cc: L. M. Boles

WELLINGTON 5-8600
1700 IRVING PARK ROAD. CHICAGO 13, ILLINOIS

23 October 1957

Dear Miss Tietjen:

Thank you for your letter of October 18th. The Institute for Advanced Study does not have a file of pictures or material such as you requested on Professor von Neumann. I believe your best source would be your local public library.

I am sorry that we cannot help you.

Sincerely yours,

(Mrs. Wilder Hobson)
Secretary to the Director

Miss Andrea H. Tietjen
245 Fairfield Avenue
Ridgewood, New Jersey

Fac von Neumann

23 October 1957

Dear Miss Tietjen:

Thank you for your letter of October 18th. The Institute for Advanced Study does not have a file of pictures or material such as you requested on Professor von Neumann. I believe your best source would be your local public library.

I am sorry that we cannot help you.

Sincerely yours,

(Mrs. Wilder Hobson)
Secretary to the Director

Miss Andrea H. Tietjen
245 Fairfield Avenue
Ridgewood, New Jersey

Oct. 18, 1957

Andrea H. Tietjen

245 Fairfield Avenue, Ridgewood, New Jersey

Dear Sirs:

Would you be so kind as to send me some free literature, pictures, etc. of John von Neuman. I would appreciate it very much if you could send this information to me as soon as possible.

I am in the eighth grade in the Benjamin Franklin Junior High School. My algebra teacher, Mr. Humiston, has asked me to make a report about John von Neuman for our class.

Thank you.

Yours Sincerely,

Miss Andrea Tietjen
245 Fairfield Avenue
Ridgewood, New Jersey

THE INSTITUTE FOR ADVANCED STUDY

PRINCETON, NEW JERSEY

September 4, 1957

Faculty, School of Mathematics:

In the hallway outside Fuld Hall 115 there are two filing cabinets of reprints from the collection of Professor von Neumann which are duplicates of ones already held ~~in the~~ files of the Library. These are, therefore, available to you. ~~If you~~ care to add any of them to your own collections please help yourselves. Later, during the fall term, they will be made available to the visiting members.

Sincerely yours,

E. Underwood

Secretary
School of Mathematics

CC: Professors Beurling
Borel
Dyson
Gödel
Montgomery
Morse
Oppenheimer
Pais
Selberg
Strömgren
Whitney
Yang

13 June 1957

Dear Mr. Bowie:

Thank you for your letter of May 28th. We understand that Professor von Neumann was preparing a manuscript on the brain and that this article was not completed. No copies of the incomplete manuscript are available; and we are therefore unable to comply with your request.

Very truly yours,

Velma A. Mumper
Office of the Director

Mr. Ray R. Bowie
930 West Cherry Street
Statesville, North Carolina

930 West Cherry Street
Statesville, North Carolina
May 28, 1957

Director
Princeton Institute of Advanced Learning
Pinceton, New Jersey

Sir:

I understand that Dr. John von Neumann, before his death, had been working on a treatise concerning the workings of the human brain.

I also understand that the document was never completed.

Since I also am working on actions of the human brain, would you please allow me to purchase a copy of the uncompleted treatise by Mr Neumann.

Thank you,
Ray R. Bowie
Ray R. Bowie

Fac von Neumann

THE INSTITUTE FOR ADVANCED STUDY

PRINCETON, NEW JERSEY

SCHOOL OF MATHEMATICS

May 14, 1957

Dear Robert,

In a telephone conversation last evening Klari told me that she was giving Johnny's books (including the reprints he has by other authors) to the Institute. She said that this action was now official and that the legal requirements for the action were complete. I am sending a copy of this letter to the lawyer for the estate who will undoubtedly let you know if there is anything to correct in the statement above.

Sincerely yours,

Deane

DM:MMM

Deane Montgomery

cc: M. Leva
Miss Sachs

Dr. Robert Oppenheimer
Fuld Hall

Fac Von Neumann

5/14/57

Professor Montgomery spoke last night by telephone with Mrs. von Neumann.

She said she does wish to give books and reprints to Institute; that this action is now complete and official, legal requirements having been met. She told M. that she had written to this effect both to Betty Gorman and to us. Apparently her memory is at fault, but M. did not press point. To have something of record, M. will write to you about his telephone conversation with her, sending copy to her lawyers.

Montgomery says he has mentioned this to Miss Sachs, who will presumably wish to go through to make choice for library.

3 May 1957

Dear Dr. Freudenthal:

You should have had an earlier reply to your letter of 3 April, but we were waiting for a more complete biography of Professor von Neumann to send you. We are pleased to send it to you now, along with a reprint of "Scientific Works of J. von Neumann" by Doctors Goldstine and Wigner. We hope that this delay has caused you no inconvenience and that the material submitted will be helpful.

Sincerely yours,

Velma A. Numper
Office of the Director

Dr. H. Freudenthal
Mathematisch Instituut der
Rijksuniversiteit te Utrecht
Boothstraat 17, Utrecht
Netherlands

Professor Dr.H.Freudenthal
Mathematisch Instituut der
Rijksuniversiteit te U trecht
Boothstraat 17, Utrecht
Netherlands

Utrecht, 3 april 1957

The Institute for Advanced Study
PRINCETON, N.J.
USA

Dear Sirs,

For an obituary of John von Neumann, who was a member of the Netherlands Academy of Sciences I need the usual personal data of his life. I suppose you will know these facts of even be in the possession of a short biography of Von Neumann. May I ask you to give me the necessary indications.

Truly yours,

H. Freudenthal

(H. Freudenthal)

AEROGRAMME

LUCHTPOSTBLAD

78

25C NEDERLAND

The Institute for Advanced Study

PRINCETON, N.J.

USA

PAR AVION / PER LUCHTPOST

EXPÉDITEUR/AFZENDER

Prof.Dr.H.Freudenthal,
Boothstr. 17, Utrecht Netherlands

NIETS INSLUITEN!

INDIEN ZULKS TOCH GESCHIEDT, DAN WORDT DEZE BRIEF PER BOOT / TREIN VERZONDEN

OUVRIR ICI / HIER OPENEN

AEROGRAMME

LUCHTPOSTBLAD

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The Institute for Advanced Study

PRINCETON, N.J.

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PAR AVION / PER LUCHTPOST

EXPÉDITEUR / AFZENDER

Prof.Dr.H.Freudenthal,
Boothstr. 17, Utrecht Netherlands

NIETS INSLUITEN!

INDIEN ZULKS TOCH GESCHIEDT, DAN WORDT DEZE BRIEF PER BOOT / TREIN VERZONDEN

OUVRIR ICI / HIER OPENEN

Professor Dr.H.Freudenthal
Mathematisch Instituut der
Rijksuniversiteit te U trecht
Boothstraat 17, Utrecht
Netherlands

Utrecht, 3 april 1957

The Institute for Advanced Study
PRINCETON, N.J.
USA

Dear Sirs,

For an obituary of John von Neumann, who was a member of the Netherlands Academy of Sciences I need the usual personal data of his life. I suppose you will know these facts of even be in the possession of a short biography of Von Neumann. May I ask you to give me the necessary indications.

Truly yours,

Hans Freudenthal

(H. Freudenthal)

File

"Scientific Works of J. von Neumann"
by Goldstine and Wigner

Mailing List

Adams, C. R. - Brown University, Providence, R.I.
Agmon, Dr. Smuel, Hebrew University, Jerusalem, Israel
Ahlfors, L. V. - Harvard University
Albert, A. A. - Yale University
Alexander, Prof. J. W. - 29 Cleveland Lane, Princeton, NJ
Alföldi, Prof. Andrew - Institute for Adv. Study
Alger, P. L. - General Electric Co., 1 River Road, Schenectady 5, NY
Alisbah, Prof. C. H. - University of Ankara, Ankara, Turkey
Allendoerfer, C. B. - University of Washington, Seattle, Wash.
Alt, Dr. F. L. - Asst.Chief,Computation Lab.,Natl.Bur.Standards,Commerce Dept.Washington
Altshuler, Dr. Bernard, New York University, New York 3, NY
Ambrose, W. - Mass. Inst. of Tech.
Amitsur, Dr. S. A. - Hebrew University, Jerusalem, Israel
Andrew, Dr. M. M. - Math. Div. Air Force Office of Scientific Res.,Washington 25, DC
Ankeny, N. C. - Mass. Inst. of Tech.
Arens, H. C. - University of California, Los Angeles
Arens, Dr. Richard - University of California, Los Angeles
Aronszajn, N. - University of Kansas, Lawrence, Kans.
Artin, Prof. Emil - Princeton University
Artin, N. J. - New York University, New York 3, NY

Barankin, Dr. E. W. - University of California, Berkeley
Bargmann, Prof. V. - Princeton University
Barnothy, J M. - 833 Lincoln Street, Evanston, Ill.
Bartky, Walter, V.P.Chg Spec. Scientific Prog., University of Chicago, Chicago 37
Bateman, Dr. P. T. - University of Illinois, Urbana, Ill.
Bay, Zoltan, 151 Quincey Street, Chevy Chast 15, Md.
Beckenbach, Dr. E. F. - Dept. of Math, University of California, Los Angeles
Begle, E. G. - Yale University, New Haven, Conn.
Behnke, Prof. H A. L. - Univ. of Münster, Münster, Westfalen, Germany
Bell, E. T - Calif. Inst. of Technology, Pasadena, Calif.
Bellman, R. E. - RAND Corporation, Santa Monica, California
Bennett, A. A. - Brown University, Providence, Rhode Island
Bernstein, D. L. - University of Rochester, Rochester, NY
Bers, L. - New York University, New York 3, NY
Besicovitch, A. S. - Cambridge University, Cambridge, England
Bethe, Hans A. - Lab. of Nuclear Studies, Cornell University, Ithaca, NY
Beurling, Prof. Arne - Inst. for Advanced Study
Bigelow, Dr. Julian H. - 542 Snowden Lane, Princeton, NJ
Bing, Dr. R. H. - University of Wisconsin, Madison 6, Wisconsin
Birkhoff, Prof. Garrett, Harvard University
Blackwell, Prof. D. - Dept. of Math., University of California, Berkeley, Calif.
Blumenthal, L. M. - University of Missouri, Columbia, Missouri
Boas, R. P. - Northwestern University, Evanston, Illinois
Bochner, Prof. S. - Princeton University

Bode, H. W. - Bell Telephone Labs., Inc., Murray Hill, NJ
Bohnenblust, Prof. H. F. - California Inst. of Technology, Pasadena 4, Calif.
Bohr, Prof. Niels - Gl. Carlsberg, Copenhagen, Denmark
Bompiani, E. - University of Rome, Rome, Italy
Booth, Dr. A. D. - University of London, London, England
Borel, Professor Armand, Institute for Advanced Study
Bott, Dr. R. - Institute for Advanced Study
Bourgin, D. G. - University of Illinois,-Urbana, Illinois
Bowker, A. H. - Stanford University, Stanford, California
Bradbury, Dr. Norris E. - Dir., Los Alamos Scientific Lab.,P.O.Box 1663, Los Alamos, NM
Brainerd, J. G. - University of Pennsylvania, Philadelphia, Pennsylvania
Braithwaite, Prof. R. B. - King's College, Cambridge, England
Brauer, A. T. - University of North Carolina, Chapel Hill, NC
Brauer, Prof. Richard - Harvard University, Cambridge 38, Mass.
Bridgman, P. W. - Harvard University, Cambridge, Mass.
Bromberg, E. - New York University, New York 3, NY
Brosin, Dr. Henry W., Dir.,Univ. of Pittsburgh,School of Medicine,3811 O'Hara St. Pittsburgh 13, Pa.
Bruck, R. H. - University of Wisconsin, Madison 6, Wisconsin
Bureau, Prof. F. J. - Inst. of Math., Leige, Belgium
Burckhardt, J. J. - University of Zurich, Zurich, Switzerland
Burington, R. S. - Spec.Asst.to Dir. of Res and Dev, Bur. of Ord, Navy Dept,Washington 2
Burington, A. J. - Math., Atomic Energy Commission, 1901 Constitution Ave., Washington 2
Burkill, J. C. - Cambridge University, Cambridge, England
Busemann, H. - University of Southern California, Los Angeles, California

Cairns, Prof. S. S - University of Illinois, Urbana, Illinois
Calderon, A. P. - Mass. Inst. of Technology, Cambridge, Mass.
Calkin, John W. - AEC Computing Facility, 253 Greene St., New York 3, NY
Campaigne, Dr. H. H. - Asst.Chief for Res, National Security Agency, Washington 25
Carrier, G. F. - Harvard University, Cambridge, Mass.
Cartan, H. - University of Paris, Paris, France
Cesari, L. - Purdue University, Lafayette, Indiana
Chandrasekhar, Dr. S. - Yerkes Observatory, Williams Bay, Wisconsin
Chandrasekharan, Prof. K. - Tata Inst. of Fundamental Research, Apollo Pier Road, Bombay 1, India
Charney, Dr. J. G. - Dept. of Meteorology, Mass. Inst. of Tech., Cambridge, Mass.
Chern, Prof. S. S. - University of Chicago, Chicago 37, Ill.
Cherniss, Prof. Harold F. - Institute for Advanced Study
Chevalley, Prof. C. C. - Columbia University, New York 27, NY
Chittenden, E. W. - State University of Iowa, Iowa City, Iowa
Choquet, G - University of Paris,Paris, France
Chow, W. L. - Johns Hopkins University, Baltimore, Maryland
Chowla, Dr. S. - University of Colorado, Boulder, Colorado
Lt. Col. Ray E. Clausen, 4105 Waxford Drive, Kensington, Maryland
Clippinger, R. F. - Datamatic Corporation, Newton Highlands, Mass.
Cooke, John - Duke University, Durham, North Carolina
Cohen, E. L. - Harvard University
Cohen, Dr. I. W. - Program Dir.,Mathematical Sciences, Natl Sci.Fndtn,Washington 25
Copeland, Prof. A. H. - University of Michigan, Ann Arbor, Mich.

Copson, Prof. E. T. - University of St. Andrews, St. Andrews, Fife, Scotland
Courant, Prof. Richard - Inst. of Math. Sci., New York University, New York 3, NY
Coxeter, H. S. M. - University of Toronto, Toronto, Canada
Cramér, H. - University of Stockholm, Stockholm, Sweden
Curry, H. B. - Pennsylvania State University, University Park, Pa.
Curtiss, J. H. - American Math. Soc., 190 Hope St., Providence 6, Rhode Island

Dantzig, G. B. - RAND Corporation, Santa Monica, California
Day, M. M - University of Illinois, Urbana, Illinois
De Carlo, C. R. - International Business Machines Corp.,590 Madison Ave., New York, NY
Dederick, Dr. L. S. - 4714 Park Lane, Washington 23, D.C.
Deg, Andrew - 21 Gordon Street, Workington, Cumberland, Scotland
Delange, Prof. Hubert - University of Clermont-Ferrand, Clermont-Ferrand, France
Delsasso, Dr. L. A. - Ballistic Res. Labs., Aberdeen Proving Ground, Md.
Deny, Prof. Jacques - University of Strasbourg, Strasbourg, France
de Rham, Prof. G. W. - University of Lausanne, Lausanne, Switzerland
Dieudonné, J. A. - Northwestern University, Evanston, Illinois
Dimsdale, B. - University of California, Los Angeles, California
Dolph, C. L. - University of Michigan, Ann Arbor, Michigan
Domony, Mr. Peter - 111 E. 75th Street, New York, NY
Doob, J. L. - University of Illinois, Urbana, Illinois
Douglas, Prof. Jesse - City College, New York 31, New York
Drescher, Dr. Paul - RAND Corporation, Santa Monica, California
Dressel, F. G. - Duke University, Durham, North Carolina
Dribin, Dr. D. M - Supervisory Analyst, National Security Agency, Defense Dept.Washingt
Dunford, N. - Yale University, New Haven, Conn.
Duren, W. L. - University of Virginia, Charlottesville, Va.
Dvoretzky, Dr. A. - Hebrew University, Jerusalem, Israel
Dwyer, P. S. - University of Michigan, Ann Arbor, Michigan
Dyer, Dr. E. - Johns Hopkins University, Baltimore, Maryland
Dyson, Prof. F. J. - Institute for Advanced Study

Eberlein, Dr. W. F. - New York University, New York 3, NY
Eckart, Dr. Carl - Scripps Inst. of Oceanography, La Jolla, California
Eckert, J. P. - Sperry Rand Corporation,2300 W. Allegheny, Philadelphia 32, Pa.
Eckert, W. J., Int. Business Machines Corp.,590 Madison Ave., New York, NY
Eckmann, B. - Swiss Federal School of Tech., Zurich, Switzerland
Ehrenpreis, Dr. L. - Johns Hopkins University, Baltimore, Md.
Eilenberg, S. - Columbia University, New York 27, NY
Eisenhart, Dr. Churchill, Chief, Stat.Eng.Lab.,National Bureau of Standards,
Commerce Department, Washington, DC
Erdelyi, A. - California Institute of Technology, Pasadena, California
Erdös, P. - University of Notre Dame, Notre Dame, Indiana
Evans, Foster - P.O. Box 1663, Los Alamos, New Mexico
Evans, Dr. G C. - University of California, Berkeley, California

Fan, K. - University of Notre Dame, Notre Dame, Indiana
Federer, H. - Brown University, Providence, Rhode Island
Fekete, Dr. M - Hebrew University, Jerusalem, Israel
Fellner, Dr. W. - 131 Edgehill Road, New Haven, Conn.

Fenchel, Prof. W. - Dept. of Math., Univ. of Copenhagen, Copenhagen, Denmark
Fernbach, Dr. Sidney - 685 Adelle Street, Livermore, California
Feynman, R. P. - Calif. Inst. of Tech., Dept of Physics, Pasadena, California
Flanders, D. A. - Argonne National Lab., P.O. Box 299, Lemont, Illinois
Ford, Prof. L. R. (Ill.Inst.Tech.) 200 Cameron Lane, Charlottesville, Va.
Forsythe, G. E. - University of California, Los Angeles, California
Foures, L. C. - University of Marseille, Marseilles, France
Fox, P. - New York University, New York 3, New York
Frame, J. S. - Michigan State University, East Lansing, Michigan
Friedrichs, K. O. - New York University, New York 3, New York
Fucks, Professor - Technische Hochschule, Aachen, Germany
Fulton, Dr. John F. - Yale University School of Medicine, 333 Cedar St., New Haven 11, C

Galbraith, Dr. A. S. - Tech.Dir., Directorate of Ballistics, Air Force Armament Center. Eglin Air Force Base. Florida
Gale, D. - Brown University, Providence, Rhode Island
Galpin, Mr. Perrin C. - Belgian American Foundation, Inc., 420 Lexington Ave., NewYork 17
Gamow, Prof. G. - Department of Physics, Geo.Washington University, Washington, DC
Garabedian, P. R. - Stanford University, Stanford, California
Garding, Prof. Lars - Lund University, Lund, Sweden
Garrison, Mr. Lloyd K. - 575 Madison Avenue, New York 22, NY
Gautschi, Dr. Werner - University of California, Berkeley, California
Gelbart, Prof. A. - Syracuse University, Syracuse 10, New York
Gergen, J. J. - Duke University, Durham, North Carolina
Giese, Dr. J H. - Math., Ballistic Research Labs., Aberdeen Proving Ground, Md.
Gilchrist, B. - Syracuse University, Syracuse 10, NY
Gillies, D B. - University of Illinois, Urbana, Illinois
Gillis, Dr. Joseph - Applied Math. Dept., Weismann Institute, Rehovoth, Israel
Givens, Prof. Wallace - Wayne State University, Detroit 2, Michigan
Gödel, Prof. Kurt - Institute for Advanced Study
Goertzel, H. - New York University, New York 3, NY
Goldman, Miss Hetty - Institute for Advanced Study
Goldman, Prof. Stanford - Dept. of Electrical Eng., Syracuse University, Syracuse 10, NY
Golomb, S. W. - California Institute of Technology, Pasadena, California
Goodall, M. C. - Mass. Inst. of Technology, Cambridge, Mass.
Gottlieb, Dr. M. J. - Dir. of Res., Market Facts, Inc., 39 S. LaSalle St., Chicago 3, Ill.
Grad, Dr. Arthur - Head, Math. Branch, Office of Naval Research, Washington 25, DC
Graves, L. M. - University of Chicago, Chicago 37, Illinois
Greenbaum, Gen. Edward S. - 285 Madison Avenue, New York 17, NY
Guilbaud, Dr. G. Th., Institut de Science Economique Appliquee, 35 Boulevard des Capucines, Paris IIe, France

Haberler, Prof. G. - Dept. of Economics, Harvard University
Hadamard, J. - College of France, Paris, France
Hall, Prof. Marshall Jr. - Ohio State University, Columbus 10, Ohio
Halmos, Prof. P. R. - University of Chicago, Chicago 37, Illinois
Halperin, Dr. I. - Queens College, Kingston, Ontario, Canada
Hamilton, Dr. L. D. - Memorial Center, 444 East 68th St., New York 21, NY
Hammer, P. C. - University of Wisconsin, Madison 6, Wisconsin
Hamming, R. W. - Bell Telephone Labs., Inc., Murray Hill, New Jersey

Harish-Chandra, Prof. - Columbia University, New York 27, NY
Harmorll, Gaylord - University of Pennsylvania, Philadelphia, Pa.
Hart, B. I. - Ballistic Research Labs., Aberdeen Proving Ground, Md.
Hayek, Prof. F. A. - Committee on Social Thought, University of Chicago, Chicago, Ill.
Hedlund, G. A. - Yale University, New Haven, Connecticut
Heins, M. H. - Brown University, Providence, Rhode Island
Herbst, Dr. R. T. - Chief, Mechanics Branch, Math. Sci. Div., Office of Ordnance Research, U.S. Army, Box CM, Duke Station, Durham, North Carolina
Herrick, H. L. - International Business Machines Corp.,590 Madison Ave., New York, NY
Herzberger, M. J. - Eastman Kodak Co., Rochester 4, New York
Hestenes, Prof. M. R. - University of California, Los Angeles 24, California
Hewitt, Prof. E. - University of Washington, Seattle, Washington
Hildebrand, F. B. - Mass. Inst. of Technology, Cambridge, Mass.
Hille, E. - Yale University, New Haven, Connecticut
Hiltebrandt, T. - University of Michigan, Ann Arbor, Michigan
Hirschfelder, E. - University of Wisconsin, Madison 6, Wisconsin
Hirschfelder, Joseph O. - Univ. of Wisconsin, Naval Res. Lab., 400 Babcock Dr.,Madison 6
Hirzebruch, Prof. F. E. P. - University of Bonn, Bonn, Germany
Hlavaty, V. - Indiana University, Bloomington, Indiana
Hochschild, G. P. - University of Illinois, Urbana, Illinois
Hochschild, Mr. Harold K. - 61 Broadway, New York 6, New York
Hoffman, Dr. A. J., Math., Applied Math Labs., National Bureau of Standards, Commerce Department, Washington, D.C.
Hopf, E. - Indiana University, Bloomington, Indiana
Hopf, H. - Swiss Federal School of Tech., Zurich, Switzerland
Hotelling, H. - University of North Carolina, Chapel Hill, NC
Householder, A. S. - Oak Ridge National Lab., Oak Ridge, Tennessee
Hull, A. W. - General Electric Co., 1 River Road, Schenectady 5, New York
Hunt, G. A. - Cornell University, Ithaca, New York
Hurd, Dr. C. C. - International Business Machines Corp.,590 Madison Ave., New York, NY
Hurwicz, Prof. Leonid - Dept. of Economics, Univ. of Minnesota, Minneapolis, Minn.

Ikehara, Prof. Shikao - Tokoyo Inst. of Technology, Oh-okayama, Meguroku, Tokoyo,Japan
Ingraham, M. H - University of Wisconsin, Madison 6, Wis.

Jacobson, N. - Yale University
James. R. D. - Univ. of British Columbia, Vancouver, British Columbia, Canada
Jessen, Prof. Børge, - University of Copenhagen, Copenhagen ø, Denmark
John, F. - New York University, New York 3
Jost, Prof. Res - Physikalisches Institut der ETH, Gloriastrasse 35, Zurich, Switzerland
Julia, G. M. - University of Paris, Paris, France

Kac, M. - Cornell University, Ithaca, NY
Kadison, R V. - Columbia University, New York 27, NY
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17 May 1957

Dear Miss Aul:

At Dr. Goldstine's request, we are sending one hundred copies of the article, "Scientific Works of J. von Neumann," to Prof. Wigner, addressed to your attention. We understand that Prof. Wigner is away; if you believe that he might want more than the hundred copies, please telephone me, and I shall be happy to send them to you.

Sincerely yours,

Velma A. Mumper
Office of the Director

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To: Dr. Goldstine
Dr. Wigner
Prof. Montgomery

From: Velma Mumper

Now that we have a thousand reprints of the article, "Scientific Works of J. von Neumann," we are making up a mailing list of people who might like to receive them. We have written Mrs. von Neumann to ask for her list, and would very much like to have your suggestions for this list. Any help that you can give us will be greatly appreciated.

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Velma A. Mumper
Office of the Director

These accounts are off hand.
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April 17, 1957

Dr. Herman H. Goldstine
School of Mathematics
Institute for Advanced Study
Princeton, New Jersey

Dear Dr. Goldstine:

In the article on von Neumann in the April 12 issue of Science, of which you are co-author, a series of papers which gave a theory of the logical organization and functioning of computers, is mentioned.

I would appreciate it very much if you would tell me where a list of these papers can be found; and if possible, how copies of the papers can be obtained.

It was very interesting to get an overall picture of the magnificent work of von Neumann.

Sincerely yours,

Stanford Goldman

Stanford Goldman
Professor
Department of Electrical Engineering

SG:aw

Preliminary Discr. of
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30 April 1957

Dear Mrs. von Neumann:

We have a thousand reprints of the article, "Scientific Works of J. von Neumann," written by Doctors Goldstine and Wigner, and published in Science; we are in the process of making up a mailing list, and it would be greatly appreciated if you could give us a list of people who you think would like to have copies of this article. We are also asking Doctors Goldstine and Wigner and Professor Montgomery for their suggestions. Mrs. Gorman tells me that you plan to be in Princeton in the near future, and it may be that you would wish to wait until that time to go into the matter.

Sincerely yours,

Velma A. Mumper
Office of the Director

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Apt. B1037, The Woodner
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P.S. We are enclosing six copies of the article which we thought you might like to have. If you would like more, please do not hesitate to ask. vm

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FOWLER, LEVA, HAWES & SYMINGTON
1701 K STREET, NORTHWEST
WASHINGTON 6, D. C.

April 24, 1957

Lewis Strauss, Esq.,
Shoreham Hotel
Washington, D. C.

Dear Lewis:

Klara Von Neumann has asked me to write you, in your capacity of President of the Board of Trustees of the Institute for Advanced Study, to thank you and the other members of the Board for the Board's action earlier this month in writing off the indebtedness which arose because of certain amounts which the Institute paid on Dr. Von Neumann's behalf during his leave of absence from the Institute. Mr. Minot Morgan has written to tell us of the Board's action, and Klara has asked that I write you this letter. Klara has asked that I express to the Board, through you, her appreciation, and that of Dr. Von Neumann's daughter, Marina, also.

Sincerely,

Marx Leva

ML.hf
bc: Minot C. Morgan, Jr.
Comptroller, Institute for Advanced Study

Dear Mr. Morgan:
Many thanks for your letter of April 22 on this matter.

Sincerely,
Marx Leva
Marx Leva

1 April 1957

Dear Klari:

Thank you for your letter of March 29th; the points that you list all agree with my understanding of our talk, and all seem consistent with the proper handling of the papers recording Johnny's work.

With regard to 2. and 5. in your letter, there have been some minor developments which I should report to you: Mrs. Gorman asked whether she could have a little more help than she was getting from Julian Bigelow in identifying and listing papers on the applied side; I told her that she should be free to call on Herman Goldstine for such help. Two people have been in to visit, both close collaborators of Johnny's: Stan Ulam and Kakutani. Deane Montgomery suggested that we encourage Kakutani to come again; he has a proper reverence, and I think he would welcome this suggestion; and I have told him that we would take care of his expenses. I hope that this seems right to you. Mr. Bailey of Princeton University Press is interested in anything that we can find on continuous geometries and has communicated with Givens; so far, we have not heard directly from him. If any of these arrangements seem bothersome to you, please do not hesitate to let me know. I will also assume that, if Deane or I should think it desirable to enlist Gödel's help on problems of logic, you will not object to that.

About ten days ago, I called Los Alamos to tell them of our thoughts and to learn of theirs. Perhaps as a result of this, we had a whirlwind invasion and a great proliferation of phone calls and letters from the dashing Captain Maxwell of Pergamon. Despite his florid style and monstrous honorary editorial board, what he intends to do, to what we call the Los Alamos Project, does seem to me inherently good and rather hard to spoil; and much of it would be quite beyond our competence here. For instance, he wants to try to get some of Johnny's secret work declassified and published, and will try to get a number of articles that summarize the present state of fields of research, which were either started by Johnny, or to which he made seminal contributions. I don't think that I can do much to watch out for the Pergamon Press adventure, but if I see anything in the account of it, that will no doubt reach us here, that alarms me, I will be in touch with Marx Leva or with you.

Your last paragraph calls for special comment: We would be grateful and very much pleased if the technical books that belonged to your husband were to be given to the Institute. I know that both his colleagues on the Faculty, and the Institute's trustees, would welcome and would accept this bequest, as would I.

With good wishes,

Very sincerely,

Robert Oppenheimer

Mrs. John von Neumann
Apt. B-1037
3636 - 16th Street, N.W.
Washington 10, D.C.

March 18, 1957

Dear Robert:

Will you be good enough to convey my most sincere thanks to the members of the Faculty at the Institute for the beautiful flowers sent by all of you to Johnny at his last rites.

Gratefully,

Klara

Dr. Robert Oppenheimer
Institute for Advanced Study

18 March 1957

Dear Sir:

On behalf of the Trustees and the Faculty of the Institute for Advanced Study, I wish to express to Der Technischen Hochschule of München our appreciation of your word of condolence on the death of Professor John von Neumann, and our gratitude.

Sincerely yours,

Robert Oppenheimer

Der Rektor
Der Technischen Hochschule
Walter v. Dyckplatz 1
München 2, Germany

DER REKTOR
DER TECHNISCHEN HOCHSCHULE
MÜNCHEN
I/ 1151

MÜNCHEN 2, Walther v. Dyckplatz 1
Fernsprecher Nr. 4562 den 25.2.1957

An das
Institute for Advanced Study

P r i n c e t o n N.J.
USA

Zu meinem großen Bedauern habe ich soeben erfahren, daß Herr Professor Dr.Dr. John von N e u m a n n vor einigen Wochen gestorben ist. Professor Dr. Neumann war Ehrendoktor unserer Hochschule. Sein Ableben geht darum auch uns sehr nahe. Ich gestatte mir daher, Ihnen zu dem schweren Verlust, der Sie durch seinen Tod getroffen hat, namens des Senats unserer Hochschule wie für mich persönlich aufrichtiges Beileid auszusprechen.

Darf ich Sie zugleich um die Freundlichkeit bitten, mir Namen und Anschrift seiner nächsten Angehörigen sowie sein genaues Sterbedatum mitzuteilen.

Mit dem Ausdruck der vorzüglichsten Hochachtung

Ihr sehr ergebener

Fac - von Neumann

15 March 1957

Dear Mr. Pastor:

On behalf of the Trustees and the Faculty of the Institute for Advanced Study, I wish to express to the Real Sociedad Matematica Española and all Spanish mathematicians our appreciation of your word of condolence on the death of Professor John von Neumann, and our gratitude.

Sincerely yours,

Robert Oppenheimer

Mr. Julius Rey Pastor
Real Sociedad Matematica Española
Serrano, 123
Madrid, Spain

von Neumann

Madrid, 20th february 1957

REAL SOCIEDAD MATEMATICA ESPAÑOLA
SERRANO, 123
MADRID

The Director of
The Institute for Advanced Study
PRINCETON, N.J.

Dear Sir:

The Managing Committee of the Real Sociedad Matemática Española decided, at their last meeting, to express to you their deepest sympathy on behalf of all spanish mathematicians on the loss of the late Prof. von Neumann.

Sincerely,

Julio Rey Pastor

[illegible] Butler Avenue
Princeton, New Jersey

March 1, 1957

Dear Dr. Oppenheimer,

I am sorry to have delayed so long in answering your note of February 18. I have written your request to Klein, and I expect that she will be in Princeton briefly sometime during the next few weeks. When she is here I will show her your letter, and I am sure she will be interested in the question.

Please give my best regards to your wife, whom I remember with such pleasure.

Very sincerely,
Marina Whitman

von Neumann

CLASS OF SERVICE
This is a fast message unless its deferred character is indicated by the proper symbol.

WESTERN UNION
TELEGRAM

W. P. MARSHALL, PRESIDENT

1201

SYMBOLS
DL = Day Letter
NL = Night Letter
LT = International Letter Telegram

The filing time shown in the date line on domestic telegrams is STANDARD TIME at point of origin. Time of receipt is STANDARD TIME at point of destination

PA 181 (55)

P CDU108 45 PD INTL=CD WARSZAWA VIA RCA 22 1546=
=LT INSTITUTE FOR ADVANCED STUDY=
PRINCETON (NJER)= 1957 FEB 22 PM 11 48

=INSTITUTE OF MATHMATICS OF THE POLISH ACADEMY OF SCIENCES DEEPLY DISTRESSED BY THE NEWS OF PROFESSOR VON NEUMANNS PASSING WISHES TO EXPRESS MOST SINCERE AND PROFOUND REGRET AT THE LOSS TO HUMANITY OF A GREAT MATHEMATICIAN STOP DIRECTOR KURATOWSKI=

TELEPHONE NO.
TELEPHONED VH.
TIME 920A
BY RP TO BE Rec'd

THE COMPANY WILL APPRECIATE SUGGESTIONS FROM ITS PATRONS CONCERNING ITS SERVICE

Von Neumann

DOMESTIC SERVICE
Check the class of service desired; otherwise this message will be sent as a full rate telegram

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DAY LETTER	
NIGHT LETTER	

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WESTERN UNION

1206 10-51

W. P. MARSHALL, PRESIDENT

INTERNATIONAL SERVICE
Check the class of service desired; otherwise the message will be sent at the full rate

FULL RATE	
LETTER TELEGRAM	
SHIP RADIOGRAM	

NO. WDS.-CL. OF SVC.	PD. OR COLL.	CASH NO.	CHARGE TO THE ACCOUNT OF	TIME FILED

Send the following message, subject to the terms on back hereof, which are hereby agreed to

WARSAW (rec'd 25 February 1957 9:20 AM)

Institute of Mathematics of the Polish Academy of Sciences deeply distressed by the news of Professor von Neumann's passing. Wishes to express most sincere and profound regret at the loss to humanity of a great mathematician. Stop.

Director Kuratowski

Von Neumann

W E S T E R N U N I O N
TELEGRAM

PA040 1957 Feb 21

P CDV150 32 PD INTL=CD ROMA VIA WUCABLES 21 1255
=LT PROFESSOR GOLDSTINE
INSTITUTE ADVANCED STUDY=PRINCETON (NJER)=

LEARNED WITH DEEP SORROW DEATH JOHN VON NEUMANN STOP

ACCADEMIA LINCEI INSTITUTO MATEMATICO ROME ISTITUTO

CALCOLO EXPRESS HEARTFELT CONDOLENCES FOR WORLD SCIENCE

GREAT LOSS

=PICONE=

To his many friends, his students, his colleagues, Dr. von Neumann was the highest and liveliest intelligence they were ever to encounter. A mathematician of immense scope and power, he contributed to many fields of learning, and created others. He was a masterful abstract analyst, with an unparallelled sense for practical invention, so that he enriched learning and practice equally. His sober and often melancholy realism was tempered by great warmth and generosity. We know no one like him.

RO statement given to Packet 2/13/57

February 13, 1957

The following is a close idea of the statement Professor Morse gave the PRINCETON PACKET concerning Professor von Neumann. The statement was made over the telephone and not recorded by Professor Morse word-for-word.

"Professor von Neumann was very kindly, and sympathetic with his colleagues. I have known him since 1930 and regarded him as one of the greatest mathematicians in the world. We relied very heavily on his judgment in assessing the value of students. He inspired many young men in mathematics. One sensed his spiritual depth without being consciously aware of it."

For v Neumann

BIOGRAPHY OF JOHN VON NEUMANN

Born: Budapest, Hungary, December 28, 1903.

Education: Univ. of Berlin, Berlin, Germany 1921-23 -- no degree.
Federal Inst. of Technology, Zurich, Switzerland -- Engr. of Chemistry 1925.
Univ. of Budapest, Budapest, Hungary -- Ph.D. 1926.

Honorary Degrees: D.Sc.(hon) Princeton Univ. 1947; Univ. of Pennsylvania and Harvard Univ. 1950; Univ. of Istanbul, Case Inst. of Technology and Univ. of Maryland 1952; Inst. of Polytechnics, München 1953; Columbia Univ. 1954.

Positions:
1926-29 - Asst. Professor ("Privat dozent"), Univ. of Berlin, Berlin, Germany.
1929-30 - Asst. Professor ("Privat dozent"), Univ. of Hamburg, Hamburg, Germany.
1930 - Visiting Lecturer, Princeton Univ., Princeton, N.J.
1930-33 - Visiting Professor, Princeton Univ., Princeton, N.J.
1933-date - Research Professor of Mathematics, Institute for Advanced Study, Princeton, N.J.
1945-date - Director of Electronic Computer Project, Institute for Advanced Study, Princeton, N.J.

Also member and consultant:

1940-date - Scientific Advisory Committee, Ballistic Research Labs., Aberdeen Proving Ground, Md.
1941-46 - Navy Bureau of Ordnance, Wash., D.C.
1943-date - Los Alamos Scientific Lab. (AEC), Los Alamos, N.M.
1947-date - Naval Ordnance Lab., Silver Spring, Md.
1949-53 - Research and Development Bd., Wash., D.C.
1949-date - Oak Ridge National Lab., Oak Ridge, Tenn.
1950-date - Armed Forces Special Weapons Project, Wash., D.C.
" " - Weapons Systems Evaluation Group, Wash., D.C.
1951-date - Scientific Advisory Bd., U.S. Air Force, Wash., D.C.
1952-54 - Member, General Advisory Committee, U.S. Atomic Energy Commission (Presidential appointment)
1953-date - Technical Advisory Panel on Atomic Energy, Wash., D.C.

Honorary Positions: Gibbs Lecturer, American Math. Society -- 1937.
American Math. Society Colloquium Lecturer -- 1937.
President, American Math. Society -- 1951-53.
Vanuxem Lecturer, Princeton University -- 1953.
Member, Board of Advisors, Universidad de Los Andes, Colombia, S.A. -- 1950-date.

Society Memberships: American Mathematical Society
American Physical Society
Econometric Society
International Statistical Institute, The Hague, Netherlands
Sigma Xi

Academy Memberships: Academia Nacional de Ciencias Exactas, Lima, Peru
American Academy of Arts and Sciences
American Philosophical Society
Istituto Lombardo di Scienze e Lettere, Milano, Italy
National Academy of Sciences
Royal Netherlands Academy of Sciences and Letters, Amsterdam, Netherlands.

Co-editor: Annals of Mathematics (Princeton)
Composito Mathematica (Amsterdam, Netherlands)

Achievements of General Interest: Rockefeller Fellowship -- 1926
Bocher Prize, American Math. Society -- 1937
Medal for Merit (Presidential award), Distinguished Civilian Service Award -- U.S. Navy, 1947.

Author: 2 books -- "Mathematical Foundations of Quantum Mechanics" (German), Berlin 1932, New York 1942, various translations.
"Theory of Games and Economic Behavior" with O. Morgenstern, Princeton 1944, several editions since.

About 100 papers on subjects in mathematics (theory of Functional operators, quantum theory, mathematical economics, mathematical physics, numerical analysis and its automatization and theory of automata).

November 1954

Quotation from

THE WASHINGTON POST--Tuesday, February 12, 1957--Page A12

John von Neumann

The untimely death of John von Neumann is a loss not only to the laboratory and seminar, but to the world of affairs where he played so large and honorable a role. Dr. von Neumann had been a valued adviser to the Government long before his appointment to the Atomic Energy Commission in 1954. Not the least of his services was his warm defense of J. Robert Oppenheimer in that most painful of loyalty controversies.

Through much of his career, Dr. von Neumann was as celebrated among scientists as he was unknown to the public. Yet he was one of the rarest of scientists; his mind dwelt in the abstract universe of mathematics but his feet were firmly on earth. We owe to his genius the development of electronic calculators, a "theory of games" which has proven a useful economic tool, and even an improved method of weather forecasting.

Dr. von Neumann's life is, as President Eisenhower rightly stressed, an example of how American society has been enriched by refugees from other lands. A native of Hungary, he came to this country from Germany in the 1930s; Dr. von Neumann was a key figure in the virtual league of nations that enabled America to construct an atomic bomb. Those who would close our doors of asylum might ponder how empty America's pantheon of science would be if this were literally a land without aliens.

von Neumann

Flat arrangement of daffodils to lay on grave ordered 2/11/57 to be delivered tomorrow a.m. to Mather Funeral Home, with message:

From the colleagues of John von Neumann at the Institute.

(abt. $15.)

Burial service at 11 a.m. 2/12/57 in protestant cemetery. Entrance on Witherspoon Street.

YALE UNIVERSITY SCHOOL OF MEDICINE
333 CEDAR STREET · NEW HAVEN 11 · CONNECTICUT

Department of the History of Medicine
Historical Library

26 March 1956

PERSONAL

My dear Oppie:

From the Silliman Committee I have just learned that John von Neumann is seriously ill and will not be able to give his Silliman Lectures. He is, however, submitting his manuscript. Can you tell me anything about his illness as I feel that the Silliman Committee should know. Von Neumann, after all, is a very young man.

Yours sincerely,

John

Dr. Robert Oppenheimer
Institute for Advanced Study
Princeton, New Jersey

Looking forward to seeing you Thursday

answered in conversation with Dr. Fulton, 3/29

Fac von Neumann

RELEASE DATE: NOW

AMERICAN METEOROLOGICAL SOCIETY

3 JOY STREET, BOSTON 8, MASSACHUSETTS

CAPITOL 7-1881 KENNETH C. SPENGLER, EXECUTIVE SECRETARY

Founded in 1919 for the development and dissemination of knowledge of meteorology in all its phases and applications, and the advancement of its professional ideals.

Dr. John von Neumann Cited for Extraordinary Scientific Accomplishment

Dr. John von Neumann received this month the American Meteorological Society's Award for Extraordinary Scientific Accomplishment.

The award states that Dr. von Neumann was honored "for his farsighted contribution to the science of meteorology and the national interests in developing the modern, high-speed electronic computer with meteorological application as an ultimate aim, and for his support and encouragement in organizing the world's first research group in numerical weather prediction." The numerical weather prediction research group mentioned in the AMS award was established at the Institute of Advanced Study as the Electronic Computer Project.

Born in Budapest in 1903, Dr. von Neumann attended Berlin University, Zurich Institute, and Budapest University where he was awarded the Ph.D. He received D.Sc. degrees at Princeton University, University of Pennsylvania, Harvard University, Case Institute of Technology, University of Istanbul, University of Maryland, Munich Inst. Polytechnics, and Columbia University.

Dr. von Neumann began his career at Berlin University where he was privatdozent in mathematics in 1927. In 1930 he became visiting professor of mathematical physics at Princeton University and later professor until his appointment in the Institute of Advanced Study in 1933.

(More)

Since World War II Dr. von Neumann has served as a member and consultant on various Army, Navy, O.S.R.D. and A.E.C. Committees. In 1946 he was awarded the Medal for Merit and Distinguished Civilian Service.

Dr. von Neumann is a Fellow of the American Physical Society and a member of the American Mathematical Society for which he served as president in 1950-51. He also holds membership in the American Mathematical Association, National Academy of Sciences, American Philosophical Society, American Academy of Arts and Sciences, Royal Dutch Academy of Sciences (The Hague), Istituto Lomardo (Milan, Italy), Academia Nacional de Ciencias Exactas (Lima, Peru), Sigma Xi, and in the Nassau and Cosmos Clubs.

Contributing numerous articles on mathematical subjects throughout his career, Dr von Neumann has served as Editor of the Annals of Mathematics (Princeton) and coeditor of Compositio Mathematica (Amsterdam, Holland).

Washington, D. C. is the home of Dr. von Neumann.

The AMS Award for Extraordinary Scientific Accomplishment has been presented three times before since it was originated in 1951. The first award in 1951 honored Prof. Hurd C. Willett at M.I.T. In 1953 Prof. Carl-Gustaf Rossby of the University of Stockholm received the award and Mr. Jerome Namias of the United States Weather Bureau in 1955.

24 December 1956

Von Neumann

10 Sept. 1956

Velma heard on radio last night that Prof. von Neumann had made a statement about warfare of the future being by climate control. Betty Gorman had also heard it; said she was surprised that he had been well enough to make a statement (she has heard nothing for 2 weeks from the v.N.s). Betty said Mrs. Montgomery had called her (to check on sex of Klari v.N.'s dog), and said she had been interviewed by Life magazine for an upcoming article on v.N. Betty said she understood that RO had also been interviewed!

Fac von Neumann

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON 25, D. C.

March 19, 1956

Dear Robert:

I want to thank you for your previous friendly letter in connection with my future plans.

After thinking matters over, I have decided to proceed in a direction which will lead me away from the Institute. In order to make matters precise and definite, I plan to resign from the Institute's faculty, probably as of December 31. I will write you on this subject in due time, but I thought that I ought to inform you of the nature of my plans without delay.

This does not mean that I am not considering the 22 years that I spent at the Institute the most fruitful ones of my life and scientific career. The association with you and my other colleagues at the Institute has been a great experience.

Please consider this matter strictly confidential until we communicate further.

Sincerely yours,

John von Neumann

John von Neumann

Dr. J. Robert Oppenheimer, Director
Institute for Advanced Study
Princeton, N. J.

Copies sent to Mr. Maass and Mr. Leidesdorf, 3/26/56

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON 25, D. C.

March 1, 1956

Dear Robert:

Many thanks for your good note of February 29. I certainly had a very nice visit with Harry Smyth, and I enjoyed the occasion to chat with him.

It is good to know that both you and Kitty keep us in mind.

I am equally appreciative of the details you gave me of the probable future of the computer.

Finally, I want to thank you for your warm remarks regarding the future. I hope that I will have an occasion to talk with you again regarding matters connected with that subject.

Sincerely yours,

John

John von Neumann

Dr. J. Robert Oppenheimer, Director
Institute for Advanced Study
Princeton, N. J.

Fac von Neumann

2/28/56

William Lawrence of the Times called. They have heard reliably that Prof. von Neumann is dying, and he wants to prepare xx obituary material. He would like a statement from you (not for attribution if you wish) about v.N. as man, physicist, mathematician, inventor of computer, theory of games, role in atomic program, etc.

This is, of course, all strictly confidential, and would be held as file material.

xxxxxx

Fac von Neumann

29 February 1956

Dear Johnny:

Thank you for your good note. I bought you one other book, but Kitty said you would have to get a lot more healthy before she would let me send it to you.

Harry Smyth was here this morning, to meet with us and the Government people about the future of the Computer. It will probably work out that we continue to operate it for one more year beyond this, on a reduced basis, without Jim Pomerene and his assistants, and, of course, without Charney. After that, I hope and think that the University will be prepared to take over.

Harry told me that you are now trying to settle the question of what you will do when the time comes for you to leave the Commission. I cannot settle this for you, I know. I do want to write that you will be warmly, generally, and very deeply welcomed if you come back here. We cannot know how much your health will let you do; what we do know is that whatever it is, it will be for our good, and that we would cherish it. Be sure that this is in the pot as you make your decision.

Very sincerely,

Robert Oppenheimer

Dr. John von Neumann
Hotel Woodner
3636 16th Street, NW
Washington, D. C.

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON

February 24, 1956

Dear Robert:

Thank you for your very kind attention in sending me the books, as you suggested you would.

I am out of the hospital, but a walking inhibition, which appears to be neurotic in nature, still restricts me to quarters. By the way, our quarters are now Hotel Woodner, 3636 16th Street, N.W., Washington, D. C.

Hoping that all of these varied miseries will disappear as they came, and with many thanks for what you did in order to alleviate them, and with best personal regards in which Klari joins me, I am

Yours, as ever,

Johnny

John von Neumann

Dr. J. Robert Oppenheimer, Director
Institute for Advanced Study
Princeton, New Jersey

JvN Vanuxem Lectures

April 14, 1955

Dear Professor Cooper:

I have just received your very kind inquiry of April 12.

The only existing write-up connected with my Vanuxem Lectures at Princeton University is the article of Dr. Kemeny, to which you refer. However, I have written two papers on related subjects, the titles of which are the following: "The General and Logical Theory of Automata" from "Cerebral Mechanisms in Behavior— The Hixon Symposium", Sept. 1948, Pasadena, edited by L.A. Jeffress, John Wiley and Sons, Inc., New York (1951), and "Probabilistic Logics and the Synthesis of Reliable Organisms from Unreliable Components". Lectures given at Caltech, Jan. (1952), notes by R.S. Pierce.

I can send you a copy of Probabilistic Logics, if you wish. It will also appear soon with part of a collection of articles in the Annals of Mathematics Studies, published by the Princeton University Press.

Sincerely yours,

John von Neumann

JvNeg

Professor W. W. Cooper
Graduate School of Industrial Administration
Carnegie Institute of Technology
Schenley Park
Pittsburgh 13, Pennsylvania

CARNEGIE INSTITUTE OF TECHNOLOGY
SCHENLEY PARK
PITTSBURGH 13, PENNSYLVANIA
GRADUATE SCHOOL OF INDUSTRIAL ADMINISTRATION

April 12, 1955

Professor John von Neumann
The Institute for Advanced Studies
Princeton, New Jersey

Dear Professor von Neumann:

I understand, from an article by J. F. Kemeny in a recent article in Scientific American, that you have been giving a series of lectures on computing machine theory and logic. I would very much appreciate receiving a copy of these lectures if it is no trouble to you and will, of course, be glad to reimburse you for any expense involved.

Sincerely yours,

Wm Cooper

W. W. Cooper
Professor of Economics and
Industrial Administration

WWC:rmp

von Neumann

M E M O R A N D U M

TO: The Director

FROM: Minot C. Morgan, Jr.

SUBJECT: Professor von Neumann DATE November 30, 1954

Dear Dr. Oppenheimer:

At Professor von Neumann's request I have gotten together, with the help of the New York office, certain figures regarding his mortgage, taxes, insurance, etc. He will conceivably at a later date raise the question of the possibility of our waiving capital payments and simply charging interest during the period of his leave of absence. This is, I believe, a matter that can be settled by you and Mr. Leidesdorf, if Professor von Neumann does raise the question, without bothering the full Board of Trustees.

In the course of our conversation he did raise one other question that he may also have mentioned to you, to wit: the effective date of his leave of absence. Because the matter of his confirmation by the Senate is still up in the air, he would like some flexibility with regard to this date. I assume that the granting of a leave of absence to a faculty member does require action by the Board. If their action could be, "January 1st or some later date at Professor von Neumann's discretion," I think he would be very pleased.

Respectfully submitted,

Mike

MCM:ck

16 June 1954

Dear Mr. Rogers:

Dr. Oppenheimer has asked me to send you the enclosed biography of Professor von Neumann. I am sorry that your first letter was not answered; Dr. Oppenheimer has been very busy, and away from the Institute a good deal in the past few weeks.

Sincerely yours,

(Mrs. Wilder Hobson)
Secretary to the Director

Mr. Stanley Rogers, Supervisor
Electronics and Engineering Labs.
2nd Floor, Building 51, Plant 1
Consolidated Vultee Aircraft Corp.
San Diego 12, California

enclosure

CONVAIR
Consolidated Vultee Aircraft Corporation-San Diego 12 California

June 10, 1954

Dr. R. Oppenheimer, Director
Institute for Advanced Study
Princeton University
Princeton, New Jersey

Dear Dr. Oppenheimer:

I wrote you on May 5, requesting your assistance in obtaining a biographical sketch and statement of accomplishment of Professor John von Neumann, whom I have nominated for the Edison Medal.

As I have not received your reply, it has occurred to me that your letter may have gone astray, and that perhaps I should have given you a more complete address. Will you therefore please address your reply as shown below?

Sincerely yours,

Stanley Rogers

Stanley Rogers, Supervisor
Electronics and Engineering Labs.
2nd Floor, Building 51, Plant 1

8 June 1954

Memorandum to Mr. Morgan:

In response to a request from Professor von Neumann, Dr. Oppenheimer has authorized the payment to Professor von Neumann of $1,500 from his travel fund. This represents the balance of $500 from last year, and this year's fund of $1,000.

53-54 54-55

Verna Hobson

Copy to Professor von Neumann

THE INSTITUTE FOR ADVANCED STUDY

PRINCETON, NEW JERSEY

SCHOOL OF MATHEMATICS

June 8, 1954

MEMORANDUM TO: Dr. J. R. Oppenheimer

FROM: J. von Neumann

I would like to apply for the balance of the amount that the Institute has reserved for travel to scientific meetings on my account. If I am not mistaken, this is $1000 a year, with a possible accumulation over three years. As you know, I made use of $500 of this last year. I plan to go to Europe this summer to attend the International Congress of Mathematicians in Amsterdam on September 1-9 where I am also to deliver one of the invited addresses, and the International Congress of Geophysics in Rome on September 15-29 where I am participating in a symposium on dynamic meteorology. I also plan to visit some scientific institutions in England. In all, I expect to be on this trip from August 20 to the end of September. Since the journey will extend over forty days and imply crossing and recrossing the Atlantic, I would like to apply for the balance of last year's fund and all of this year's, that is, $1500.

John von Neumann

OK
R.O.

CONVAIR
Consolidated Vultee Aircraft Corporation-San Diego 12 California

May 5, 1954

Dr. R. Oppenheimer, Director
Institute for Advanced Study
Princeton University
Princeton, New Jersey

Dear Dr. Oppenheimer:

As you may know, the American Institute of Electrical Engineers awards the Edison Medal each year for "meritorious achievement" in the field of electrical science, electrical engineering, or the electrical arts. I have placed the name of Professor John von Neumann in nomination for this medal. Since these nominations are, I believe, kept confidential, I am writing to ask your assistance in obtaining a biographical sketch and records of accomplishment of Professor von Neumann. This information has been requested by the Secretary of the Edison Medal Committee.

I should greatly appreciate your help in obtaining the requested information.

Sincerely yours,

Stanley Rogers

Stanley Rogers
Member, Committee on Computing Devices
American Institute of Electrical Engineers

INSTITUTE FOR ADVANCED STUDY

LOUIS BAMBERGER AND MRS. FELIX FULD FOUNDATION

PRINCETON, NEW JERSEY

Director: J. ROBERT OPPENHEIMER

OFFICE OF THE TREASURER
125 PARK AVENUE
NEW YORK 17, N. Y.

October 27, 1953

Professor John von Neumann
Institute for Advanced Study
Princeton, New Jersey

Dear Professor von Neumann:

In response to your inquiry, I am pleased to advise you that there is nothing in the deed to you from the Institute to indicate any option to repurchase your property by the Institute.

Under these circumstances, therefore, you are not restricted in any way by the Institute to sell your property.

With all good wishes, I am

Sincerely,

Treasurer

c.c. Dr. Oppenheimer
Mr. Maass

Professor von Neumann's mother died (this fact being kept from him). Funeral services in Washington tomorrow (Friday, 10 August). Burial to be in Princeton cemetary at 3:00 PM (dependent on time of arrival from Washington by auto). Prof. von Neumann's two brothers and their wives, and Marina (?), Mrs. Gorman, the Montgomery's, and a few others will be there (Princeton)

THE INSTITUTE FOR ADVANCED STUDY
PRINCETON, NEW JERSEY

SCHOOL OF MATHEMATICS

Sunday, May 25, 1953.

Dear Robert,
there are two matters I wanted to mention to you before leaving. They are the following ones.

As I mentioned to you, we plan to go to Mexico, about July 15 - August 15. I intend to be mainly in Mexico City. Apart from the obvious things one does in Mexico, I want to see, and spend a good deal of time with Dr. A. Rosenbluth, the head of the Physiological Section of the Instituto Nacional de Cardiologia in Mexico City. He is interested in questions of nerve- and muscle-physiology and organisation in which I am interested from the logical and automat-istic point of view, he

collaborated for years with N. Wiener on such problems and was one of the dozen or so participants of the J. Macy conferences on this subject. I may have other, mathematical, contacts there, but Rosenbluth is more essential. I assume that this is a proper charge against the Institute travel allowances, and I would therefore like to propose it for your approval. I would estimate the extra cost of this trip to be approximately $ 500,—. (I will go to Mexico City from Los Angeles and return from there to Santa Fé – Los Alamos; therefore I cannot combine it with my return from the West to Princeton.)

The other matter is this.
It has been our plan all along to move the computing machine from its present position (which is essentially the one where it was constructed), to a better, properly equipped, final one

SCHOOL OF MATHEMATICS

at the other end of the building. It is logical to combine this with some medium-size changes and improvements, which our present experiences have indicated as desirable. These operations are estimated to require together about 2½ - 3 months. If our present computing program goes reasonably well, we propose to do this between July 1 and October 1. It is therefore desirable to get alternative computing facilities for the meteorological group in the mean time.

It seems, that we could get some time, free, on the IBM 701 machine (the one at whose inauguration you spoke in New York). I am therefore

asking Jule Charney to discuss this matter with the technical people in IBM — both the coding of the problem that we have in mind, and the timing. He ought to take it up with them about the middle of the week of May 25-29.

Could you let me know whether you approve these two matters. (My mail will be forwarded to me from the Institute.) Charney will also inquire at your office about the second one, and he can also give you any detailed technical information on this project that you may wish. I had discussed it with C. L. Hurd in IBM.

With best regards, and best wishes for the summer,

as ever Johnny.

~~JRO~~ John von Neumann

1a.

CC: Miss Trinterud--
Point 1;
cc: Dr. Charney--Point 2.

25 May 1953

Dear Johnny:

Thank you for your good letter of May 25th.

To Point 1: Your request for a travel allowance for something like $500 for your forthcoming visit to consult with Rosenbluth in Mexico appears on the face of it proper and reasonable, and I shall approve it. Since this is the first occasion I have had to apply the new travel allowance for the faculty, I may write down what would seem to be obvious considerations.

I shall, in general, approve the use of these funds within the budgeted amount as long as the primary purpose of the travel is clearly scientific or scholarly; as long as the applicant in applying indicates that no other arrangements of any kind are being made for reimbursement for the same travel; and also as long as there is a reasonable correspondence between the amount paid and the cost of the travel involved.

To Point 2: It is good news to me that the computer is going to be moved, and I am very happy that it may be possible to get the meteorological problems on to the IBM machine. I shall tell Charney of my concurrence.

With every good wish to you and Klari for a pleasant summer,

Robert Oppenheimer

Professor John von Neumann
Institute for Advanced Study

copy to Miss Trinterud

April 6, 1953

Dear Professor von Neumann:

At a regular meeting of the Board of Trustees of the Institute for Advanced Study on April 3, 1953, it was voted:

(1) To make available to you, as to all members of the Faculty, $1,000 a year as a fund for your professional travel. This fund, if not required by you in any one year, may accumulate, but will not at any time exceed $3,000. It is to be available to you only for these purposes, and only as long as you are a member of the Faculty of the Institute;

(2) To alter the provisions for your retirement--as for all members of the Faculty--in that retirement, which has until now been mandatory as of the June 30th following your 65th Birthday, will now become optional with you from your 65th Birthday on, and will be mandatory only as of the June 30th following your 68th Birthday.

Yours sincerely,

Robert Oppenheimer

Professor John von Neumann
Institute for Advanced Study
Princeton, N. J.

November 17, 1952

Memorandum to: A. Pais
J. von Neumann
C. N. Yang

Princeton University has embarked on a study project for a strong focussing high energy accelerator. The Physics Department and Milton White, who is in charge of the study, have asked the Institute to participate in the planning and discussion of this undertaking; and I have suggested that the four of us might from time to time serve in that capacity. There will be a regular weekly meeting at 11:30 a.m. on Wednesdays for these planning discussions. The first will be held this Wednesday in Room 222, Palmer. My understanding is that the initial subject will be "speculation about the purposes and overall philosophy of an accelerator designed for the 10 BEV region." I hope that you will be able to attend this week, and as often in the future as your work permits.

Robert Oppenheimer

Copy to Dr. Milton White

THE NON-ISOMORPHISM OF CERTAIN CONTINUOUS RINGS

By John von Neumann

Reprinted from Annals of Mathematics
Vol. 67, No. 3, May, 1958
Printed in Japan

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THE NON-ISOMORPHISM OF CERTAIN CONTINUOUS RINGS

BY JOHN VON NEUMANN

(Received June 19, 1957)

[This manuscript was written in the period 1935-37 when von Neumann's interest in continuous geometry was most intense, and was found after his death. It seems likely that he intended to include it in the Colloquium volume which he never completed.

The necessary background for this paper is contained in the papers listed in the Bibliography. I will add only a few introductory remarks.

By a continuous geometry L we mean here an irreducible one, in the infinite case. There exists a unique regular ring $\mathfrak{R}$ coordinatizing L, and $\mathfrak{R}$ is called a continuous ring. It is a simple ring with unit, and its center is a field $\mathfrak{Z}$. Starting with an arbitrary field $\mathfrak{Z}$, von Neumann had given a purely algebraic construction of a continuous geometry $L_\infty(\mathfrak{Z})$ whose coordinatizing continuous ring $\mathfrak{Z}_\infty$ has center $\mathfrak{Z}$. Now in case $\mathfrak{Z}$ is the field of complex numbers, there is another way to get a continuous geometry with center $\mathfrak{Z}$, namely from a factor $\boldsymbol{M}$ of type II_1. The corresponding continuous ring U is obtained by adjoining to $\boldsymbol{M}$ suitable unbounded operators. In this paper von Neumann shows that the algebraic $\mathfrak{Z}_\infty$ is never isomorphic to a ring U derived from a factor of type II_1. Irving Kaplansky]

[Some editorial changes have been made in preparing the handwritten manuscript for publication.]

1. Let L, $\mathfrak{R}$ be as before. We wish to investigate the *continuous ring* $\mathfrak{R}$. We assume $\mathfrak{Z}$ = the center of $\mathfrak{R}$ = the field of complex numbers. We define a *continuous set of matrix units* s^l_{ij}, $l = 0, 1, 2, \cdots$, $i, j = 1, \cdots, n_l$, where $n_0 = 1$, $n_l = n_{l-1}q_l$ $(l > 0)$ with integer $q_l > 1$, by the following properties:

(I) $$s^l_{ij}\, s^l_{kh} = \begin{cases} s^l_{ih} & \text{for } j = k, \\ 0 & \text{for } j \neq k, \end{cases}$$

(II) $$\sum_{t=1}^{q_l} s^l_{(i-1)q_l+t,\,(j-1)q_l+t} = s^{l-1}_{ij}\,, \qquad i, j = 1, \cdots, n_{l-1},$$

(III) $$s^0_{11} = 1\,.$$

Observe that (II), (III) give immediately

(III′) $$\sum_{k=1}^{n_l} s^l_{kk} = 1\,, \qquad l = 0, 1, 2, \cdots\,.$$

From now on, throughout Sections 1 and 2, we will assume that a fixed continuous set of matrix units s_{ij}^l is given.

An element $\bar{x} \in \mathfrak{R}$ is called *continuous with respect to the* s_{ij}^l if, for each $l = 0, 1, 2, \cdots$, there exists a set of mutually distinct rational numbers ρ_i^l, $i = 1, \cdots, n_l$, such that

$$(1) \qquad s_{ii}^l(\bar{x} + \rho_i^l)s_{1i}^l = s_{ii}^l\bar{x} = \bar{x}s_{ii}^l \ .$$

Finally we denote by γ the set of all finite linear combinations (with coefficients $\in \mathfrak{Z}$) of the s_{ij}^l. Given an element $a \in \gamma$, there is a maximum l occurring in its s_{ij}^l's; by (II), all other l's can be replaced by this one. So we obtain the following normal form for any $a \in \gamma$:

$$a = \sum_{i,j=1}^{n_l} \alpha_{ij}s_{ij}^l \ , \qquad \alpha_{ij} \in \mathfrak{Z},$$

for some $l = 0, 1, 2, \cdots$.

2. Consider a fixed $\bar{x} \in \mathfrak{R}$ which is continuous with respect to the s_{ij}^l. We will derive several properties of such an $\bar{x}$, gradually increasing in strength until we reach our final result which is expressed in Theorem A.

LEMMA 1. *$\bar{x}^{-1}$ exists.*

PROOF. For any $l = 0, 1, 2, \cdots$, we have $\bar{x}s_{ii}^l \in (\bar{x})_r$, so $(\bar{x}s_{ii}^l)_r \leqq (\bar{x})$ and $\sum_{i=1}^{n_l}(\bar{x}s_{ii}^l)_r \leqq (\bar{x})_r$. Also $((\bar{x}s_{ii}^l)_r \ ; \ i = 1, \cdots, n_l)\perp$, because

$$\begin{aligned}\sum_{\substack{i=1\\(i\neq j)}}^{n_l} (\bar{x}s_{ii}^l)_r \cdot (\bar{x}s_{jj}^l)_r &= \sum_{\substack{i=1\\(i\neq j)}}^{n_l} (s_{ii}^l\bar{x})_r \cdot (s_{jj}^l\bar{x})_r \\ &\leqq \sum_{\substack{i=1\\(i\neq j)}}^{n_l} (s_{ii}^l)_r \cdot (s_{jj}^l)_r \\ &\leqq (1 - s_{jj}^l)_r \cdot (s_{jj}^l)_r = (0) \ ,\end{aligned}$$

since $s_{ii}^l \in (1 - s_{jj}^l)_r$ for $i \neq j$. Hence

$$R(\bar{x}) = D((\bar{x})_r) \geqq \sum_{i=1}^{n_l} D((\bar{x}s_{ii}^l)_r) = \sum_{i=1}^{n_l} R(\bar{x}s_{ii}^l) \ .$$

Next, by (1) and (I),

$$(2) \qquad \begin{aligned} s_{1i}^l \cdot \bar{x}s_{ii}^l \cdot s_{i1}^l &= s_{1i}^l \cdot s_{ii}^l(\bar{x} + \rho_i^l)s_{1i}^l \cdot s_{i1}^l = s_{11}^l(\bar{x} + \rho_i^l)s_{11}^l \\ &= \bar{x}_1 + \rho_i^l s_{11}^l \ ,\end{aligned}$$

where $\bar{x}_1 = s_{11}^l\bar{x} = \bar{x}s_{11}^l \in \mathfrak{R}(s_{11}^l)$. Hence $R(\bar{x}s_{ii}^l) \geqq R(\bar{x}_1 + \rho_i^l s_{11}^l)$, and so

$$(3) \qquad R(\bar{x}) \geqq \sum_{i=1}^{n_l} R(\bar{x}_1 + \rho_i^l s_{11}^l) \ .$$

We prove next $((\bar{x}_1 + \rho_i^l s_{11}^l)_r^\wedge \ ; \ i = 1, \cdots, n_l)\perp$, where $(\cdots)_r^\wedge$ denotes the ideal taken in $\mathfrak{R}(s_{11}^l)$. Assume $u \in \sum_{i=1(\neq j)}^{n_l}(\bar{x}_1 + \rho_i^l s_{11}^l)_r^\wedge \cdot (\bar{x}_1 + \rho_j^l s_{11}^l)_r^\wedge$ (of course $u \in \mathfrak{R}(s_{11}^l)$). Then

$$(4) \qquad u = \sum_{\substack{i=1\\(i\neq j)}}^{n_l} v_i, \quad \text{where} \quad (\bar{x}_1 + \rho_i^l s_{11}^l)v_i = 0 \ ,$$

and

$$(5) \qquad (\bar{x}_1 + \rho_j^l s_{11}^l)u = 0 \ .$$

Now (4) gives

$$\prod_{\substack{k=1\\(k\neq j)}}^{n_l} (\bar{x}_1 + \rho_k^l s_{11}^l)v_i = 0 \ , \qquad i = 1, \cdots, n_l, \ i \neq j \ ;$$

hence

$$\prod_{\substack{k=1\\(k\neq j)}}^{n_l} (\bar{x}_1 + \rho_k^l s_{11}^l)u = 0 \ .$$

By (5) and the fact that $u \in \mathfrak{R}(s_{11}^l)$, this equation becomes

$$\prod_{\substack{k=1\\(k\neq j)}}^{n_l} (\rho_k^l - \rho_j^l)u = 0 \ .$$

But the ρ_i^l, $i = 1, \cdots, n_l$, are mutually distinct, so the coefficient of u possesses a reciprocal ($\in \mathfrak{Z}$), and $u = 0$. Thus

$$\sum_{\substack{i=1\\(i\neq j)}}^{n_l} (\bar{x}_1 + \rho_i^l s_{11}^l)_r^\wedge \cdot (\bar{x}_1 + \rho_j^l s_{11}^l)_r^\wedge = (0) \ ,$$

or $((\bar{x}_1 + \rho_i^l s_{11}^l)_r^\wedge \ ; \ i = 1, \cdots, n_l)\perp$, as stated above.

Using $\hat{D}$, $\hat{D}'$, and $\hat{R}$ in $\mathfrak{R}(s_{11}^l)$ we now obtain

$$\begin{aligned} 1 \geqq \hat{D}\Big(\sum_{i=1}^{n_l} (\bar{x}_1 + \rho_i^l s_{11}^l)_r^\wedge\Big) &= \sum_{i=1}^{n_l} \hat{D}((\bar{x}_1 + \rho_i^l s_{11}^l)_r^\wedge) \\ &= \sum_{i=1}^{n_l} \{1 - \hat{D}'((\bar{x}_1 + \rho_i^l s_{11}^l)_r^\wedge)\} = \sum_{i=1}^{n_l} \{1 - \hat{R}(\bar{x}_1 + \rho_i^l s_{11}^l)\} \ ,\end{aligned}$$

so

$$(6) \qquad \sum_{i=1}^{n_l} \hat{R}(\bar{x}_1 + \rho_i^l s_{11}^l) \geqq n_l - 1 \ .$$

Now observe that $\hat{R}(y) = n_l R(y)$ for every $y \in \mathfrak{R}(s_{11}^l)$; then (6) becomes

$$(7) \qquad \sum_{i=1}^{n_l} R(\bar{x}_1 + \rho_i^l s_{11}^l) \geqq 1 - \frac{1}{n_l} \ .$$

Combining (3) and (7) we obtain

$$R(\bar{x}) \geqq 1 - \frac{1}{n_l} \ , \qquad l = 0, 1, 2, \cdots \ .$$

For $l \to \infty$ we have $n_l \to \infty$; hence $R(\bar{x}) \geqq 1$, and therefore $R(\bar{x}) = 1$. That is, $\bar{x}^{-1}$ exists.

LEMMA 2. *The element $\bar{x}_1 = s_{11}^l\bar{x} = \bar{x}s_{11}^l$ has a reciprocal in $\mathfrak{R}(s_{11}^l)$.*

PROOF. We have

$$\begin{aligned} 1 = R(\bar{x}) &\leqq R(\bar{x}_1) + R(\bar{x}(1 - s_{11}^l)) \\ &\leqq R(\bar{x}_1) + R(1 - s_{11}^l) = R(\bar{x}_1) + (1 - \frac{1}{n_l}) \ ,\end{aligned}$$

so $R(\bar{x}_1) \geqq 1/n_l$. Then $\hat{R}(\bar{x}_1) = n_l R(\bar{x}_1) \geqq 1$, so $\hat{R}(\bar{x}_1) = 1$. That is, $\bar{x}_1$ has a reciprocal in $\Re(s^l_{11})$.

LEMMA 3. *For each $\rho \in \mathfrak{Z}$, the element $\bar{x}_1 - \rho s^l_{11}$ has a reciprocal in $\Re(s^l_{11})$.*

PROOF. Obviously $\bar{x} - \rho$ is continuous with respect to the s^l_{ij}, along with $\bar{x}$ (with the same ρ^l_i). Hence Lemma 2 also applies to $\bar{x} - \rho$; but when we replace $\bar{x}$ by $\bar{x} - \rho$, then $\bar{x}_1 = \bar{x}s^l_{11}$ is replaced by

$$\bar{x}_1 - \rho s^l_{11} = (\bar{x} - \rho)s^l_{11} .$$

Then Lemma 2 states that $\bar{x}_1 - \rho s^l_{11}$ has a reciprocal in $\Re(s^l_{11})$.

LEMMA 4. *For each $p(x) \in P$, $p(\bar{x}_1)$ has a reciprocal in $\Re(s^l_{11})$.*

PROOF. Any $p(x) \in P$ has the form

$$p(x) \equiv x^h + \alpha_1 x^{h-1} + \cdots + \alpha_{h-1}x + \alpha_h , \quad \alpha_1, \cdots, \alpha_h \in \mathfrak{Z}.$$

Here $\mathfrak{Z}$ = the field of complex numbers. Therefore, by the fundamental theorem of algebra,

$$p(x) \equiv (x - \sigma_1) \cdots (x - \sigma_h) , \qquad \sigma_1, \cdots \sigma_h \in \mathfrak{Z}.$$

Hence

$$p(\bar{x}_1) = (\bar{x}_1 - \sigma_1 s^l_{11}) \cdots (\bar{x}_1 - \sigma_h s^l_{11}) .$$

By Lemma 3, $\bar{x}_1 - \sigma_k s^l_{11}$ has a reciprocal in $\Re(s^l_{11})$, $k = 1, \cdots, h$; hence $p(\bar{x}_1)$ also has a reciprocal in $\Re(s^l_{11})$.

LEMMA 5. *For any $\alpha_{ij} \in \mathfrak{Z}$, $(\bar{x} - \sum^{n_l}_{i,j=1} \alpha_{ij}s^l_{ij})^{-1}$ exists.*

PROOF. For any $b \in \Re$, define the matrix (b_{ij}), $b_{ij} \in \Re(s^l_{11})$, $i, j = 1, \cdots, n_l$, by

$$b_{ij} = s^l_{1i} b s^l_{j1} , \quad b = \sum^{n_l}_{i,j=1} s^l_{i1} b_{ij} s^l_{1j} .$$

Observe that b^{-1} exists if and only if the matrix (b_{ij}) has a reciprocal in $\Re(s^l_{11})$.

Now take

$$b = \bar{x} - \sum^{n_l}_{k,h=1} \alpha_{kh} s^l_{kh} .$$

Then

$$\begin{aligned} b_{ij} &= s^l_{1i}(\bar{x} - \textstyle\sum^{n_l}_{k,h=1} \alpha_{kh} s^l_{kh}) s^l_{j1} \\ &= s^l_{1i} \bar{x} s^l_{j1} - \alpha_{ij} s^l_{11} \\ &= \delta_{ij}(\bar{x}_1 + \rho^l_i s^l_{11}) - \alpha_{ij} s^l_{11} \end{aligned}$$

where

$$\delta_{ij} = \begin{cases} 1 & \text{for } i = j, \\ 0 & \text{for } i \neq j. \end{cases}$$

In fact, using (I) and (1), we have $s^l_{1i}\bar{x}s^l_{j1} = s^l_{1i}s^l_{ii}\bar{x}s^l_{j1} = s^l_{1i}\bar{x}s^l_{ii}s^l_{j1}$ and this expression is 0 if $i \neq j$, while if $i = j$ it is $s^l_{1i}\bar{x}s^l_{i1} = \bar{x}_1 + \rho^l_i s^l_{11}$ by (2).

The elements of our matrix (b_{ij}) commute with each other: $\rho^l_i s^l_{11}$, $\alpha_{ij}s^l_{11}$ belong to the center of $\Re(s^l_{11})$, and there occurs only one further element of $\Re(s^l_{11})$: $\bar{x}_1$. Therefore we can use the rules of the determinant-matrix calculus to decide whether this matrix possesses a reciprocal in $\Re(s^l_{11})$. In other words, the matrix (b_{ij}) has a reciprocal in $\Re(s^l_{11})$ if and only if Determinant (b_{ij}) has a reciprocal in $\Re(s^l_{11})$. Now for any variable x (for which s^l_{11} acts as a unit),

$$\text{Determinant } (\delta_{ij}(x + \rho^l_i s^l_{11}) - \alpha_{ij} s^l_{11}) \equiv p(x) \in P ;$$

hence Determinant $(b_{ij}) = p(\bar{x}_1)$ and has a reciprocal in $\Re(s^l_{11})$ by Lemma 4.

COROLLARY. *For any $\alpha_{ij} \in \mathfrak{Z}$,*

$$R(\bar{x} - \textstyle\sum^{n_l}_{i,j=1} \alpha_{ij} s^l_{ij}) = 1 .$$

We have thus proved:

THEOREM A. *If $\bar{x}$ is continuous with respect to the s^l_{ij}, then its (rank metric) distance from the set γ is 1.*

3. Consider now the example $L_\infty(\mathfrak{Z})$, where $\mathfrak{Z}$ = the division algebra of all complex numbers, described in [4], p. 21. The continuous ring $\mathfrak{Z}_\infty$ belonging to it is obtained as follows: Form the n_l-th order matrix algebra $\mathfrak{Z}_{n_l}$ over $\mathfrak{Z}$ for $l = 0, 1, 2, \cdots$. Imbed $\mathfrak{Z}_{n_{l-1}}$ into $\mathfrak{Z}_{n_l}$ ($l = 1, 2, \cdots$) by mapping the matrix $(x_{ij}) \in \mathfrak{Z}_{n_{l-1}}$, $i, j = 1, \cdots, n_{l-1}$, into the matrix $(\bar{x}_{uv}) \in \mathfrak{Z}_{n_l}$, $u, v = 1, \cdots, n_l$, defined by

$$\bar{x}_{(i-1)q_l+s,\,(j-1)q_l+t} = \begin{cases} x_{ij} & \text{for } s = t, \\ 0 & \text{for } s \neq t, \end{cases}$$

$$s, t = 1, \cdots, q_l.$$

Then $\mathfrak{Z}_\infty$ arises by completion (in the sense of G. Cantor) of $\sum^\infty_{l=0} \mathfrak{Z}_{n_l}$ in the rank metric.

For $l = 0, 1, 2, \cdots, k, h = 1, \cdots, n_l$, define

$$s^l_{kh} = (s^l_{kh|ij}) \in \mathfrak{Z}_{n_l} \subset \mathfrak{Z}_\infty, \qquad i, j = 1, \cdots, n_l,$$

by

$$s^l_{kh|ij} = \begin{cases} 1 & \text{for } k = i, h = j, \\ 0 & \text{otherwise.} \end{cases}$$

One verifies immediately that these s^l_{kh} form a continuous set of matrix units in $\mathfrak{Z}_\infty$. Also, for any $(\alpha_{ij}) \in \mathfrak{Z}_{n_l} \subset \mathfrak{Z}_\infty$,

$$(\alpha_{ij}) = \textstyle\sum^{n_l}_{i,j=1} \alpha_{ij} s^l_{ij} .$$

Hence, for this choice of the continuous set of matrix units s^l_{kh}, the set γ is $\sum^\infty_{l=0} \mathfrak{Z}_{n_l}$, and therefore everywhere dense in $\mathfrak{Z}_\infty$ (in the rank metric).

Therefore Theorem A excludes the existence of an $\bar{x} \in \Re = \mathfrak{Z}_\infty$ which

is continuous with respect to these s^i_{kh}, whatever the choice of the ρ^i_i.

We have thus proved :

THEOREM B. *For the continuous ring $\mathfrak{B}_\infty$ described above, a continuous set of matrix units s^i_{ij} can be chosen in such a way that there exists no $\bar{x} \in \mathfrak{B}_\infty$ which is continuous with respect to these s^i_{ij}, whatever the choice of the ρ^i_i.*

4. Before considering our second example, we prove two lemmas.

If u and v are integers, with $0 \leqq u \leqq v$, let

$$q_{vu} = \frac{n_v}{n_u} = q_v \cdots q_{u+1} .$$

Then $q_{vv} = 1$, $q_{v,v-1} = q_v$, $q_{v0} = n_v$, and if $v \leqq w$, then $q_{wu} = q_{wv}q_{vu}$. Further, if ρ is a rational number > 0, let $\{\rho\}$ denote the integer determined by the condition

$$\{\rho\} - 1 < \rho \leqq \{\rho\} .$$

LEMMA 6. *If s^i_{ij} is a continuous set of matrix units, then for $u \leqq v$,*

$$(I') \qquad s^u_{il}s^v_{kk} = s^v_{kk}s^u_{il} = \begin{cases} s^v_{kk} & \text{for } i = \{k/q_{vu}\}, \\ 0 & \text{otherwise,} \end{cases}$$

$$(II') \qquad \sum_{t=1}^{q_{vu}} s^v_{(i-1)q_{vu}+t,(j-1)q_{vu}+t} = s^u_{ij} , \qquad i, j = 1, \cdots, n_u.$$

PROOF. We begin with (II'). For $u = v$, the formula is trivial ; for $u = v - 1$, it coincides with (II). The general case then follows from the fact that if (II') holds for u, v $(u \leqq v)$ and for v, w $(v \leqq w)$, then it holds for u, w. In fact,

$$s^u_{ij} = \sum_{p=1}^{q_{vu}} \sum_{r=1}^{q_{wv}} s^w_{((i-1)q_{vu}+p-1)q_{wv}+r,((j-1)q_{vu}+p-1)q_{wv}+r}$$

$$= \sum_{t=1}^{q_{wu}} s^w_{(i-1)q_{wu}+t,(j-1)q_{wu}+t}$$

using $q_{wu} = q_{wv}\,q_{vu}$ and $t = (p-1)\,q_{wv} + r = 1, \cdots, q_{wu}$ as $p = 1, \cdots, q_{vu}$, $r = 1, \cdots, q_{wv}$. For $u = 0$, (II') coincides with (III') of Section 1.

To prove (I'), we use (II') to give

$$s^u_{il}s^v_{kk} = \sum_{t=1}^{q_{vu}} s^v_{(i-1)q_{vu}+t,(i-1)q_{vu}+t}s^v_{kk} .$$

By (I), a product on the right vanishes unless $(i-1)q_{vu} + t = k$, in which case $(i-1)q_{vu} < k \leqq iq_{vu}$ or $i = \{k/q_{vu}\}$. If we substitute for s^u_{il} in the product $s^v_{kk}s^u_{il}$ we again obtain s^v_{kk} if $i = \{k/q_{vu}\}$ and 0 otherwise.

COROLLARY. *The elements s^v_{kk}, for varying choices of v and k, commute with each other.*

LEMMA 7. *Let $r(u, v)$ denote the remainder in the divisiou of u by v, $u = 0, 1, 2, \cdots$, $v = 1, 2, \cdots$. Then $r(u, v) = 0, 1, \cdots, v - 1$ as u varies.*

For any $p = 1, 2, \cdots, i = 1, \cdots, n_p$, we have

$$(8) \qquad i - 1 = \sum_{l=1}^{p} r(\{i/q_{pl}\} - 1, q_l)q_{pl} .$$

PROOF. For $l = 1, \cdots, p$, we have

$$(9) \qquad r(\{i/q_{pl}\} - 1, q_l) = \{i/q_{pl}\} - 1 - (\{i/(q_{pl}q_l)\} - 1)q_l$$

since the expression

$$r(\{i/q_{pl}\} - 1, q_l) - (\{i/q_{pl}\} - 1) + (\{i/(q_{pl}q_l)\} - 1)q_l$$

is clearly divisible by q_l, and is also

$$< (q_l - 1) - (i/q_{pl} - 1) + (i/(q_{pl}q_l))q_l = q_l$$

and

$$> -(i/q_{pl}) + (i/(q_{pl}q_l) - 1)q_l = -q_l$$

and therefore vanishes. Observe that $q_{pl}q_l = q_{p,l-1}$, $q_{pp} = 1$. Thus, if we multiply (9) by q_{pl} and sum over l, we obtain

$$\begin{aligned} \sum_{l=1}^{p} r(\{i/q_{pl}\} - 1, q_l)q_{pl} &= \sum_{l=1}^{p} (\{i/q_{pl}\} - 1)q_{pl} \\ &\quad - \sum_{l=1}^{p} (\{i/(q_{pl}q_l)\} - 1)q_{pl}q_l \\ &= (\{i/q_{pp}\} - 1)q_{pp} - (\{i/(q_{p1}q_1)\} - 1)q_{p1}q_1 \\ &= \{i\} - 1 - (1 - 1)n_p \end{aligned}$$

since $q_{p1}q_1 = q_{p0} = n_p \geqq i$, so that $\{i/(q_{p1}q_1)\} = 1$.

COROLLARY. *If $i \neq j$, then*

$$r(\{i/q_{pl}\} - 1, q_l) \neq r(\{j/q_{pl}\} - 1, q_l)$$

for at least one l, $l = 1, \cdots, p$.

PROOF. If we assume that these expressions are equal for all $l = 1, \cdots, p$, then (8) implies $i = j$.

5. Let $\mathfrak{H}$ be a (complex) Hilbert space, $\boldsymbol{M}$ a ring of (bounded) operators in $\mathfrak{H}$ which is a *factor* in $\mathfrak{H}$, and of *Class* II_1 (cf. [8], pp. 138 and 172). Let $U(\boldsymbol{M})$ be the set of all linear closed operators (in $\mathfrak{H}$) with an everywhere dense domain which are $\eta\boldsymbol{M}$ (that is, which are invariant by all unitary transformations $U' \in \boldsymbol{M}'$, i.e. by those which leave every element of $\boldsymbol{M}$ invariant ; cf. [8], pp. 229 and 141).

Now $U(\boldsymbol{M})$ is a ring if we define the sum and product of X, $Y \in U(\boldsymbol{M})$ to be the operators $[X + Y]$, $[XY]$ respectively, where $[\ ]$ denotes the closure (cf. [8], p. 229). One verifies easily that the center of $U(\boldsymbol{M})$ consists of all αI, $\alpha \in \mathfrak{Z}$ = division algebra of all complex numbers, I = identity operator. Hence we can identify the center of $U(\boldsymbol{M})$ with $\mathfrak{Z}$. It has been shown elsewhere ([6], 1936-1937, pp. 26-27) that $U(\boldsymbol{M})$ is a regular ring and that it generates a continuous geometry.

Thus $U(\boldsymbol{M})$ is a continuous ring with center $\mathfrak{Z}$, and insofar resembles $\mathfrak{Z}_\infty$ from Section 3. We wish to establish, however, that $U(\boldsymbol{M})$ and $\mathfrak{Z}_\infty$

are never (ring) isomorphic.

6. Consider a continuous set of matrix units S^l_{ij}, $l = 0, 1, 2, \cdots$, $i, j = 1, \cdots, n_l$, in $U(\boldsymbol{M})$; that is,

$$(\mathrm{I}_0) \qquad [S^l_{ij}S^l_{kh}] = \begin{cases} S^l_{ih} & \text{for } j = k, \\ 0 & \text{for } j \neq k, \end{cases}$$

$$(\mathrm{II}_0) \qquad [\textstyle\sum_{t=1}^{q_l} S^l_{(i-1)q_l+t,(j-1)q_l+t}] = S^{l-1}_{ij}, \qquad i, j = 1, \cdots, n_{l-1},$$

$$(\mathrm{III}_0) \qquad S^0_{11} = I.$$

By Lemma 6, we have also, for $u \leqq v$,

$$(\mathrm{I}'_0) \qquad [S^u_{il}S^v_{kk}] = [S^v_{kk}S^u_{il}] = \begin{cases} S^v_{kk} & \text{for } i = \{k/q_{vu}\}, \\ 0 & \text{otherwise,} \end{cases}$$

$$(\mathrm{II}'_0) \qquad [\textstyle\sum_{t=1}^{q_{vu}} S^v_{(i-1)q_{vu}+t,(j-1)q_{vu}+t}] = S^u_{ij}, \qquad i, j = 1, \cdots, n_u.$$

In discussing the properties of this system S^l_{ij}, we will make use of the results of [8], pp. 227-229, without further explicit reference.

The S^l_{ij}, S^{l*}_{ij}, $l = 0, 1, 2, \cdots$, $i, j = 1, \cdots, n_l$, form an enumerable subset $\mathfrak{U}$ of $U(\boldsymbol{M})$. Hence the set $\mathfrak{D} \subset \mathfrak{H}$, consisting of all those f for which each expression $X_1 \cdots X_h f$, $X_1, \cdots, X_h \in \mathfrak{U}$, $h = 1, 2, \cdots$, is defined, is everywhere dense in $\mathfrak{H}$. Let ϕ_k, $k = 1, 2, \cdots$, be a sequence which is contained and dense in $\mathfrak{D}$. Then it is also everywhere dense in $\mathfrak{H}$. Each $X_1 \cdots X_h\phi_k$, $X_1, \cdots, X_h \in \mathfrak{U}$, $h = 1, 2, \cdots$, $k = 1, 2, \cdots$, also belongs to $\mathfrak{D}$. This set is also enumerable; we denote its elements by ψ_m, $m = 1, 2, \cdots$. Further, this set contains ϕ_k, $k = 1, 2, \cdots$, and is contained in $\mathfrak{D}$. Hence

(α) The sequence ψ_m, $m = 1, 2, \cdots$, is everywhere dense (in $\mathfrak{H}$);

(β) Every $S^l_{ij}\psi_m$ and every $S^{l*}_{ij}\psi_m$ is defined, and again a $\psi_{m'}$.

Because of (β), the brackets denoting closure may be omitted in the case of any operator obtained from the S^l_{ij} by ring operations in $U(\boldsymbol{M})$ whenever the operator is applied to a ψ_m; for example,

$$[S^l_{ij}S^p_{kh}]\psi_m = S^l_{ij}S^p_{kh}\psi_m .$$

This will be done without further comment in the computations to be carried out in Section 7. Because of (α), $X, Y \in U(\boldsymbol{M})$ and $X\psi_m = Y\psi_m$ for $m = 1, 2, \cdots$, implies $X = Y$ in $U(\boldsymbol{M})$.[1]

Define M_l to be the smallest positive integer such that

[1] In general, if $X, Y \in U(M)$, and if $Xf = Yf$ on an everywhere dense set of f's then $X = Y$ (operatorially). Proof: By assumption, $(X-Y)f = 0$ for an everywhere dense set of f's; hence, a fortiori, $[X-Y]f = 0$ for an everywhere dense set of f's. Since $[X-Y]$ is closed (and one valued), this implies that $[X-Y]f$ is defined and $=0$ for all f. Hence $[X-Y] = 0$. Now $X = [Y+[X-Y]] = [Y+0] = [Y] = Y$, completing the proof.

$$(10) \qquad M_l \geqq \|S^l_{i1}\psi_m\|, \; M_l \geqq \|S^{l*}_{i1}\psi_m\|, \qquad i = 1, \cdots, n_l, \; m = 1, \cdots, l;$$

then clearly

$$(11) \qquad 1 \leqq M_0 \leqq M_1 \leqq M_2 \leqq \cdots .$$

Define next

$$(12) \qquad \varepsilon_l = \frac{1}{2^l n_l^2 M_l} > 0 .$$

Then

$$(13) \qquad \varepsilon_l > \textstyle\sum_{h=l+1}^{\infty} (q_h - 1)\varepsilon_h .$$

In fact, by (11) and (12),

$$\textstyle\sum_{h=l+1}^{\infty}(q_h - 1)\varepsilon_h = \sum_{h=l+1}^{\infty}(q_h - 1)\frac{1}{2^h n_h^2 M_h} < \sum_{h=l+1}^{\infty} q_h \frac{1}{2^h n_l^2 q_h M_l}$$

$$= \textstyle\sum_{h=l+1}^{\infty} \frac{1}{2^h n_l^2 M_l} = \frac{1}{2^l n_l^2 M_l} = \varepsilon_l .$$

7. In this section we will construct an element $[A] \in U(\boldsymbol{M})$ which is continuous with respect to the S^l_{ij}.

LEMMA 8. *For $l = 1, 2, \cdots$, define*

$$R_l = [\varepsilon_l \textstyle\sum_{k=1}^{n_l} r(k-1, q_l) S^l_{kk}], \quad T_l = [\varepsilon_l \sum_{k=1}^{n_l} r(k-1, q_l) S^{l*}_{kk}],$$

where $r(u, v)$ is defined in Lemma 7. Define

$$A = \textstyle\sum_{l=1}^{\infty} R_l , \quad B = \sum_{l=1}^{\infty} T_l .$$

(These definitions are to be understood as follows: Af (or Bf) is defined if and only if all $S^l_{i1}f$ (or $S^{l*}_{i1}f$) are defined, and $\sum_{l=1}^{\infty}$ converges for this f.) Then all $A\psi_m$, $B\psi_m$, $m = 1, 2, \cdots$, are defined. Further $[A]$, $[B]$ are (one valued) operators $\in U(\boldsymbol{M})$, and $[A]^* = [B]$.

PROOF. All $S^l_{kk}\psi_m$, $S^{l*}_{kk}\psi_m$ are defined, by (β) of Section 6; hence all $R_l\psi_m$, $T_l\psi_m$ are defined. Then $A\psi_m$, $B\psi_m$, $m = 1, 2, \cdots$, are defined if $\sum_{l=1}^{\infty} R_l\psi_m$, $\sum_{l=1}^{\infty} T_l\psi_m$ converge. This convergence follows from the convergence of $\sum_{l=1}^{\infty}\|R_l\psi_m\|$, $\sum_{l=1}^{\infty}\|T_l\psi_m\|$, which in turn is a consequence of the estimates $\|R_l\psi_m\| \leqq 1/2^l$, $\|T_l\psi_m\| \leqq 1/2^l$, for $l \geqq m$. Indeed,

$$\|R_l\psi_m\| \leqq \varepsilon_l \textstyle\sum_{k=1}^{n_l} r(k-1, q_l)\|S^l_{kk}\psi_m\| \leqq \varepsilon_l \sum_{k=1}^{n_l} q_l M_l$$

$$\leqq \varepsilon_l n_l q_l M_l \leqq \varepsilon_l n_l^2 M_l = \frac{1}{2^l} ,$$

$$\|T_l\psi_m\| \leqq \varepsilon_l \textstyle\sum_{k=1}^{n_l} r(k-1, q_l)\|S^{l*}_{kk}\psi_m\| \leqq \varepsilon_l \sum_{k=1}^{n_l} q_l M_l$$

$$\leqq \varepsilon_l n_l q_l M_l \leqq \varepsilon_l n_l^2 M_l = \frac{1}{2^l} .$$

R_l, T_l are clearly partially adjoint, and so the same is true for A, B. Both have everywhere dense domains (since their domains contain the ψ_m, $m = 1, 2, \cdots$). Hence A^*, B^*, which contain B, A respectively, also have everywhere dense domains. Therefore the operators $[A]$, $[B]$ are one valued (cf. [7], p. 301). They are obviously linear, closed. Since every S^l_{kk}, S^{l*}_{kk} is invariant under all unitary $U' \in \boldsymbol{M}'$, the same is true for R_l, T_l, and for A, B, and finally for $[A]$, $[B]$. Finally, $[A]$, $[B]$ have everywhere dense domains, because this is true even for A, B. Thus $[A]$, $[B] \in U(\boldsymbol{M})$.

A is partially adjoint to B; hence the same is true for $[A]$ and $[B]$, that is, $[A]^* \supset [B]$. Since $[A]^*$, $[B]$ are both $\in U(\boldsymbol{M})$, this relation implies even $[A]^* = [B]$.

LEMMA 9. *For $p = 0, 1, 2, \cdots$, $i = 1, \cdots, n_p$, define the rational numbers ρ^p_i by*

$$\rho^p_i = \sum_{l=1}^{p} \varepsilon_l r(\{i/q_{pl}\} - 1, q_l) , \qquad \text{for } p > 0, \tag{14}$$

with $p^0_i = 0$. Then, for each $p = 1, 2, \cdots$, the ρ^p_i are distinct.

PROOF. If $i \neq j$, then by the Corollary to Lemma 7,

$$r(\{i/q_{pl}\} - 1, q_l) \neq r(\{j/q_{pl}\} - 1, q_l)$$

for at least one $l = 1, \cdots, p$. Let l_0 be the smallest l for which this occurs, and suppose

$$r(\{i/q_{pl_0}\} - 1, q_{l_0}) > r(\{j/q_{pl_0}\} - 1, q_{l_0}) . \tag{15}$$

Then

$$\begin{aligned} \rho^p_i - \rho^p_j &= \sum_{l=l_0}^{p} \varepsilon_l (r(\{i/q_{pl}\} - 1, q_l) - r(\{j/q_{pl}\} - 1, q_l)) \\ &\geqq \varepsilon_{l_0} - \sum_{l=l_0+1}^{p} (q_l - 1)\varepsilon_l \\ &\geqq \varepsilon_{l_0} - \sum_{l=l_0+1}^{\infty} (q_l - 1)\varepsilon_l > 0 \end{aligned}$$

by (13). If the inequality in (15) is reversed, then we obtain $\rho^p_j > \rho^p_i$, but in any case $\rho^p_i \neq \rho^p_j$, $i, j = 1, \cdots, n_p$.

LEMMA 10. *For any $m = 1, 2, \cdots$, and $p \leqq q$ and $i = 1, \cdots, n_p$, we have*

$$S^p_{i1}(\sum_{l=1}^{q} R_l + \rho^p_i)S^p_{1i}\psi_m = S^p_{i1}(\sum_{l=1}^{q} R_l)\psi_m = (\sum_{l=1}^{q} R_l)S^p_{i1}\psi_m . \tag{16}$$

PROOF. The second equality (commutativity) follows from the Corollary to Lemma 6 and the definition of the R_l in Lemma 8. To prove the first equality in (16), it is clearly sufficient to prove

$$S^p_{i1}R_lS^p_{1i}\psi_m = \begin{cases} 0 & \text{for } l \leqq p, \\ S^p_{i1}R_l\psi_m & \text{for } l > p, \end{cases} \tag{17}$$

and

$$S^p_{i1}\rho^p_lS^p_{1i}\psi_m = S^p_{ii}(\sum_{l=1}^{p} R_l)\psi_m , \qquad \text{for } p > 0, \tag{18}$$

To prove (17) for $l > p$, we expand the operators S^p_{i1}, S^p_{1i}, and S^p_{ii} in terms of S^l_{kh} using (II'_0), and then evaluate by means of (I_0). We have $q_{lq} = n_l/n_p \leqq n_l$ and

$$\begin{aligned} S^p_{i1}R_lS^p_{1i}\psi_m &= (\sum_{t=1}^{q_{lp}} S^l_{(i-1)q_{lp}+t,t})(\varepsilon_l \sum_{k=1}^{n_l} r(k-1, q_l)S^l_{kk}) \\ &\quad \cdot (\sum_{u=1}^{q_{lp}} S^l_{u,(i-1)q_{lp}+u})\psi_m \\ &= \varepsilon_l \sum_{t=1}^{q_{lp}} r(t-1, q_l)S^l_{(i-1)q_{lp}+t,(i-1)q_{lp}+t}\psi_m \end{aligned}$$

and

$$\begin{aligned} S^p_{ii}R_l\psi_m &= (\sum_{t=1}^{q_{lp}} S^l_{(i-1)q_{lp}+t,(i-1)q_{lp}+t})(\varepsilon_l \sum_{k=1}^{n_l} r(k-1, q_l)S^l_{kk})\psi_m \\ &= \varepsilon_l \sum_{t=1}^{q_{lp}} r((i-1)q_{lp}+t-1, q_l)S^l_{(i-1)q_{lp}+t,(i-1)q_{lp}+t}\psi_m . \end{aligned}$$

These expressions are equal since $r(t-1, q_l) = r((i-1)q_{lp}+t-1, q_l)$. Indeed, $(i-1)q_{lp}+t-1-(t-1) = (i-1)q_{lp}$ which is divisible by q_l.

To prove (17) for $l \leqq p$, we again use (II'_0) and expand the operators S^l_{kk} in the expression for R_l in terms of S^p_{kh}:

$$S^p_{i1}R_lS^p_{1i}\psi_m = S^p_{i1}(\varepsilon_l \sum_{k=1}^{n_l} r(k-1, q_l)\sum_{t=1}^{q_{pl}} S^p_{(k-1)q_{pl}+t,(k-1)q_{pl}+t})S^p_{1i}\psi_m .$$

By (I), these terms give 0 unless $(k-1)q_{pl}+t = 1$, which implies $t = 1$, $k = 1$. But for $k = 1$, the coefficient $r(k-1, q_l)$ vanishes.

The formula (18) is proved by using (I'_0) to evaluate the right hand side:

$$\begin{aligned} S^p_{i1}(\sum_{l=1}^{p} R_l)\psi_m &= \sum_{l=1}^{p}\sum_{k=1}^{n_l} \varepsilon_l r(k-1, q_l)S^p_{ii}S^l_{kk}\psi_m \\ &= \sum_{l=1}^{p} \varepsilon_l r(\{i/q_{pl}\} - 1, q_l)S^p_{ii}\psi_m \\ &= \rho^p_i S^p_{ii}\psi_m = S^p_{i1}\rho^p_iS^p_{1i}\psi_m \end{aligned}$$

by (I) since ρ^p_i commutes with S^p_{kh}.

LEMMA 11. *The equation*

$$[S^p_{i1}([A] + \rho^p_i)S^p_{1i}] = [S^p_{ii}[A]\,] = [\,[A]S^p_{ii}] \tag{19}$$

holds in $U(\boldsymbol{M})$, $p = 0, 1, 2, \cdots$, $i = 1, \cdots, n_p$.

PROOF. For any m and for fixed p and i, let $q \to \infty$ in (16). Now A is defined for all ψ_m's (Lemma 8), so the expressions $AS^p_{1i}\psi_m$, $A\psi_m$, and $AS^p_{ii}\psi_m$ are also defined, by (β) of Section 6. Thus the expressions

$$\sum_{l=1}^{q} R_lS^p_{1i}\psi_m , \quad \sum_{l=1}^{q} R_l\psi_m , \text{and} \sum_{l=1}^{p} R_lS^p_{ii}\psi_m$$

converge to these values. Further, the operators S^p_{i1} and S^p_{1i} are closed, so we get

$$S^p_{i1}(A + \rho^p_i)S^p_{1i}\psi_m = S^p_{ii}A\psi_m = AS^p_{ii}\psi_m$$

and a fortiori

$$[S_{ii}^{p}([A] + \rho_i^p)S_{ii}^{p}]\psi_m = [S_{ii}^{p}[A]\,]\psi_m = [\,[A]S_{ii}^{p}]\psi_m\ ,$$

$m = 1, 2, \cdots$. Since the ψ_m, $m = 1, 2, \cdots$, form an everywhere dense set in $\mathfrak{H}$, this implies (19).

Thus we have proved:

THEOREM C. *The operator* $[A]$ *defined in Lemma* 8 *is* $\in U(\boldsymbol{M})$ *and is continuous with respect to the given* S_{ij}^{ι}.

8. The above Theorem C gives immediately:

THEOREM D. *For the continuous ring* $U(\boldsymbol{M})$ *described in Section* 5 *and for every choice of a continuous set of matrix units* S_{ij}^{ι} *in* $U(\boldsymbol{M})$, *it is possible to find an* $X \in U(\boldsymbol{M})$ *which is continuous with respect to these* S_{ij}^{ι}.

Comparing Theorem B with Theorem D, we get:

THEOREM E. *The continuous rings* $\mathfrak{Z}_\infty$ (*described in Section* 3) *and* $U(\boldsymbol{M})$ (*described in Section* 5) *are not* (*ring*) *isomorphic.*

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