

Towards a biography of Georg Cantor

I. Grattan-Guinness M.A. M.Sc. Ph.D.

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TOWARDS A BIOGRAPHY OF GEORG CANTOR

By I. GRATTAN-GUINNESS, M.A., M.Sc., Ph.D.*

[PLATES XXV-XXVIII]

SUMMARY

The great influence of Georg Cantor's theory of sets and transfinite arithmetic has led to a considerable interest in his life. It is well known that he had a remarkable and unusual personality, and that he suffered from attacks of mental illness; but the 'popular' account of his life is richer in falsehood and distortion than in factual content. This paper attempts to correct these misrepresentations by drawing on a wide variety of manuscript sources concerning Cantor's life and career, including the texts of some important documents. An appendix describes the most important collection of *missing manuscripts*, whose location would help further the preparation of a biographical study of Cantor.

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LIST OF MANUSCRIPT SOURCES USED IN THIS STUDY

We list here, in alphabetical order of our reference titles, the location of documents on which we have drawn; and we also describe the method of classification and foliation that we use for each source in our footnotes. We have drawn only on parts of all these sources, and so the information below is not to be taken as a complete catalogue reference: any information or enquiry concerning them should be made to the appropriate address given below.

1. *Berlin/Darmstaedter.*

These documents were collected by L. Darmstaedter: they are known as the *Sammlung Darmstaedter*, and are now kept at the *Staatsbibliothek der Stiftung Preussischer Kulturbesitz—Handschriftenabteilung*, 1 Berlin 33 (Dahlem), Archivstrasse 12–14. In our references we have used the call-mark of each group of documents, and thus have, for example:

‘*Berlin/Darmstaedter, [call-mark] H 1683.*’

2. *Berlin/Schwarz.*

The papers of K. H. A. Schwarz. They are kept in the *Akademie-Archiv, Deutsche Akademie der Wissenschaften zu Berlin*, 108 Berlin 8, Otto-Nuschke-Strasse 22/23. As the collection is not yet catalogued and in fact its collection of letters is a little disorganised, we have not in general given any further classification of documents. An exception, however, is the four *Copiebücher* in which Schwarz made carbon copies of his letters. In these cases, we have, say:

‘*Berlin/Schwarz, [Copiebuch] 3, [page] 31.*’

The next three sources are all kept at the *Niedersächsische Staats- und Universitätsbibliothek Göttingen—Handschriftenabteilung*, 34 Göttingen, Prinzenstrasse 1, W. Germany.

3. *Göttingen/Dedekind.*

The papers of R. Dedekind given by his nephews to Göttingen University. They are divided into sections and subsections, with a short hand-written catalogue. We have cited only sections XIII and XIV, which are, respectively, the letters from and to Dedekind. Thus we have:

‘*Göttingen/Dedekind, [section] XIII.*’

The letters are in fact numbered within each section.

4. *Göttingen/Hilbert.*

The papers of D. Hilbert. A full catalogue of these manuscripts has recently been prepared, and we have followed its numeration of items. Thus we have:

‘*Göttingen/Hilbert, [item] 313.*’

The letters are not available for general examination until 1973, the thirtieth anniversary of Hilbert’s death.

5. Göttingen/Klein.

The papers of F. Klein, of which there exists a full catalogue dividing them into sections and subsections. We have cited here the letters from Cantor, which are kept among the thousands of letters stored in five box-files and designated as sections VIII to XII. Thus we have:

‘*Göttingen/Klein*, [section] VIII, [letter] 435.’

There are also a number of letters in other parts of this collection, which deal with specific matters and events, and we also call attention to the tens of thousands of sheets of lecture notes.

The next three sources are kept at the *Martin-Luther-Universität Halle-Wittenburg-Universitätsarchiv*, 401 Halle/Saale, Weidenplan 12, E. Germany D.D.R.

6. Halle/Cantor.

The University file on Cantor, entitled *Halle Universität. Philosophische Fakultät II. Acta betreffend G. Cantor*. Its documents date from 1891 to 1951, and is only partly foliated, and so we have:

‘*Halle/Cantor*, [folio] 7’; or

‘*Halle/Cantor*, 23 October 1905’.

7. Halle/Circulare.

The administrative documents of the philosophical Faculty of Halle University, entitled *Halle Universität. Philosophische Fakultät II. Reportorium 21. III. Circulare*. The series on which we have drawn starts in 1884 with volume 24, and is not foliated: thus we have:

‘*Halle/Circulare*, [volume] 26, 3 April 1903.’

8. Halle/Phil. Fac.

Before 1884 all the documents of the philosophical Faculty were kept in one series of volumes, each of which covered a semester and was bound in parts when the total collection of documents was very substantial. The series is entitled *Halle Universität. Philosophische Fakultät II. Reportorium 21*, and is only incompletely foliated. Thus we have:

‘*Halle/Phil. Fac.*, [volume] 135, [perhaps part] II, [folio] 17; or

‘*Halle/Phil. Fac.*, [volume] 135, [perhaps part] II, 11 December 1881’.

9. London/Young.

The papers of W. H. and G. C. Young, in the possession of their daughter, Dr. R. C. H. Tanner, 13 Boundary Road, Wallington, Surrey, England. As this collection is being catalogued, we have not used any further classification of the documents.

The next two sources are kept at the *Deutsches Zentralarchiv—Historische Abteilung II*, 42 Merseberg, Weisse Mauer 48, E. Germany D.D.R.

10. *Merseburg/Althoff.*

The papers of F. Althoff, listed as *Reportorium* 92. *Nachlass F. Althoff*. Under the magnificent catalogue that has recently been prepared this collection is divided into several main sections (*Abteilungen*) and then into numbers and sometimes volumes, with a full foliation. Thus we have:

‘*Merseburg/Althoff*, [section] B, [number] 59, [perhaps volume] 1, [folio] 241.’

11. *Merseburg/Halle Univ.*

The State documents for Halle University. We have drawn on two series:

(1) *Reportorium* 76. *Kultusministerium. Va. Sekt. 8. Tit. 4. Nr. 34. Die Anstellung und Besoldung der ausserordentlichen und ordentlichen Professoren der philosophischen Facultät der Universität Halle.*

This is a fully foliated series of 25 volumes ending in 1912, bound in roughly three-year sections. Thus we have:

‘*Merseburg/Halle Univ.*, [above series, including mention of number] 34, [volume] XI, [folio] 77.’

(2) The continuation of the above series from 1912 onwards, entitled *Reportorium 76. Kultusministerium. Va. Sekt. 8. Tit. 4. Nr. 48. Fortsetzung.* This series is also fully foliated, and so we have:

‘*Merseburg/Halle Univ.*, [number] 48, [volume] II, [folio] 49.’

12. *Nachlass Cantor.*

The surviving fragments of the personal papers of Georg Cantor collected together in the manner described in the first part of our appendix. The future of this collection is not yet decided, but it is quite likely that it will be placed in a public archive. For the purpose of our own research, we have prepared the following provisional classification:

- I. Papers concerning G. W. Cantor.
- II. Letters between Georg and Vally Cantor.
- III. Letters between Georg Cantor and other members of his family.
- IV. Other family letters, and photographs.
- V. Assorted letters and drafts between Cantor and correspondents outside the family.
- VI. Letter-book used by Cantor between 1884 and 1888.
- VII. Letter-book used by Cantor between 1890 and 1895.
- VIII. Letter-book used by Cantor between 1895 and 1896.
- IX. Documents and lecture notes from Cantor's student days.
- X. Papers concerning Cantor's Halle career, and honours.
- XI. Mathematical manuscripts.
- XII. Miscellaneous unordered mathematical notes.

- XIII. Religious and philosophical manuscripts.
- XIV. Offprints of Cantor's published papers.
- XV. Manuscripts and offprints of other papers.
- XVI. Papers concerning Else Cantor.
- XVII. Death notices, obituaries and reminiscences on Cantor.

We have not used further classifications of these categories except for the paginated letter-books VI–VIII, where we have:

‘*Nachlass Cantor*, [section] VII, [page] 159.’

13. *Paris/Cavaillès.*

The papers of J. Cavaillès, in the possession of his sister and brother-in-law, M. et Mme. Marcel Ferrières, 91 rue Boileau, Paris 16, France. We have not used any further classification of these documents.

The last two sources are kept at the Institut Mittag-Leffler, Auravägen 17, S-182 62 Djursholm, Stockholm, Sweden.*

14. *Stockholm/Jourdain.*

The papers of P. Jourdain. They are kept in a box, and consist mainly of two notebooks in which he both drafted some of his own letters and pasted in letters that he had received. We have used only these parts of the collection, and so we have:

‘*Stockholm/Jourdain*, [note-book] 1, [page] 129.’

15. *Stockholm/Mittag-Leffler.*

The papers and estate of G. Mittag-Leffler, comprising thousands of letters to him, both drafts and copies of his own letters, documents of some of his colleagues that he had collected (such as the papers of Jourdain), the files of *Acta Mathematica*, and a wonderful and growing library of books, journals and offprints: one of the great mathematical archives of the world. We have not used further classification of these sources except for the letters to and from Cantor, which are kept in eleven envelopes in a special box and for these we have:

‘*Stockholm/Mittag-Leffler*, [envelope] H.’

1. INTRODUCTION

THE influence of Georg Cantor's theories of sets and transfinite arithmetic on modern mathematics is as widespread as it is deep: the repercussions include not only the introduction of these two new and interrelated subjects, but also involve foundational questions in the most basic parts

* On the important but unknown collections of manuscripts held here, see I. Grattan-Guinness, ‘Materials for the history of mathematics in the Institut Mittag-Leffler’ (forthcoming in *Isis*).

of mathematics, and the development of axiomatic studies. The famous 'Continuum Hypothesis' of transfinite arithmetic was one of the great unsolved problems of its time, while through the use of completed infinities Cantor brought new ideas into a host of old problems that have influenced mathematics and philosophy alike. From the importance of Cantor's work has developed an interest in his life; but this interest has suffered from serious misunderstandings and distortions. It is true that he had a remarkable and forceful personality, that at times he behaved eccentrically, and that he suffered attacks of mental illness that forced him to spend periods of his later life in various sanatoria; but the nature, cause and even chronology of these events are often misrepresented. It is generally believed that he turned away from mathematics to religion and philosophy because of the opposition to his mathematical achievements by certain of his contemporaries, and that his (alleged) madness was caused by his failure to solve the Continuum Hypothesis. This view is not wholly false, but it is more misleading than accurate: it appears to have spread mostly by word of mouth among his contemporaries and successors, and also by rather inadequate historical studies of his life and work. In 1927 A. Schönfliess published a well-known account of Cantor's development during the mid-1880s, based on his correspondence with G. Mittag-Leffler and followed by a few remarks from Mittag-Leffler himself;¹ and in 1930 a more substantial biography was published by A. Fraenkel, who had himself not known Cantor personally.² These were the two principal writings of the time, and their inadequate use of existing materials failed to prevent the spread of the myths and half-truths, which themselves passed to a wider audience through the popular but unscholarly works of E. T. Bell.³ Recent work by H. Meschkowski has provided a limited amount of new information on Cantor's life and work, without resolving questions concerning his illness or personality;^{4, 5} thus the present paper is intended as a first step towards an evaluation of these important problems.

We describe below the general history of Cantor's family background and career, his philosophical and religious interests, his personal relations

¹ A. Schönfliess, 'Die Krisis in Cantor's mathematischem Schaffen,' *Acta Math.*, 1927, **50**, 1–23; and G. Mittag-Leffler, 'Zusätzliche Bemerkungen,' *ibid.*, 25–26.

² A. Fraenkel, 'Georg Cantor', *Jsbr. dtsc̄h. Math.-Ver.*, 1930, **39**, 189–266. (Reprinted Leipzig, 1930.)

³ See especially his *Men of Mathematics*, New York, 1937, ch. 29, perhaps the most widely read modern book on the history of mathematics. As it is also one of the worst, it can be said to have done considerable disservice to the profession.

⁴ H. Meschkowski, 'Aus den Briefbüchern Georg Cantors', *Arch. Hist. Exact Sci.*, 1962–66, **2**, 503–519.

⁵ H. Meschkowski, *Probleme des Unendlichen. Werk und Leben Georg Cantors*, Braunschweig, 1967.

with prominent colleagues, and the chronology and apparent nature of his mental illness. We have drawn on a variety of manuscript sources for our information—the surviving papers of both Cantor and of certain of his colleagues, as well as pertinent University and State documents—and publish here a selection of documents most closely relevant to our story. We cannot claim to have discovered all relevant material, however, because so many documentary sources are missing: for example, the great majority of Cantor's own personal papers have been lost for 25 years. Thus in addition to describing in detail the location of documents that we have used, we have given also a list of the principle *missing* sources of which we are aware, and we would greatly welcome any information on their whereabouts.

2. CANTOR'S FAMILY BACKGROUND AND EARLY CAREER

Georg Ferdinand Ludwig Philipp Cantor was born in St. Petersburg on 3 March 1845 (new style), the first child of Georg Woldemar and Maria Cantor. G. W. Cantor's background is obscure, but it was given a detailed investigation in 1937 by a Danish genealogist, from which most of the following details have been drawn. He was born sometime between 1809 and 1814, probably in Copenhagen, into a family which may have come to Denmark from Portugal or Spain: the fact that he was given Christian names implies that the Cantors were not Jewish, a classification which in those days was characterised by religious conviction rather than racial inheritance. His mother's family name was Meyer, and her relatives held important positions in Russia—in particular, one of her nephews was to become a professor of law at Kazan University (during the time of N. Lobachevsky) and to teach the novelist L. Tolstoy. Thus, in view of the strong anti-semitism practised in Russia at that time, it is most unlikely that the Meyers were Jewish either. He married Maria Anna Böhm on 21 April 1842 in the German Evangelical Lutheran church in St. Petersburg, and they had four children: Georg (born in 1845), Ludwig (1846), Sophie (1848) and Constantin (1849). His wife came from a Roman Catholic family of that city, but she aligned her religious position to that of her husband's evangelism; and having been a Roman Catholic she was by definition non-Jewish. Thus it follows that Georg Cantor was *not* Jewish, contrary to the view which has prevailed in print and in general opinion for many years.⁶ The surname

⁶ The investigation of G. W. Cantor's background was prepared by Th. Hauch-Tausböll of the Danish Genealogical Institute, Copenhagen: a German translation exists in *Nachlass Cantor*, I, along with a few documents concerning his life and work.

In our footnotes we use only short titles such as *Nachlass Cantor* or *London/Young* to denote the manuscript source cited: the full details of its location, together with its manner of classification and foliation (if any), have been given in the list of sources at the beginning of the paper.

'Cantor', from the Latin for a singer or poet, had been used since the fifteenth century by families of both Jewish and non-Jewish convictions: thus, for example, Georg's contemporary, the historian of mathematics Moritz Cantor, came from an unrelated Jewish line.⁷

G. W. Cantor was a very successful business man, firstly as a wholesaling agent in St. Petersburg, and later as a broker on the city's Stock Exchange. His health was not good, and the family moved from St. Petersburg to the warmer climate of Germany in 1856. Georg Cantor remembered his early years in Russia with great nostalgia⁸ and never felt at ease in Germany, although he lived there for the rest of his life and seemingly never wrote in the Russian language, which he must have known. He was greatly influenced by his father, a man of great cultural and philosophical interests, and when he was at school and university he received much well-meaning advice on his life and his career:⁹ but on 6 June 1863 his father died in Heidelberg, leaving half a million Marks. He ended his studies at Zürich to go to Berlin, where he made friends especially with K. H. A. Schwarz, who was to feature prominently in his later life. At Berlin they both attended the lectures of K. Weierstrass, E. Kummer and L. Kronecker, and under the influence of the latter two Cantor took both his *Dissertation* in 1867 and his *Habilitation* in 1869 on

⁷ Georg himself asserted that he and Moritz were unrelated: see, for example, *Nachlass Cantor*, VIII, 82. But in his *Storia e filosofia dell' analisi infinitesimale*, Turin, 1947, p. 186, L. Geymonat claimed (without reference) that both Georg and Moritz's families had common origins in a Portuguese family which emigrated to Denmark. Moritz was born of a branch which then moved to Holland and Germany, while Georg was a member of another branch which moved to Russia. We record but cannot verify this assertion by Geymonat, which in principle could be true: it may have its origins in a claim of the relatedness of the two Cantors in P. Tannery, 'Cantor (Moritz)', *La grande encyclopédie*, Paris, 1890(?), vol. ix, pp. 127–128.

The extent to which nonsensical stories have circulated about Cantor's birth and background can be judged from the one which alleges that he was born and found on a ship bound for St. Petersburg and that his parents were unknown. This tale appeared in print (probably not for the first time) in H. Brandt, 'Übersicht über die Mathematiker in Halle', *250 Jahre Universität Halle. Streifzüge durch ihre Geschichte in Forschung und Lehre*, Halle/Saale, 1944, pp. 274–277 (p. 276): it was definitely not Brandt's invention, for he heard it from a Halle colleague and they both hastened to publish a correction slip for the unsold copies of the book after having been alerted to its falsity by one of Cantor's sons-in-law. Much of the inspiration for these stories stemmed of course from the tireless Nazi scholarship exercised during their regime on the problem of Jewish descent.

⁸ See, for example, a draft letter of 1894 in *Nachlass Cantor*, VII, 131.

⁹ Typed copies of extracts from many of the letters exist in *Nachlass Cantor*, I. For quotations from them, see A. Fraenkel, *loc. cit.* (foot-note 2), pp. 191–192; and H. Meschkowski, *op. cit.* (foot-note 5), pp. 1–4.

problems in theory of numbers.¹⁰ By then he had moved to Halle University as a *Privatdozent*, replacing Schwarz (who went to Zurich) and working under E. Heine, the professor of mathematics there. Under Heine's influence both young men became especially interested in foundational problems in analysis as treated by Weierstrassian principles, and many letters passed between them on these questions in 1870.¹¹ In 1872 Cantor was promoted to *ausserordentlicher Professor* at Halle, and he also met in Switzerland another mathematician interested in the foundations of analysis—R. Dedekind, the professor of mathematics at the *Technische Hochschule* at Brunswick. In the spring of 1874 he became engaged to Vally Guttmann, a friend of his sister Sophie, who came from a Jewish Berlin family,¹² the marriage taking place on 9 August. The first of their six children, Else, was born in the following June, Gertrud in 1877, Erich in 1879, Anna-Marie in 1881, Margrete in 1885 and Rudolf in 1886. During this period Cantor achieved his main results in theory of sets and transfinite arithmetic, starting from inspiration in Heine's work on the uniqueness of the representation of a function by a trigonometric series to develop his own theorems on the problem and then the discipline of theory of sets as a study in its own right: he was also fulfilling his teaching requirements, and on Heine's recommendation was promoted in 1879 to be a second *ordentlicher Professor* in mathematics.¹³ But the promotion to a more important centre for which he was hoping did not materialize: the opposition to his work was forming, especially for its use of completed infinities. A paper of 1877 was accepted by Kronecker for publication in the *Journal für die reine und angewandte Mathematik* only with considerable reservation and after the intervention of Dedekind:¹⁴ the

¹⁰ G. Cantor, *De aequationibus secundi gradus indeterminatis* (Berlin, 1867); and *De transformatione formarum ternariarum quadraticarum* (Halle/Salle, 1869). Both works were re-issued in *Georg Cantor gesammelte Abhandlungen. Mathematischen und philosophischen Inhalts* (ed. E. Zermelo), Berlin, 1932, reprinted Hildesheim, 1962, pp. 1–31 and 51–62 respectively. We refer to this edition in later foot-notes as *Abhandlungen*; on pp. 452–481 it contains a condensed version of A. Fraenkel (foot-note 2).

¹¹ Some of the letters from Schwarz are in *Nachlass Cantor*, V; Schwarz's own copies and the letters from Cantor are in *Berlin/Schwarz*.

¹² Georg and Vally wrote to each other daily, in letters now in *Nachlass Cantor*, II: congratulatory letters to them are in IV and V. For a photograph of the pair taken in about 1880, see Plate XXV.

¹³ For documents on this appointment, see especially *Halle/Phil. Fac.*, vol. 127, ff. 31–41 *passim*: vol. 130, part I, ff. 29 and 35; and *Merseburg/Halle Univ.*, no. 34, vol. XII, ff. 171–176 and 213–218.

¹⁴ G. Cantor, 'Ein Beitrag zur Mannigfaltigkeitslehre', *Journ. rei. ang. Math.*, 1878, **84**, 242–258 (*Abhandlungen*, pp. 119–133). For commentary, see A. Fraenkel (foot-note 2), pp. 197–198.



PLATE XXV. Georg and Vally Cantor, in about 1880.
(In the possession of E. Schneider.)

correspondence with Schwarz stopped in 1880;¹⁵ there was apparently also opposition from Kummer (who was Schwarz's father-in-law). Only Weierstrass of the leading German mathematicians came to accept Cantor's work, and he was always greatly revered by Cantor.¹⁶ Then there came the first major personal upset of his life, involving his friend Dedekind with whom he was in frequent correspondence. Heine died in October 1881, and the University had to choose a successor.

3. THE EPISODE OF HEINE'S REPLACEMENT

The normal procedure at that time for the appointment of an *ordentlicher Professor* was as follows. The Faculty in which the chair was to be held would write to the head of the University and thence to the *Kultusministerium*, suggesting in order its preferred choice of candidates. The Minister could in principle change the list, and often did consult leading figures in the subject involved; but when the list was put in its final form, he would write to the first name on it and offer him the post. The recipient of the offer was at liberty to decline it; if he did, then the next name was invited, and so on. If all the proposees declined the post then a new list was prepared and the process repeated once more.

For the replacement of Heine, Cantor drew up the proposal of the philosophical Faculty in a letter which was approved by his colleagues and sent on to the Ministry in Berlin. His choice was: (1) Dedekind; (2) H. Weber; and (3) F. Mertens.¹⁷ With Cantor and Dedekind together at Halle it would rapidly have ceased to be an unimportant centre for mathematics. But this state of affairs was not to be, for early in 1882 Dedekind declined the offer. He gave his reasons as largely financial, but his letter is somewhat apologetic in tone and surely reflects his fear of the clash of personalities with his impulsive friend that would certainly have taken place.¹⁸ Cantor, lonely and frustrated in Halle, must have been very disappointed; and it may be that the almost total lack of correspondence between them from late in 1882 until 1899 was a consequence of that disappointment. The establishment or refutation of this

¹⁵ According to the collection of letters from Cantor to Schwarz in *Berlin/Schwarz*: Schwarz left a voluminous collection of papers and would quite likely have kept any further letter.

In H. Meschkowski (foot-note 5), p. 269, there is published a letter from Cantor to Schwarz written on 22 January 1913. This letter comes from a pencil draft in *Nachlass/Cantor*, V and is not in *Berlin/Schwarz*; and it may very well be that Cantor did not in the end send a copy to Schwarz.

¹⁶ On Cantor's relations with Weierstrass, see our Document IX below.

¹⁷ See our Document I below.

¹⁸ See our Document II below.

view is hampered by the fact that of the surviving letters (which were found among Dedekind's papers) only the mathematical parts were published,¹⁹ and the original documents are now missing; but from the correspondence which passed between the editors of the published sections (Miss E. Noether and J. Cavaillès) it is clear that the call to Halle had been much discussed.²⁰

Meanwhile, Dedekind was not the only one to reject the Halle post. Weber and Mertens also turned it down,²¹ and so a fresh list was prepared after consultation with the University and with Weierstrass, and A. Wangerin was appointed in March, 1882.²² Cantor never developed close relations with his new colleague, but he did make intimate contact at the time with the correspondent by whom he replaced Dedekind—Mittag-Leffler.

4. CANTOR'S FIRST ATTACK OF MENTAL ILLNESS

Like Cantor, Mittag-Leffler was influenced by Weierstrass's teaching in analysis, and his importance as a mathematician was enhanced when he married a millionairess and used their money to found in 1882 a new mathematical journal, *Acta Mathematica*. In the late 1880s he built himself a large magnificent house in the suburbs of Stockholm, which was turned into a mathematical institute in the late 1920s under the terms of his will and continues to be the editorial office of the journal. In the early years Mittag-Leffler wanted it to make a substantial impact on the mathematical world by the publication of significant work, and so he approached Cantor over the possibility of issuing French translations of the most important papers on analysis and theory of sets that Cantor had so far published (mainly in the friendly *Mathematische Annalen*). The two had first met sometime previously, but this project brought them into close contact and much correspondence passed between them over the next few years. The translations were supervised by the pupils of C. Hermite, including H. Poincaré; they were read and corrected by Cantor, and after a great deal of correspondence with Mittag-Leffler

¹⁹ The letters sent between 1872 and 1882 were published as E. Noether and J. Cavaillès (ed.), *Briefwechsel Cantor—Dedekind*, Paris, 1937: the letters of 1899 had already appeared in G. Cantor, *Abhandlungen*, pp. 442–451. For a French translation of all of them, see the collection: J. Cavaillès, *Philosophie mathématique*, Paris, 1962, pp. 177–251.

²⁰ Paris/Cavaillès, E. Noether to Cavaillès, 9 November 1932 and 12 March 1933. We discuss the Cantor—Dedekind letters in our appendix below.

²¹ Weber's letter does not appear to have survived, but Mertens's is in *Berlin/Darmstaedter*, H 1870, with a typed copy in *Merseburg/Halle Univ.*, no. 34, vol. XIII, f. 169.

²² For Weierstrass's correspondence, see *Merseburg/Halle Univ.*, no. 34, vol. XIII, ff. 170 and 182; and a typed copy of Wangerin's letter of acceptance in *ibid.*, ff. 183–184. The original of this latter document is in *Berlin/Darmstaedter*, H 1889.

during the first half of 1883 they appeared later in the year together with an original paper from Cantor, which was written in French and subtitled ‘first communication’ (*première communication*).²³ Cantor published another original paper in French in a volume for the following year,²⁴ and yet another in 1885, this time written in German with the subtitle ‘second communication’ (*Zweite Mitteilung*) and a foot-note indication that it was the successor to the ‘first communication’ of 1883.²⁵ But this was not true: it succeeded a paper which was *never published*.

This incident marked one of the turning-points of his life, and to describe it we return to the summer of 1884, when Cantor suffered his first attack of depression. Very little is known about it, but according to his eldest daughter Else (who was nine years old at the time) it was very sudden and greatly upset the whole family.²⁶ It appears to have lasted during May and June, for in his first letter to Mittag-Leffler for seven weeks, written on 21 June Cantor mentioned his illness and doubted the progress of his mathematical research.²⁷ In August he took a holiday in his favourite Harz mountains and for some reason decided to try to reconcile himself with Kronecker. Kronecker accepted the gesture, but it must have been difficult for both of them to forget their enmities and the philosophical disagreements between them remained unaffected. Cantor reported the whole episode to Mittag-Leffler,²⁸ and he also described another matter of anxiety, which came in the autumn and concerned his great unsolved problem in theory of sets and transfinite arithmetic, the Continuum Hypothesis. Firstly, he thought that he had found a proof that it was

²³ The translations appeared in *Acta Math.*, 1883, 2, 305–408; Cantor’s own paper was ‘Sur divers théorèmes de la théorie des ensembles de points situés dans un espace continu à n dimensions. Première communication. Extrait d’une lettre adressée à l’éditeur’, *ibid.*, 409–414 (*Abhandlungen*, 247–251).

²⁴ G. Cantor, ‘De la puissance des ensembles parfaits de points. Extrait d’une lettre adressée à l’éditeur’, *Acta Math.*, 1884, 4, 381–392 (*Abhandlungen*, 252–260).

²⁵ G. Cantor, ‘Über verschiedene Theoreme der Punctmengen in einem n-fach ausge-dehnten stetigen Raume G_n . Zweite Mitteilung’, *Acta Math.*, 1885, 7, 105–124 (*Abhandlungen*, 261–277).

²⁶ See M. Peters, *Lied eines Lebens* 1875–1954, Haale/Saale, 1961 [privately printed], p. 27; and also p. 15.

The last two copies of this book have been placed in public libraries for the benefit of scholars; one is in the British Museum, London, and the other in the *Universitäts-Bibliothek*, Halle/Saale (full address in foot-note 85).

²⁷ See our Document III below.

²⁸ See A. Schönfies (foot-note 1), pp. 9–12; and p. 13 on Cantor’s belief that Kronecker never abandoned his opposition to his work.

true: the next day he had a proof of its falsehood: then he found a new proof of its truth: finally, he must have seen that all his proofs were invalid.²⁹

It was during this period that Cantor was preparing his paper on theory of sets that was never published. We have ourselves published the paper and other relevant documents elsewhere,³⁰ and so here we shall deal only with the specifically personal aspects of the affair. The paper survives among the remaining fragments of Cantor's personal papers, partly in proof-pages and otherwise in manuscript, while another copy of the proof-pages and the rest of the manuscript lie in the files of *Acta Mathematica*; and in addition there survives the draft of the paper in one of the surviving three of the many letter-books in which he used to plan his letters before writing out a clean and unaltered version for posting.³¹ Its inspiration came from a long letter to Mittag-Leffler commenced on 20 October, in which he commented on the opposition to his work in Berlin, announced his intention of applying to the Ministry to teach philosophy rather than mathematics in the next semester (an application which he did not in fact make³²), and then presented in a clear and precise form a whole new range of ideas in theory of sets which he claimed to have devised during the previous winter and which he now promised to extend in new papers.³³ The first two were written between November and the following February: one of them was the *zweite Mitteilung* published in 1885 in *Acta Mathematica*, which applied the new ideas to general sets of an arbitrary number of dimensions, but it succeeded not the 1883 *première communication* but an *erste Mitteilung* which demonstrated some of the ideas in the context of ordered sets. That paper was intended for the same volume of *Acta Mathematica* as the *Zweite Mitteilung* but in March, while it was early in the proof stage, Cantor accepted Mittag-Leffler's advice to withdraw it.

²⁹ See A. Schönflies, *loc. cit.* (foot-note 1), pp. 16–19; and H. Meschkowski, *op. cit.* (foot-note 5), pp. 237–243. These references included also an August letter from Cantor on the Continuum Hypothesis.

³⁰ See I. Grattan-Guinness, 'An unpublished paper by Georg Cantor: *Principien einer Theorie der Ordnungstypen. Erste Mitteilung*', *Acta Math.*, 1970, **124**, 65–107.

³¹ See *Nachlass Cantor*, VI, pp. 10–23 and 28–30: the manuscript and corrected proofs are in *ibid.*, XI. The files of *Acta Mathematica* are located at Stockholm/Mittag-Leffler.

³² There seems to be no such letter in *Merseburg/Halle Univ.*, no. 34, vol. XIV.

³³ This section of the letter is quoted in I. Grattan-Guinness, *loc. cit.* (foot-note 30), pp. 74–79: the first seven sides are quoted in H. Meschkowski (foot-note 5), pp. 244–246. The letter is kept at Stockholm/Mittag-Leffler, G, while its draft is in *Nachlass Cantor*, VI, pp. 1–10.

Mittag-Leffler's suggestion had been well-meant: he had written to Cantor that, since the paper did not contain the proof of any important result (such as the Continuum Hypothesis) then it would be better to withdraw it and to allow posterity to discover the quality of Cantor's ideas. Prophetic words; but they reveal only Mittag-Leffler's own failure to appreciate Cantor's new work. Indeed he may have later regretted the affair.³⁴ Cantor himself certainly regretted it, for his correspondence with Mittag-Leffler fell away rapidly after 1886, and in surviving drafts of letters of 1896 to Poincaré and F. Gerbaldi he reminisced rather bitterly on the matter, although he still asserted the value of his friendship with Mittag-Leffler.³⁵ But in 1885 he had accepted Mittag-Leffler's advice warmly and received back that part of his manuscript which had not been set in proofs.³⁶

Cantor never recovered from the impact of this series of events in 1884 and 1885. He published no more papers on the development of his new ideas and indeed seems to have found only a very few results at all in theory of sets in his later years. But he was far from exhausted by his experiences, for from this time onwards he began to devote much of his energy to other matters—and so to begin to sow the seeds of mis-understanding among his contemporaries.

5. CANTOR'S MIDDLE YEARS AT HALLE

In the autumn of 1886 Cantor purchased a magnificent new house at Händelstrasse 13 in Halle to accommodate his wife and five children, whose number was increased to six by the birth of Rudolf in December. He was a loving father to his children, and wrote to them as well as to his wife when he was away from home. He made no effort to dominate the household: indeed, at mealtimes he would sit silently and allow his children to lead the conversation, and then rise and thank his wife for the meal with: 'Are you content with me and do you then also love me?'³⁷ He

³⁴ When Schönflies drew on Mittag-Leffler's collection of letters for his 1927 paper (foot-note 1), he quoted on p. 15 part of a letter from Cantor to Mittag-Leffler which appears in full on p. 103 of I. Grattan-Guinness, *loc. cit.* (foot-note 30), and in which Cantor requested the return of his manuscript. Schönflies took it to refer to part of a paper published by Cantor a few years later which we have listed as the first reference of foot-note 43 below; and Mittag-Leffler did not enlighten him.

³⁵ See I. Grattan-Guinness, *loc. cit.* (foot-note 30), pp. 104–105.

³⁶ See I. Grattan-Guinness, *loc. cit.*, *ibid.*, p. 103.

³⁷ This is a well-remembered recollection of the family and is also noted in M. Peters, *op. cit.* (foot-note 26), p. 65.

used a large room on the ground floor of his house as both his study and his library, and its walls were stacked from floor to ceiling with books; and there he would work quietly for long periods of the day and night. The mathematicians at Halle and at nearby Leipzig met quite frequently, sometimes in the large double-room next to Cantor's study; and then, as was often the case with his colleagues but in complete contrast to his behaviour with his family, he would try to lead the conversation with outspoken pronouncements on a wide variety of matters.³⁸

During the early 1880s one of the mathematicians who attended these meetings was F. Klein, then at Leipzig, who came to know Cantor well. However, their relations seem to have become strained in 1885 when the appointment to a professorship at Göttingen was to be made. Cantor had not given up hope of moving from Halle, blaming the influence of Kronecker and Schwarz on his failure to make that move;³⁹ and when the Göttingen post became available he hoped very much to get it. But Schwarz was still there, and Cantor was not even considered, being passed over in favour not only of Klein but also of his undoubtedly inferiors A. Voss, G. Hettner and A. Enneper. The proposal of these four men was made, and Klein was appointed in November.⁴⁰ Cantor was undoubtedly upset: after 1886 very few more letters passed between him and Klein⁴¹ and in 1888 Schwarz, now firmly opposed to Cantor's work and even personally against his old friend, described in sarcastic tones to a colleague Cantor's behaviour at a recent gathering arranged by Weierstrass.⁴² With this disappointment Cantor seems to have abandoned hope of a move: the purchase of the house in late 1886 was doubtless his recognition of the fact that he was going to spend his whole career in Halle.

At this time Cantor's mathematical work began to attract the attention not only of certain mathematicians but also of philosophers and theologians, who were especially interested in his transfinite arithmetic and

³⁸ For memories of later meetings of this type and Cantor's behaviour at them, see G. Kowalewski, *Bestand und Wandel*, Munich, 1950, pp. 106–109.

³⁹ See the letter of 1 January 1884 from Cantor to Mittag-Leffler in *Stockholm/Mittag-Leffler*, H: the relevant section is quoted in A. Schönflies, *loc. cit.* (foot-note 1), pp. 3–4.

⁴⁰ This information has come from the *Deutsches Zentralarchiv* at Merseberg, where are kept the *Acta* of Göttingen University; and also the *Universitäts-Archiv*, Göttingen, Wilhelmplatz 2, W. Germany, who hold the University file on Klein. Enneper died in March 1885, while the appointment was still under consideration.

⁴¹ According to the collection of Cantor's letters to Klein in *Göttingen/Klein*, VIII, letters 394–455. Like Schwarz (see above, foot-note 15), Klein also left a voluminous collection of papers especially rich in letters.

⁴² See our Document IV below. Weierstrass did not mention this episode when describing the meeting in a letter of 1888 to P. du Bois Reymond: see 'Briefe von K. Weierstrass an P. du Bois Reymond', *Acta Math.*, 1923, 39, 199–225 (p. 222).

its use of complete infinities. He corresponded widely with them at this time, publishing a selection of his letters in 1888.⁴³ His other main interest was in the founding of a mathematical association in Germany; and his motives seem to have included the formation of a society that would not only bring mathematicians closer together but also provide an institution to protect its younger members from the kind of treatment that he himself had received. Very few of his letters on its founding have survived, but he organised the first three of its meetings and it is clear that he wrote to many of his colleagues to encourage them to form and join it; and it was in Halle, in September 1891, that the *Deutsche Mathematiker-Vereinigung* held its first meeting, with Cantor as chairman. He was also one of the editors of its *Jahresbericht* for the first three years, a journal which was distinguished from the start not only by its important papers but also by its long historical articles and reports on various branches of mathematics.⁴⁴ He published only one short paper in it himself, but it was an important one, for in it he gave a form of the 'diagonal argument' for the non-denumerability of the real numbers.⁴⁵

Cantor was not able to attend the September 1893 meeting in Munich because of illness: it was the last of its meetings that he organized.⁴⁶ It may be that he suffered another attack of mental illness, for his next publication, in 1894, was a somewhat eccentric piece of work for a mathematician of his abilities. We recall that his first mathematical interests had been in the field of theory of numbers, and he worked occasionally on some of its problems throughout his life: his 1894 contribution was an empirical verification up to the number 1000 of Goldbach's

⁴³ G. Cantor, 'Mitteilungen zur Lehre vom Transfiniten', *Zeitschr. Phil. philos. Krit.*, 1887, **91**, 81–125 and 252–270; and 1888, **92**, 240–265 (*Abhandlungen*, pp. 378–439). Compare the earlier 'Über die verschiedenen Standpunkte in Bezug auf das actuale Unendliche', *ibid.*, pp. 224–233 (*Abhandlungen*, pp. 370–377): the draft of this paper follows the draft of the unpublished paper of 1884–85 in *Nachlass Cantor*, VI, pp. 31–34. The two papers were published together as a booklet: *Zur Lehre vom Transfiniten*, Halle/Saale, 1890.

⁴⁴ On the history of the *Deutsche Mathematiker-Vereinigung*, see A. Gutzmer, 'Geschichte der deutschen Mathematiker-Vereinigung von ihrer Begründung bis zur Gegenwart dargestellt', Leipzig, 1904 (*Jsbr. dtsh. Math.-Ver.*, 1909, **10**, pt. 1, 1–49); and H. Gericke, 'Aus der Chronik der Deutschen Mathematiker-Vereinigung', *ibid.*, 1966, **68**, 46–74. The latter article includes a photograph of the participants (including Cantor) of a foundation meeting at Bremen in September 1890. For a recollection of Cantor's tireless efforts to encourage its founding, see A. Schönflies, 'Zur Erinnerung an Georg Cantor', *Jsbr. dtsh. Math.-Ver.*, 1922, **31**, 97–106 (p. 105).

⁴⁵ G. Cantor, 'Über eine elementare Frage der Mannigfaltigkeitslehre', *Jsbr. dtsh. Math.-Ver.*, 1891–92, **1**, 75–78 (*Abhandlungen*, pp. 278–281).

⁴⁶ See *Jsbr. dtsh. Math.-Ver.*, 1892–93, **3**, 3. The 1892 meeting in Nürnberg had been postponed for a year because of an epidemic of cholera.

conjecture that every even integer can be written as the sum of two primes, and so it consisted merely of a list of the smaller member of each prime-pair for every even number from 2 to 1000. But its introductory paragraph was most significant, for there Cantor stated that he had done this work 'about ten years ago'. Now the paper was presented to the Caen congress of the *Association Française pour l'Avancement des Sciences* in August 1894: thus the work had been done during the fateful summer of 1884.⁴⁷ In addition, his former pupil P. Stäckel pointed out in 1896 that the verification itself had been done up to 10,000 forty years previously,⁴⁸ but Cantor did use his work to formulate a new conjecture, concerning the behaviour of the function which denoted the number of different prime-pairs for a given even integer.⁴⁹

In the following year (1895) Cantor published the first part of his last major mathematical work—a survey paper on transfinite arithmetic and its laws—the second part appearing in 1897.⁵⁰ While he did not attempt a proof of the Continuum Hypothesis he did give a very clear presentation of his ideas which must have helped to widen the interest in them among mathematicians; for during the last years of the century his achievements began at last to receive a measure of recognition and importance in the mathematical world. The survey paper appeared in *Mathematische Annalen*, with whose editorship Klein was still concerned, and their correspondence over its publication restored something of their former friendship.⁵¹ Although Klein did not use theory of sets in his own research he was extremely interested in it, and must have been instrumental in the publication of Cantor's main series of papers on the theory in the early 1880s in that journal: certainly the letters to him from Cantor at that time had included many discussions of the new theorems and

⁴⁷ G. Cantor, 'Vérification jusqu'à 1000 du théorème empirique de Goldbach', *C.R. Ass. Franç. l'Avanc. Sci.*, 1894 (publ. 1895), pt. 2, 117–134.

⁴⁸ See P. Stäckel, 'Über Goldbach's empirisches Theorem: Jede gerade Zahl kann als Summe von zwei Primzahlen dargestellt werden', *Nachr. Königl. Gesell. Wiss. Göttingen*, math.-phys. Kl., 1896, 292–299 (p. 292). The verification of the theorem up to 10,000 was claimed by H. A. Desboves, in 'Sur un théorème de Legendre et son application à la recherche de limites qui comprennent entre elles des nombres premiers', *Nouv. Ann. Math.*, 1855, 14, (1) 281–295 (p. 293).

⁴⁹ Cantor never published this work, but discussed it in a letter of November 1895 to Hermite, drafted in *Nachlass Cantor*, VIII, pp. 45–50: it is partly quoted in H. Meschkowski, *op. cit.* (foot-note 5), pp. 262–263 and discussed on pp. 168–172.

⁵⁰ G. Cantor, 'Beiträge zur Begründung der transfiniten Mengenlehre', *Math. Ann.*, 1895, 46, 481–512; and 1897, 49, 207–246 (*Abhandlungen*, pp. 282–356).

⁵¹ See *Göttingen/Klein*, sect. VIII, letters 448–454.

properties.⁵² He never lost his interest during the period of their estrangement, and as the moving spirit behind the *Encyclopaedie der mathematischen Wissenschaften* in the 1890s he advised that an article on theory of sets (written by Schonflies) be set as part of the first article in the volumes for arithmetic and algebra.⁵³ He also encouraged W. H. and G. C. Young to take an interest in the subject, and thus inspired their important work on theory of measure and especially, in 1906, the first comprehensive text-book on theory of sets and its applications.⁵⁴ The theory of measure itself began to make real progress in the 1890s, when C. Jordan produced results which were greatly developed by his French compatriots E. Borel and H. Lebesgue.⁵⁵ Jordan also brought out the second edition of his important *Cours d'Analyse* during the decade, and not only extended the treatment of theory of sets that he had given in the first edition in the 1880s but also moved it from the appendix of the final volume of the work to the opening chapters of the first one,⁵⁶ where it has remained ever since in textbooks on mathematical analysis. In August 1897 Cantor took his daughters Else and Gertrud to the first International Congress of Mathematicians, and heard both A. Hurwitz and J. Hadamard explicitly discuss the application and significance of theory of sets,⁵⁷ while at the next conference at Paris in August, 1900

⁵² Cantor's main papers were the series: 'Über unendliche, lineare Punktmannichfaltigkeiten', *Math. Ann.*, 1879, 15, 1–7; 1880, 17, 355–358; 1882, 20, 113–121; 1883, 21, 51–58 and 545–591; and 1884, 23, 453–488 (*Abhandlungen*, pp. 139–246). For his letters with Klein at that time, see *Göttingen/Klein*, sect. VIII, letters 395–439: this collection includes 37 letters sent in 1882 alone.

⁵³ A. Schonflies, 'Mengenlehre', *Enc. der Math. Wiss.*, vol. 1, pt. 1 (Leipzig, 1898–1904), pp. 185–207.

⁵⁴ W. H. and G. C. Young, *The theory of sets of points*, Cambridge, 1906. A reprint of this work is planned, to which the present author has contributed an article on the Young's intended revisions for an abortive second edition, based on their copy now in *London/Young*. From other documents in this source comes the information on Klein's encouragement of the Youngs and of A. Schonflies (foot-note 53).

For a similar work, which was also published in 1906, see G. Hessenberg, 'Grundbegriffe der Mengenlehre', *Abh. der Fries'schen Schule*, 1906, 1 (2), 479–706. (Reprinted, Göttingen, 1906.)

⁵⁵ The best available account of these developments is T. Hawkins, *Lebesgue's theory of integration. Its origins and development*, Madison, 1970. See also I. N. Pesin, Развитие понятия интеграла, Moscow, 1966, recently issued in an English translation as *Classical and modern integration theories*, New York, 1970.

⁵⁶ C. Jordan, *Cours d'Analyse*, 2nd ed., 3 vols., Paris, 1893–96, see esp. vol. i, pp. 1–31.

⁵⁷ A. Hurwitz, 'Über die Entwicklung der allgemeinen Theorie der analytischen Functionen in neuerer Zeit', *Verhandlungen des I. Internationalen Mathematiker-Kongresses* (ed. F. Rudio), Leipzig, 1898, pp. 91–112 (*Mathematische Werke*, vol. i, pp. 461–480). J. Hadamard, 'Sur certaines applications possibles de la théorie des ensembles', *ibid.*, pp. 201–202 (*Oeuvres*, vol. i, pp. 311–312). See also the remarks on Hadamard's paper by S. Pincherle and E. Borel in *ibid.*, pp. 203–205.

(which Cantor did not attend), D. Hilbert delivered a famous address on the most important unsolved problems of mathematics and gave his Continuum Hypothesis as the first of them.⁵⁸

But this success came too late to inspire him to renewed efforts: he was by now a tired man on whom the shadows of depression were beginning to fall. They had begun to manifest themselves in an unexpected but erratic way—in Elizabethan scholarship, and especially in a belief that Bacon wrote Shakespeare's works.

6. 'ONE OF THE GREATEST GENIUSES OF CHRISTIANITY'

Eccentricity is not a necessary condition for believing that Shakespeare did not write his own plays,⁵⁹ which was in fact a belief quite often put forward in Germany at that time; but the way in which Cantor treated the problem does reflect some instability of mind. Part of the legend concerning Cantor is that this work was just distractive fancy on his part to take his mind off other things; but in fact he worked intensely over many years on Elizabethan scholarship, and through wide reading and correspondence built up an extremely detailed knowledge of the whole period as well as a valuable collection of first editions in his library. But, according to his children's recollections, the work was done mostly during his periods of depression; and again it was an activity which he had begun in 1884.⁶⁰ His beliefs were shared by his sister Sophie, who lived nearby at Naunhof,⁶¹ and perhaps with her encouragement in 1896 and 1897 he published at his own expense three pamphlets on the question. The first was an edition of 'A Confession of Faith of Mr. Francis Bacon', together with the Latin translation by Bacon's secretary W. Rawley and a short introduction by Cantor himself which drew almost entirely on the

⁵⁸ D. Hilbert, 'Mathematische Probleme', *Nachr. Königl. Gesell. Wiss. Göttingen*, math.-phys. Kl., 1900, 253–297. (Republished with additions in *Arch. Math. Phys.*, 1901, 1 (3), 44–63 and 213–237; also in *Gesammelte Abhandlungen*, vol. iii, pp. 290–329.) The paper appeared in a French translation in the *Comptes Rendus du deuxième Congrès International des Mathématiciens* (ed. E. Duparcq), Paris, 1902, pp. 58–114, and in English in the *Bull. Amer. Math. Soc.*, 1902, 8 (2), 437–479.

⁵⁹ For a survey of the various theories of this type that have been put forward at one time or another see R. C. Churchill, *Shakespeare and his betters*, London, 1959. Cantor is not discussed in this study.

⁶⁰ Cantor mentioned this in several places; see, for example, folio 142 verso of Document VI below.

⁶¹ Cantor mentioned her interest in a letter to a fellow-Baconian drafted in *Nachlass Cantor*, VIII, p. 14. The letter-books in VII and VIII contain drafts of many letters on the Bacon–Shakespeare question and on Elizabethan scholarship in general.

preface to the essay in the recent edition of Bacon's works.⁶² The pamphlet was ready in March 1896: in the following month he completed another one, the introduction to which (in English) contained his statement of faith on the question:

‘For many years I have in the hours of leisure granted me, given much study to the Life and Works of Francis Bacon, who in my eyes is one of the greatest geniuses of Christianity. By this I have become persuaded, that the opinion so ridiculed by most scholars, of Francis Bacon being the writer of the Shakespearian Dramas, is founded on truth; The proofs, I believe I have found, are purely historical, and I propose gradually to publish all the material in question I have at command.’⁶³

The main text itself consisted of two parts. Firstly there was the last of thirty-two elegies to Bacon as edited by Rawley, written by T. Randolph and followed here by a translation into English. The significance of this poem was that it contained the only documentary ‘proof’ of Baconian authorship of Shakespeare’s writings that Cantor ever offered, namely that in the seventeenth distich:

‘Crescere Pegaseas docuit, velut Hasta Quirini
Crevit, et exiguo tempore Lauras erat’,

the phrase ‘Hasta Quirini’, which literally means ‘the spear of Quirinus [that is, Romulus]’ was an allusion to the ‘Spear-swing’ or ‘Spear-shaker’, and thus to Shakespeare.⁶⁴ That the phrase could have this etymological connotation is, according to the majority of scholars, doubtful, and that it would have been so understood in its own day apparently even more so; but Cantor asserted in his introduction that Bacon

‘is addressed as Shakespeare; for Quirinus . . . denotes clearly in English >> Spear-swing << or >> -Shaker <<.’⁶⁵

The second part of the pamphlet contained Rawley’s brief life of Bacon, which Cantor found to be

⁶² G. Cantor, *Confessio Fidei Francisci Baconi*, Halle/Saale, 1896. Compare the edition of the essay in Bacon’s *Works* (ed. J. Spedding, R. L. Ellis and D. D. Heath), London, 1859, vol. vii, pp. 217–226.

⁶³ G. Cantor, *Resurrectio Divi Quirini Francisci Baconi*, Halle/Saale, 1896, p. iii.

⁶⁴ *Ibid.*, pp. 2, 5.

⁶⁵ *Ibid.*, p. iv.

' the most authentic, weighty and significant of all biographies that have ever been ventured on this unparalleled man.'⁶⁶

The last of these tracts was published in 1897, and consisted of an edition of all the Bacon elegies preceded by Cantor's own introduction (in German) which include a German translation of Randolph's poem and polemics against fellow-members of the *Deutsche Shakespeare Gesellschaft*.⁶⁷ The three pamphlets together make no contribution at all to Shakespearean criticism and scholarship despite their author's deep knowledge of the subject, and it is probably fortunate that he never did publish his 'purely historical proof' of Baconian authorship from 'all the material in question' that he had to hand. The reason *why* he did not fulfil his intention is doubtless to be found in the catastrophe that overcame him in the autumn of 1899.

7. CANTOR'S CRISIS OF 1899

During his preparation of the 1895–97 paper on transfinite arithmetic Cantor had discovered the first of the paradoxes of the theory of sets, and he had communicated it to Hilbert in a letter of 1896.⁶⁸ He did not publish it in his paper, but it was discovered independently and published in 1897 by C. Burali-Forti, after whom it is now known.⁶⁹ It concerned an alleged property of ordinal numbers, and Cantor himself found a similar property in cardinal arithmetic around the same time. These surprising and disturbing results brought him to a new effort in researches into the theory of sets: having resumed cordial relations with Dedekind at the 1897 Zurich Congress, he corresponded with him in the late summer of 1899 on the restoration of mathematical consistency to the theory of sets by means of a distinction between 'consistent' and 'inconsistent'

⁶⁶ *Ibid.*

⁶⁷ G. Cantor, *Die Rawley'sche Sammlung von zweihunddreissig Trauergedichten auf Francis Bacon*, Halle/Saale, 1897.

⁶⁸ According to F. Bernstein, 'Über die Reihe der transfiniten Ordnungszahlen', *Math. Ann.*, 1905, **60**, 187–193 (p. 187). The letter was not drafted in *Nachlass Cantor*, VIII, one of his letter-books for that year, and neither is it in *Göttingen/Hilbert*; but, like Cantor's papers, Hilbert's are also incomplete and there is no reason to doubt the report of Bernstein, who studied the theory of sets for his *Habilitation* under Cantor at Halle during the early years of the century. Compare also P. E. B. Jourdain, 'On the transfinite cardinal numbers of well-ordered aggregates', *Phil. Mag.*, 1904, **7** (6), 61–75 (p. 70).

⁶⁹ C. Burali-Forti, 'Una questione sui numeri transfiniti', *Rend. Circ. Mat. Palmero*, 1897, **11**, 154–164; and 'Sulle classi ben ordinate', *ibid.*, p. 260.

multitudes (*Vielheiten*).⁷⁰ The correspondence soon ended (apparently for ever), but Cantor was obviously worried and uncertain about the problem in much the same way as he had been disconcerted by his proofs and disproofs of the Continuum Hypothesis in the autumn of 1884. In October he applied for and was granted leave from his duties at Halle University for the winter semester,⁷¹ but he still attended there and indeed during December and January he wrote some agitated protests against Faculty procedures in the administrative *Circulare* which passed among the professors.⁷² The University had been troubled for a number of years by controversies of various kinds, especially in the rapidly expanding philosophical Faculty: the increase in staff had been caused largely by new appointments at various levels of scientists and mathematicians, who formed a ‘progressive’ group opposed by the conservative circle of classicists. Some of the issues were wider still, involving social and political questions of the freedom of the universities and the power of the State which were beginning to rise in importance in German thought.⁷³ Cantor appears to have been an important figure for the liberal cause, but his efforts can only have contributed to his personal mental stress. In November he brought the matter to the attention of the Government in Berlin, in a letter which reveals persecution complexes of various kinds. He sought some other kind of employment (at his current salary!),

⁷⁰ See G. Cantor, *Abhandlungen*, pp. 443–447, for the extract of the letter to Dedekind dated 28 July 1899. In *Nachlass Cantor*, V survives the seemingly complete draft of a succeeding letter sent to Dedekind and dated 3 August 1899: it refers to the previous letter, but its text is almost identical with the published extract cited above. It begins on a sheet of paper already used for the end of an unintelligible essay, written in English, on mathematics as a subject.

A well-known and amusing incident occurred at this time. On 4 September 1899 Dedekind had Cantor as a guest for lunch; but in Teubner’s Mathematical Calendar for 1904 it was reported that Dedekind had died on that day. Dedekind wrote to the editor of the Calendar to assure him of his good health on that day! [See E. Landau, ‘Richard Dedekind’, *Nachr. Königl. Gesell. Wiss. Göttingen, geschäfsl. Mitt.*, 1917, pp. 50–70 (pp. 53–54).]

⁷¹ See *Halle/Cantor*, pp. 12–14.

⁷² See *Halle/Cantor*, vol. 26, especially 17 December 1899, and 4 and 7 January 1900. We have not quoted these documents as they are difficult to appreciate out of context, but in our Document VIII below we quote some similar protests of 1902 from the same source, which show more immediately the kind of situation that applied in the Faculty at the time —or, at least, as Cantor saw it!

⁷³ A forthcoming study by Dr. H. Schwabe, Head of *Halle Universitätsarchiv*, will explain the development of the philosophical Faculty at that time. For a history of the University, written by its Kurator to celebrate the bicentenary of its foundation, see W. Schrader, *Geschichte der Friedrichs-Universität zu Halle*, Berlin, 1894, 2 vols., esp. vol. ii, pp. 269–290. A photograph of Cantor was taken for the University’s jubilee celebrations of that year, and is reproduced as our Plate XXVI.



PLATE XXVI. Cantor at Halle University, 1894.
(In the possession of the *Universitätsarchiv*, Halle/Saale, E. Germany D.D.R.)

perhaps in a library, where he could serve the Kaiser: he felt the pressure on him, a foreigner, of the 'German professors', and added that he had been working on the Bacon-Shakespeare question.⁷⁴ He sent in copies of his three pamphlets, and also a set of nine of his visiting cards upon which he had described his family history and given both a fresh plea against the German professors and also a reference to his 'old beloved' ruler, Czar Nicholas II of Russia.⁷⁵

The *Kultusministerium* appears to have treated this episode with great tact and diplomacy. Although there were certainly difficulties in the situation at Halle, there would seem little reason to believe the general antagonism against his person that Cantor believed was taking place. Indeed, the Director of Education in the Ministry at this time was F. Althoff, a truly remarkable man who worked ceaselessly for liberal causes himself at that difficult time and who discharged his responsibilities by means of an extraordinarily detailed correspondence which make the mass of his surviving papers a source of the first importance for the history of German science and education during this period.⁷⁶ Unfortunately, almost all the letters he received from Cantor are missing; but other sources, such as Cantor's personal file in Halle University, show that in fact both the Ministry and the University authorities were as sympathetic as possible to Cantor's requests for extra payment, travel grants, and leave from teaching duties.⁷⁷ We must see in these communications to the Ministry evidence of Cantor's state of mind rather than of Halle's state of affairs—and indeed the autobiographical passage gives evidence of another source of stress: the deaths of his relatives. His mother had died in October 1896, and his younger brother Constantin in January 1899; and then on 16 December came perhaps the final blow—his youngest child, Rudolf, died in his thirteenth year.

The boy had been weak from birth, but Cantor had always hoped that his strength would grow as he got older, and he saw in his talents a continuation of the family's considerable artistic gifts. But it was not to be. Cantor described the circumstances of the child's death in movingly restrained terms in a letter sent at the end of the year to Klein: he had been to a lecture on the Bacon-Shakespeare question in Leipzig,

⁷⁴ See our Document V below.

⁷⁵ See our Document VI below.

⁷⁶ This source is denoted as *Merseburg/Althoff*, and would greatly benefit from a detailed study; the missing letters from Cantor are discussed in our appendix below. For a biography of Althoff which makes only slight use of the papers, see A. Sachse, *Friedrich Althoff und sein Werk*, Berlin, 1928.

⁷⁷ *Halle/Cantor*: the documents date only from 1891 onwards.

and returned home in the evening to find that the child had died in the afternoon.⁷⁸ It was a deep disappointment to Cantor as well as a shock, and it seems to have been the decisive stimulus of the mental attacks from which he was to suffer from time to time until the end of his life.

8. CANTOR'S MENTAL ILLNESS

From the popular view of Cantor's mental history, it would be deduced that he spent the whole of his last twenty years in seclusion and inactivity in mental institutions; but the true picture is quite different. He overcame the immediate pressure of all these events of 1899 to spend some time in Berlin at the end of January 1900, working on both mathematics and the Bacon-Shakespeare question,⁷⁹ but in the spring and early summer he must have shown signs of distress, for he was relieved of his teaching responsibilities for the summer semester.⁸⁰ Thereafter he was regularly allowed leave from his work: for the winter semesters of 1902–03, 1904–5 and 1907–08, for much of 1909 and then from early in 1911 until his application for retirement in April 1913 was approved.⁸¹ He spent some of the time on leave in sanatoria, especially at the *Nervenklinik* in Halle: their (incomplete) records show that he stayed at some other institution in 1899, 1902 and 1904, and then at the *Nervenklinik* itself from 22 October 1907 until 15 June 1908, from 28 September 1911 to 18 June 1912 (and thence to another sanatorium), and finally from 11 May 1917 until his death on 6 January 1918.⁸²

The lack of documentary evidence combined with the rudimentary nature of psychological treatment at that time precludes the possibility of a definitive professional evaluation of his mental illness; but certain significant features can be mentioned. The attacks all began suddenly, usually in an autumn season, and exhibited phases of excitement and

⁷⁸ See our Document VII below: it is the last letter from Cantor in *Göttingen/Klein*, sect. VIII. The connection between Cantor and Klein has not been discussed by biographers of either: Klein himself did not mention it in his autobiography 'Göttinger Professoren. Lebensbilder von eigener Hand. 4. Felix Klein', *Univ.bund Göttingen Mitt.*, 1923, 5, (pt. 1), 11–36.

⁷⁹ According to letters to his son Erich in *Nachlass Cantor*, III.

⁸⁰ See *Halle/Cantor*, ff. 16–17; and *Merseburg/Halle Univ.*, no. 34, vol. XX, ff. 230–232.

⁸¹ Cantor's leave is dealt with in various documents in *Halle/Cantor*; *Merseburg/Halle Univ.*, no. 34, vols. XX–XXII; and the *Verzeichnis der auf der königlichen vereinigten Friedrichs-Universität Halle-Wittenbergim . . . zu haltenden Vorlesungen . . .* published at Halle for each semester. Cantor's application for resignation and its acceptance are in *Merseburg/Halle Univ.*, no. 48, vol. II, ff. 34–35; and also in *Halle/Cantor*, 23 and 29 April 1913.

⁸² Communication from the *Klinik und Poliklinik für Psychiatrie und Neurologie*, 401 Halle/Saale, Julius-Kühn-Strasse 7, E. Germany D.D.R.

exaltation: they ended suddenly in the following spring or summer, and were sometimes followed by what we now understand to be the depressive phase. In Cantor's day it was seen as a cure, and he would be sent home to sit silent and motionless for hours on end; but then this phase would end suddenly and he would resume his work and duties. The documents that belong to these periods, some of which we have given here at the end of our narrative, reveal both excitements and depressions, and also persecution complexes of various kinds—against mathematical colleagues, against 'German professors', and also against some of his fellow scholars on the Bacon-Shakespeare problem. The first attack of 1884 did not fully follow the pattern of its successors, being of much shorter duration; but it doubtless led to the rather strange work on theory of numbers and the beginning of the Bacon-Shakespeare obsession, both of which began in that year. All these features suggest to the modern professional viewpoint that Cantor's illness was basically *endogenous*, and probably showed some form of manic depression: exogenous factors, such as the difficulties of his researches and the controversies in Halle University, are likely to have played only a small part in the genesis of his attacks, little more than the clap that starts the avalanche. Thus he would have suffered his attacks if he had pursued only an ordinary mundane career. Today he would have been treated with drugs, and probably successfully; but his own doctors were almost entirely lacking in any kind of effective treatment. An example of the attitudes of that time is given by his wife: although one of her brothers was the director of a hospital in Berlin and so familiar with medical problems, she herself always attributed her husband's illness simply to overwork.⁸³ But if his contemporaries were uncomprehending of his illness, at least they were unusually liberal in granting him as they did the periods of release that he would not have secured in many another country.

9. CANTOR'S FINAL YEARS AT HALLE

Our final task is to describe these last twenty years of Cantor's life. We have seen that they were only punctuated, rather than dominated, by periods of illness; but the activities to which he devoted himself during his periods of clarity were sometimes related both intellectually and chronologically to his depressions. During his correspondence with Dedekind in 1899 he claimed to have abandoned work on the Bacon-Shakespeare question,⁸⁴ but in 1902, when he was on leave from the

⁸³ According to family reminiscence. Cantor's brother-in-law, Paul Guttmann, died in 1893, before Cantor's illness assumed serious proportions. Many letters to him from Cantor survive in *Nachlass Cantor*, III.

⁸⁴ See the introduction to E. Noether and J. Cavaillès, *op. cit.* (foot-note 19).

University, he secured the co-operation of his colleague at Halle, G. Wissowa, the professor of classics, in the preparation of the second edition of his 1897 pamphlet on the Rawley collection of elegies to Bacon. This time the Latin texts would appear opposite a *German* translation: the translations were prepared with Wissowa's help, but he must have become understandably sceptical about the project and it was abandoned at the page-proof stage, presumably when Cantor had an attack during the summer which manifested itself in further protests in the Faculty *Circulare*.⁸⁵ By September 1903, he had recovered sufficiently to address the Kassel meeting of the *Deutsche Mathematiker-Vereinigung* on the paradoxes of the theory of sets and express his suspicions of the 'French philosophers' (presumably Poincaré's) methods of solving them.⁸⁶ In August 1904, he attended the third International Congress of Mathematicians at Heidelberg with his daughters Else and Anna-Marie. Although he did not read a paper, some controversial results were announced concerning well-ordered sets which in part implied that his Continuum Hypothesis was false; and he was long remembered for his exhortations to the fellow participants to find the mistake in the new results.⁸⁷ He was suffering the beginnings of another attack, and a month later was in hospital once more.

Shortly after his release in the following spring he stayed with his sister Sophie at Naunhof near Leipzig and was inspired on 29 March to write a religious tract. On the same day he wrote to P. Jourdain, a young English mathematician who wrote both on theory of sets and its application to analysis and also on the historical development of the

⁸⁵ See our Document VIII. The proofs of the second edition of Cantor's *Die Rawley'sche Sammlung* (foot-note 67), along with copies of *Confessio Fidei* (foot-note 62) and *Resurrectio Divi Quirini* (foot-note 63), are in a bound volume entitled *Georg Cantors Baconniana* in the Universitäts- und Landesbibliothek, 401 Halle/Saale, August-Bebel-Strasse 13, E. Germany D.D.R. This library also possesses a few letters from Cantor to his colleagues, including one to F. Loofs of 24 February 1900, which appeared in photographic reproduction in H. Meschkowski, *op. cit.* (foot-note 5), between pp. 272 and 273. This letter belongs to the period of Cantor's 1899 breakdown and is concerned with the University controversies of the time: it is singularly unfortunate that it was published without any explanation of its contents or the reasons for its extremely forceful character.

⁸⁶ For a notice of the lecture, entitled 'Bemerkungen zur Mengenlehre', see *Jsbr. dtsc. Math.-Ver.*, 1903, **12**, 519. It was not published, and our information on it comes from A. Schönflies, 'Über die Stellung der Definition in der Axiomatik', *ibid.*, 1911, **20**, 222–255 (p. 251).

⁸⁷ The controversial paper was J. König, 'Zum Kontinuum-Problem', *Verhandlungen des dritten internationalen Mathematiker-Kongresses* (ed. A. Krazer), Leipzig, 1905, pp. 144–147, which claimed to prove that the continuum was not well-ordered, in contrast to Cantor's belief that every set had this property. On Cantor's behaviour at the Congress, see A. Schönflies (foot-note 44), 100–101 (also in his 'Georg Cantor', *Miteld. Lebensb.*, 1928, **3**, 548–563, pp. 560–563); and G. Kowalewski (foot-note 38), pp. 198–205.

subject, and who had recently been in correspondence with Cantor on his work. Cantor did not say in his letter at which hospital he had been staying, but he gave the dates as from 17 September 1904 to 1 March 1905 and described the writing of his new tract.⁸⁸ He also enclosed the manuscript and requested an English translation, which Jourdain apparently prepared and sent to him but which is now lost. In early April, while a copy of the manuscript made by one of his sister's children was in the press, he wrote about it to Mrs. Young,⁸⁹ and later in the month he sent her a copy of the published version, a small twelve-page pamphlet entitled *Ex Oriente Lux*.⁹⁰ This was the first of an intended series of conversations between a master and his student on 'essential points of documentary Christianity'. Although Cantor described himself on the title page as the student, he was clearly speaking in forthright style as the master in the main text, chiefly on the theme that Christ was the natural son of Joseph of Arimathea. It is not clear why he should have taken this thesis into his collection of obsessions: the fragments of religious writings that survive in his personal papers deal with other questions. Perhaps it was an aspect of his individual religious position: he had been baptised as an evangelist⁹¹ and thus followed the religion of most of his family, but he claimed to belong to no organised Christian church as such.⁹²

Cantor had one other publication in 1905—the text of a letter on the three-body problem that he had received from Weierstrass in 1891.⁹³ But he still hoped to write further on theory of sets, and in 1908 promised to Young to send his next paper to the *Journal of the London Mathematical Society*, in a letter in which he rejected some recent unpleasant remarks

⁸⁸ See our Document IX below. The manuscript is now in Stockholm/Jourdain, notebook 2, p. 119.

⁸⁹ See our Document X below.

⁹⁰ G. Cantor, *Ex Oriente Lux. Gespräche eines Meisters mit seinem Schüler über wesentliche Punkte des urkundlichen Christenthums. Berichtet vom Schüler selbst Georg Jacob Aaron, Cand. Sacr. Theol. Erstes Gespräch*, Halle/Saale, 1905. In addition to the copy in London/Young, there is one in Wissowa's bound volume described in foot-note 85.

⁹¹ See, for example, folio 141 of our Document VII below.

⁹² For extracts from letters by Cantor on religious matters, see H. Meschkowski, *loc. cit.*, (foot-note 4), pp. 514–518; and *op. cit.* (foot-note 5), pp. 122–129.

⁹³ G. Cantor, 'Brief von Carl Weierstrass über das Dreikörperproblem', *Rend. Circ. Mat. Palermo*, 1905, 19, 305–308. See Cantor's reference to this publication in our Document IX below: his covering letter to the paper was dated 17 January 1905, while he was still confined in hospital. He had been requested to publish the letter by colleagues at the International Congress of 1904 at Heidelberg.

For a photograph of Cantor taken in 1906, see Plate XXVII.

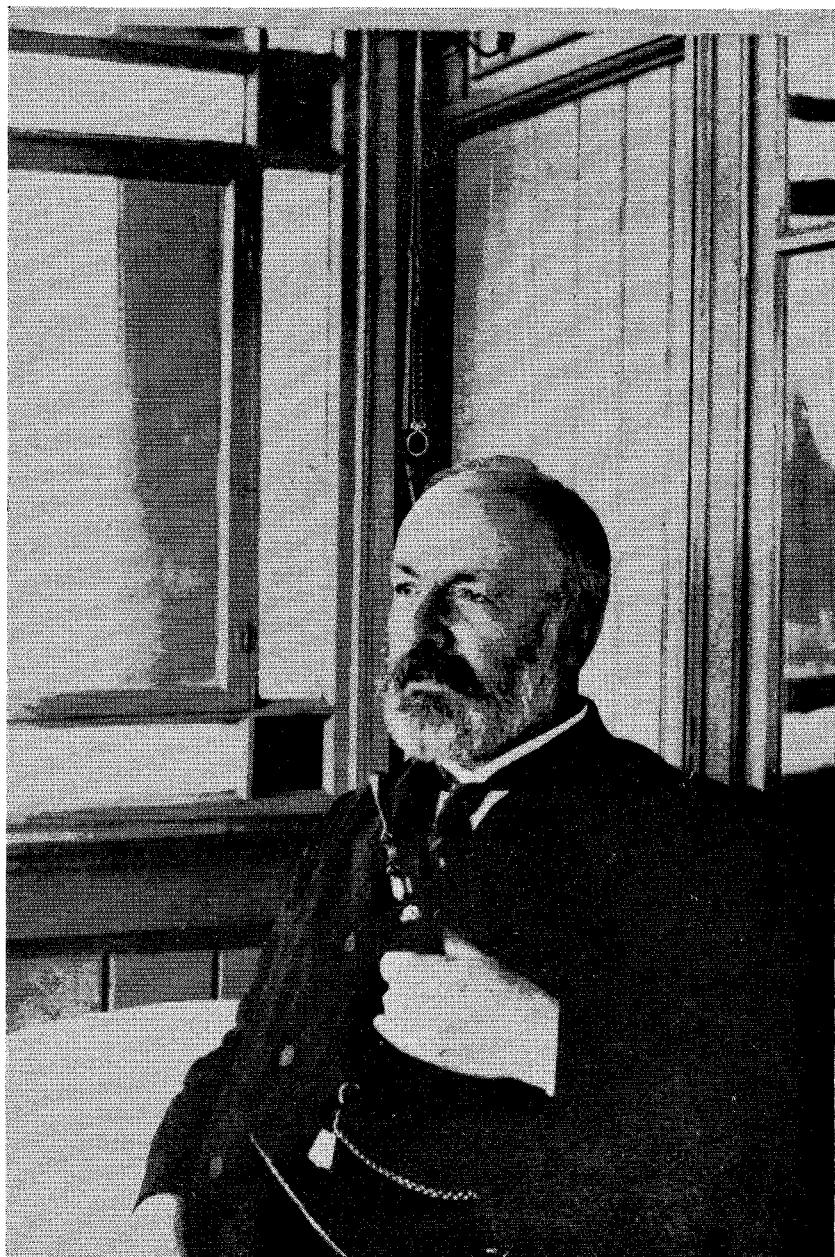


PLATE XXVII. Cantor on holiday at Strobahai in the Harz mountains, 1906.
(In the possession of E. Schneider.)

by Poincaré against the theory and also against his friend, Hermite.⁹⁴ The paper that he had promised was never written, but during his periods of good health he fulfilled all his University duties; and in September 1911 he at last achieved his long-held ambition to visit Britain, the home of Bacon and Shakespeare. But the stay was terminated by an illness of his son Erich in Germany, and, more importantly, the onset of another attack of mental illness.

The main reason for the visit was the celebration of the 500th anniversary of the foundation of St. Andrews University in Scotland from the 12–15 September. Cantor had been invited as a distinguished foreign scholar:⁹⁵ it seems most likely that the suggestion for his invitation would have come from A. E. Taylor, the professor of moral philosophy, who had a deep interest in symbolic logic and all branches of mathematics (such as theory of sets) that were of philosophical interest and importance. During the visit he apparently began to behave eccentrically, talking at great length on the Bacon–Shakespeare question; and then he travelled down to stay in London for a few days. On the 16 and 19 September he wrote to the then Hon. B. Russell, who had just finished with A. N. Whitehead their *Principia Mathematica*, a work in which the whole treatment of arithmetic and real numbers was based on Cantor's ideas and part of whose purpose was to formulate a mathematical system that would avoid the known paradoxes of the theory of sets.⁹⁶ Cantor was naturally interested in Russell's work, and wrote in order to arrange a meeting which in the end never took place. It is a matter of singular misfortune that in his recent *Autobiography* Lord Russell chose to publish these letters in the way that he did, with an introduction in which he stated his admiration for Cantor but then thoughtlessly, as well as inaccurately, remarked on his mental illness as follows:

⁹⁴ See W. H. Young, 'The progress of mathematical analysis in the twentieth century', *Proc. Lond. Math. Soc.*, 1926, **24** (2), 421–434 (pp. 422–423); the letter in question was written by Cantor in German, and is in *London/Young*. Poincaré's remarks may be seen in the section 'le Cantorisme' of his address 'L'avenir des mathématiques' to the 1908 International Congress of Mathematicians in Rome, in the *Atti del IV Congresso Internazionale dei Matematici* (3 vols., ed. G. Castelnuovo), Rome, 1909, vol. i, pp. 167–182. (Also published in *Rev. gén. sci. pur. appl.*, 1908, **19**, 930–939; *Scientia*, 1908, **4**, 1–23; *Rend. Circ. Mat. Palermo*, 1908, **26**, 152–168; *Bull. sci. math.*, 1908, **32** (2), pt. 1, 168–190; and *Science et méthode*, Paris, 1908, book 1, ch. 2.)

⁹⁵ See *University of St. Andrews. Celebration of the five hundredth anniversary of the foundation. List of guests and hosts and list of hosts and guests*, Dundee, 1911, pp. 7 and 38.

⁹⁶ A. N. Whitehead and B. A. W. Russell, *Principia Mathematica*, 1st ed., 3 vols., Cambridge, 1910–13.

'George Cantor, the subject of the following letter,⁹⁷ was in my opinion, one of the greatest intellects of the nineteenth century After reading the following letter, no one will be surprised to learn that he spent a large part of his life in a lunatic asylum,'⁹⁸

The two letters from Cantor are undeniably erratic: in fact, the manuscripts are even more revealing, for they show several of his habits when he was in a state of agitation. The handwriting is very flowery and tends to rise up the page; and not only does it continue in the margins of the page (a practice that he often followed) but on one page of the second letter he cross-writes from top to bottom over lines already written from left to right: there is even a paragraph on the back of the envelope.⁹⁹ Quite clearly the letters should have been published only with the most careful and sympathetic annotation; the fact that they have appeared with such a careless introduction can only have added to the difficulties of destroying the Cantor legend.¹⁰⁰

After his retirement in April 1913, Cantor lived quietly at home. He had been at Halle University for 44 years, 34 of them as *ordentlicher Professor*; and although he had suffered his share of controversy in University affairs during a difficult period and never enjoyed either the administrative or teaching responsibilities of his post, he always discharged them conscientiously and was remembered as a clear and indeed inspiring teacher.¹⁰¹ During his last years he received various honours and honorary degrees, including a Doctorate of Laws from St. Andrew's University in 1912 which he was too ill to receive personally;¹⁰² in 1915 his 70th birthday was celebrated with a ceremony at his home and the commission of a bust by his friends which was completed in the following

⁹⁷ From an acquaintance of Russell's, who had just met Cantor after his visit to St. Andrews.

⁹⁸ See *The Autobiography of Bertrand Russell*, 3 vols., London, 1967–69, vol. i, p. 217; Cantor's letters are on pp. 218–220. Cantor could not attend the next International Congress, at Cambridge, in the following August. For Russell's tributary remarks to him, see *Fifth International Congress of Mathematicians Proceedings*, (2 vols., ed. E. W. Hobson and A. E. H. Love), Cambridge, 1913, vol. i, p. 53.

⁹⁹ The manuscripts are now kept in the Bertrand Russell Archives, Mills Memorial Library, McMaster University, Hamilton, Ontario, Canada. General information on this voluminous collection of papers may be gathered from *A detailed catalogue of the archives of Bertrand Russell*, London, 1967.

¹⁰⁰ It is perhaps worth remarking that this paragraph was written shortly before the recent death of Lord Russell.

¹⁰¹ See, for example, M. Krause, 'Enno Jürgens', *Jsbr. dtsc. Math.-Ver.*, 1908, 17, 163–170 (p. 165).

¹⁰² The correspondence dealing with this degree is in *Nachlass Cantor*, X. According to it and the present Secretary of the University of St. Andrews, College Gate, St. Andrews, honorary degrees were awarded by a decision of the Senatus Academicus following recommendations from its members. It is plausible that again A. E. Taylor was the inspiration behind Cantor's nomination.

year.¹⁰³ But he was gradually slipping away. The war conditions led to difficulties in obtaining food, and he became thin and hungry as well as tired and ill.¹⁰⁴ He was taken to the *Nervenklinik* in Halle for the last time in June 1917: he did not want to go, and constantly wrote to his wife asking her to come and take him home. In December he received many congratulations for the fiftieth anniversary of his *Dissertation*¹⁰⁵ and hoped to answer all the letters, but there was not to be time. In the New Year he sent to his wife the leaves of a calendar for the last forty days of the Old Year, to show that he had lived through it,¹⁰⁶ but on the 6 January he died suddenly and painlessly after a heart attack, and was buried in Halle next to his son Rudolf.¹⁰⁷

TEXTS OF CITED DOCUMENTS

We present these ten documents in chronological order, with brief introductory remarks where necessary and occasional foot-notes giving clarification to the text or the details of cited publications. We indicate the foliation by a double line || in the text and the folio number in the margin; and we preserve contemporary spellings and the occasional grammatical mistake.

DOCUMENT I. *Extracts of a letter from Cantor to the Kultusminister, 20 November 1881: the proposal for Dedekind to succeed Heine.*¹⁰⁸

We omit the sections of this letter proposing Weber and Mertens after Dedekind as Heine's replacement.

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|| Halle a/S d. 20^{ten} Nov. 1881.

Excellenz:

Durch das beklagenswerthe frühzeitige Ableben unseres verewigten Collegen Eduard S.¹⁰⁹ Heine, der sowohl eine hohe Zierde seiner Wissenschaft, als auch ein nach allen Beziehungen hochverehrter

¹⁰⁸ See W. Lorey, 'Der 70. Geburtstag des Mathematikers Georg Cantor', *Zeitschr. Math. naturw. Unterr.*, 1915, **46**, 259–274. Hilbert gave a speech whose manuscript survives in *Göttingen/Hilbert*, item 574. The bust now stands in the *Aula* of Halle University: for a photograph of it see H. Meschkowski, *op. cit.* (foot-note 5), frontispiece.

¹⁰⁹ See M. Peters, *op. cit.* (foot-note 26), p. 65. For a photograph of Cantor at this time see Plate XXVIII.

¹⁰⁵ These letters survive in *Nachlass Cantor*, X.

¹⁰⁶ The letters to his wife survive in *Nachlass Cantor*, II.

¹⁰⁷ The family grave is in a cemetery now called the *Neuer Friedhof*, Halle/Saale and contains in addition to Georg and Rudolf his wife Vally, his daughters Anna-Maria and Else, and his daughter Gertrud and her husband and daughter.

¹⁰⁸ *Halle/Phil. Fac.*, vol. 135, part II, ff. 126–127. The letter was copied out and sent to the *Kultusministerium* in the name of the University. A typed copy of that version exists in *Merseburg/Halle Univ*, no. 34, vol. XIII, ff. 166–167, with a remark that the original is in *Berlin/Darmstaedter*; but it is not to be found in that source. For discussion of this document in our narrative, see foot-note 17 and text.

¹⁰⁹ *Sic*: Heine's second name was Heinrich.



PLATE XXVIII. Cantor in 1917, a few months before his death.
(In the possession of E. Schneider.)

Mitglied unserer Fakultät und unserer Universität war, sind wir in der Lage, die Neubesetzung der von ihm zurückgelassenen Stelle der Mathematik von Ew. Excellenz Gewogenheit zu erbitten.

Indem wir uns die Ehre geben, Ew. Excellenz hierauf bezügliche Vorschläge, in der Hoffnung auf ihre Erfüllung, zu machen, gehen wir von dem Grundsätze aus, das Andenken unseres seligen Collegen am meisten dadurch zu ehren, dass wir auf einen möglichst tüchtigen und bedeutenden Nachfolger den grössten Werth legen.

An erster Stelle bezeichnen wir den Herrn Dr. *Richard Dedekind*, Professor an der technischen Hochschule in Braunschweig als derjenigen, dessen hervorragende wissenschaftliche Leistungen verbunden mit reicher Erfahrung in höheren mathematischen Unterrichtsfache ihn ganz besonders geeignet erscheinen lassen, die eingetretene Lücke in allen Richtungen aufs Beste aufzufüllen.

fol. 126
verso

Als Schüler Lejeune-Dirichlets in alle || diejenigen Gebiete vollkommen eingeweiht, welche vorzugsweise der Lehrtätigkeit des verstorbenen Herrn Heine zu Grunde lagen, hat Herr Dedekind sich nicht allein grosse Verdienste durch Herausgabe der Werke Lejeune-Dirichlets und B. Riemann's erwerben, sondern er hat auch als selbständiger Forscher durch fundamentale Untersuchungen über die algebraischen Zahlen und die elliptischen Modulfunctionen sich die Anerkennung aller Fachgenossen verschafft.

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Der Umstand, dass Herr Dedekind in den letzten achtzehn Jahren keiner Universität angehört, kann nicht gegen seine Berufung angeführt werden, sondern sogleich eher für dieselbe da es nicht um in unsern, sondern auch von allgemeinem Interesse sein dürfte, einen so ausgezeichneten Mann für den akademischen Unterricht endlich wieder zurückzugewinnen Sollten aber, ganz gegen unser Erwarten, unüberwindliche Schwierigkeiten die Berufung bei allen diesen von uns Genannten zur Unmöglichkeit machen, so ersuchen wir für diesen Fall Ew. Excellenz, ganz gehörsamst und inständigst, uns von Neuem Gelegenheit zu geben, Personen zu nennen die uns alsdann die geeignesten scheinen werden.

Cantor.¹¹⁰

DOCUMENT II. *Letter from Dedekind to the Kultusminister, 6 January 1882: the rejection of the Halle professorship.*¹¹¹

1

|| Ew. Hochwohlgeboren

Werden mein Schreiben vom 2 d. M. erhalten haben, in welchem ich mir erlaubte, für die ehrenwollen Anerbietungen der Königl. Preussischen Regierung vorläufig meinen ergebensten Dank auzusprechen. Nachdem ich von meiner Reise zurückgekehrt bin und noch die beiden letzten Tage dazu benutzt habe, über die mir eröffneten Aussichten reichlich und in völliger Ruhe nachzudenken, verfehle ich nicht, nunmehr Ew. Hochwohlgeboren mitzutheilen,

¹¹⁰ The signatures of agreement of the other professors of the Faculty follow here.

¹¹¹ A typed copy of this letter is in *Merseburg/Halle Univ.*, no 34, vol. XIII, ff. 168–169: the original is in *Berlin/Darmstaedter*, H* 1863, and we indicate the foliation of this version. For the discussion of this document in our narrative see foot-note 18 and text.

- 2 dass ich zu meinem lebhaften Bedauern mich || ausser Stande sehe,
 die Berufung nach Halle in die Stelle des verewigten Prof. Heine
 anzunehmen. Die grosse Ehre, welche darin liegt, der Nachfolger
 eines so hochangesehenen Mannes zu werden, verkenne ich keines-
 wegs, und ich füge hinzu, dass der Gedanke, an der Seite von
 hochgeschätzten Kollegen meine Wissenschaft in grösserer Ausdeh-
 nung und tieferer Auffassung lehren zu können, als es mir nach der
 Natur meines gegenwärtigen Amtes möglich ist einen Reiz auf mich
 ausübt, dem zu widerstehen mir sehr schwer wird. Auch bestehen
 die besonderen Verhältnisse schon lange nicht mehr, welche im Jahre
 1874 mich bewegen mussten, auf die Annahme der von Ew. Hoch-
 wohlgeboren mir angetragenen Professor an der Universität Greifs-
 wald zu verzichten. Andererseits brauche ich kaum zu erwähnen,
 dass es mir nicht leicht wird, nach einer bald zwanzigjährigen
 3 Wirksamkeit aus meiner hiesigen Stellung zu scheiden und damit ||
 zugleich den gemeinschaftlichen Haushalt mit meiner Mutter und
 Schwester aufzulösen, denen ich eine Uebersiedelung nach einem
 fremden Orte nicht zumuthen kann. Aber auch wenn dem nicht
 so wäre, so müssten doch schon die von Ew. Hochwohlgeboren mir
 mitgetheilten Gehaltsbedingungen mich bestimmen, meine hiesige
 Stellung nicht aufzugeben; ich beziehe jährlich als Professor an der
 technischen Hochschule 6000M, als Mitglied der Oberschulcommission
 900M und als Mitglied verschiedener Prüfungskommissionen 530M,
 in Ganzen also 7430M; da ich nicht reich bin, so kann ich auf eine
 Schmälerung dieses festen Einkommens durchaus nicht eingehen,
 und ich würde deshalb auch die Professur in Halle ohne Zusicherung
 eines festen Jahrgehalts von mindestens 7500M nicht annehmen
 können.
 Indem ich Ew. Hochwohlgeboren nochmals meinen ehrerbietigen
 4 Dank für die || mir gemachten Anerbietungen ausdrücke, die ich
 lebhaft bedaure unter den gegenwärtigen Verhältnissen ablehnen zu
 müssen, verbleibe ich mit ausgezeichneter Hochachtung,
 Ew. Hochwohlgeboren

ganz ergebenster

Braunschweig,
 6 Januar 1882.

R. Dedekind.

**DOCUMENT III. *Letter from Cantor to Mittag-Leffler, 21 June 1884:
 a return to work after illness.*¹¹²**

The handwriting of this letter is not particularly excited or depressed,
 but its tone is somewhat self-deprecating.

1

|| Halle d.21 Juni 1884.

Mein lieber Freund,

Für ihren lieben Brief v. 15 Mai sage ich Ihnen herzlichen Dank, ich
 würde ihn früher schon beantwortet haben, doch fühle ich mich seit

¹¹² Stockholm/Mittag-Leffler, H: partly quoted in A. Schönflies, foot-note 1, p. 9. For discussion of this document in our narrative, see foot-note 27 and text.

2 einige Zeit nicht so frisch, wie es sein sollte, in Folge dessen weiss ich auch nicht, wann ich zur Fortsetzung meiner wissenschaftlichen Arbeiten kommen werde; momentan kann ich darin gar nichts thun und beschränke mich auf nothwendigste Vorlesungsthätig || keit; um wie viel lieber würde ich wissenschaftlich thätig sein, wenn ich dazu mir die nöthige geistige Frische hätte!

Ihre grosse Abhandlung zur Functionenlehre¹¹³ erhalte ich heute und danke Ihnen tausendmal für die Uebersendung. Hoffentlich komme ich bald dazu, sie gründlich zu studiren. Ich freue mich herzlich, dass Sie damit endlich fertig geworden sind und danke Ihnen auch für die vielen freundlichen Erinnerungen an meine Kleinigkeiten. Sollten Sie wirklich die grosse Reise nach Algier angetreten haben so hoffe ich, dass Sie dieselbe glücklich zurücklegen werden.

3 || Meine Frau und Kinder befinden sich wohl.

Leben Sie herzlich wohl und, wenn Sie Zeit finden, erfreuen Sie gelegentlich mit Nachrichten.

Ihrem
treu ergebenen Freund
G. Cantor.

Bitte mich auch Ihrer Frau Gemahlin bestens zu empfehlen.

DOCUMENT IV. *Extract of letter from Schwarz to E. R. Noevius, 13 October 1888: Cantor's reaction to the professorship at Göttingen.*¹¹⁴

As opposed to Cantor, who drafted out his letters in a *Briefbuch*, Schwarz made copies of his final versions in a *Copiebuch* by some system of carbon copying: thus we read here the text as received by Noevius. We quote only the paragraph of the letter dealing with Cantor.

67

|| Göttingen, Weender Chaussee 17A,
den 13^{ten} October 1888.

Mein Lieber Freund!

..... Während des Endes des Monats September war ich einer dringenden Einladung der Herrn Professor Weierstrass gefolgt und nach Wernigerode gereist. Dort traf ich ausser Herrn Weierstrass Herrn Mittag-Leffler, Frau von Kowalewski und die Herren Cantor und Hettner. Herr Cantor hat mir einen Auftritt veranlasst, der die unangenehmstern Folgen zu haben schien; er wurde von Herrn W. auf das entscheidenste verurtheilt, mir gegenüber. Näheres entzieht sich einer schriftlichen Mitteilung, denn scripta littera manet.

¹¹³ G. Mittag-Leffler, 'Sur la représentation analytique des fonctions monogènes uniformes d'une variable indépendante', *Acta Math.*, 1884, 4, 1-79.

¹¹⁴ Berlin/Schwarz, *Copiebuch* 4, pp. 67-70. For discussion of this document in our narrative, see foot-note 42 and text.

Wenn Sie mich wieder einmal besuchen, können wir vielleicht über die Sache reden. Die Ursache, weshalb Herr C. auf mich so erbosst ist, ist ganz einfach, dass er nicht den Ruf nach Göttingen bekommen hat und sein Benehmen war ganz unqualifizirbar. Als die Explosion erfolgte, hatte er sich wohlweislich gedrückt und ist dann bald abgereist; er hat es seiner bekannten Gemuthsverfassung zuzuschreiben, dass er nicht eine ausgesprochene Zurechtweisung erhielt; aber ich breche hiervon ab, da er zu unerfreulich ist. Nach der Abreise des Herrn Cantor blieb ich noch einige Tage in Wernigerode und hatte unter Anderem mit Herrn Prof. Weierstrass, Herrn M. Leffler und Frau von Kowalewski noch einige sehr interessante wissenschaftliche Unterhaltungen

DOCUMENT V. *Letter from Cantor to Dr. Graf von Posadowsky-Wehner, 10 November 1899: the request for a new appointment.*¹¹⁵

The Count A. A. von Posadowsky-Wehner was a state secretary in the Ministry of the Interior and also representative of the Chancellery and the Ministry of State. Cantor's writing is very flowery and excited, especially on the last page where he also filled the margins with his final sentences. He wrote from Berlin, and from his letter it is clear that he had meetings with officials over his request.

- | | | |
|----------|---|---------------|
| fol. 146 | C. Berlin An der Nicolaikirche № 4-5 ^{II} Hochwohlgeborener Herr Graf, In der Ew. Excellenz Hände habe ich mein Gesuch um geeignete Verwendung im diplomatischen Dienst Sr. Majestät des Königs von Preussen, Kaiser Wilhelm II von Deutschland | 10 Nov. 1899. |
| fol. 147 | gelegt und danke Ew. Excellenz dafür, dass Hochdieselben es nicht abgelehnt haben, meine Bitte Sr. Durchlaucht den Herrn Reichkanzler Fürsten von Hohenlohe vorzutragen. Ew. Excellenz erlaube mir noch die private Erklärung, dass ich keine aeusseren Ehren oder Belohnungen zu erstreben habe; eine schlichte Bibliothekarstelle ohne hervortretenden Titel würde mir am meisten zusagen. Auch das Gehalt brauchte nicht erheblich höher, als mein jetztiges zu sein. Nur um meinen aus eigener Machtvollkommenheit | |
| fol. 148 | | |

¹¹⁵ *Merseburg/Halle Univ.*, no. 34, vol. XX, ff. 146-149. For discussion of this document in our narrative, see foot-note 74 and text.

fol. 149

gethanen Schritt vor meiner theuren Gattin gerechtfertigt erscheinen zu lassen (die naturgemäss die Geburtsstadt ihrer lieblichen Kinder nur höchst ungern verlassen würde und von meinen unabänderlichen Entschlusse, den deutschen Profess || orenstand unter allen Umständen aufzugeben, noch nichts weiss) würde es sich, im Falle Gewährung meines Gesuchs, vielleicht empfehlen, *mit der Verwendung oder Anstellung einen einfachen Geheimrathstitel zu verfinden*. Zu Ew. Excellenz Information möchte ich noch hinzufügen, dass ich in den letzten fünfzehn Jahren *die Frage der Autorshaft der Shakespeare-dichtungen bis auf dem innersten Grund gelöst habe*, und zwar zu Günsten von Baron von Verulam, Vicegrafen von St. Alban (Francis Bacon) und dass ich gleichzeitig historischen Erkenntnissen über *die ersten Könige von Grossbritannien* gelangt bin, welche die englische Regierung in einen *heilsamen Schrecken unfehlbar setzen werden, sobald die Sache publicirt sein wird*. Genehmigen Sie, Hochgeborener Herr Graf, den Ausdruck ehrerbietigster Hochschätzung.

Ihres ergebensten Dieners
Georg Cantor.

DOCUMENT VI. *Visiting cards from Cantor to the Ministry, November, 1899: biographical details.*¹¹⁶

It is not absolutely certain to whom these cards were addressed or when they were written, but, as they are catalogued immediately prior to Document V above, it is quite likely that they accompanied that letter to Count von Posadowsky-Wehner. On folio 142 Cantor incorporates his printed name on the card into his text, and we have set it centrally in our rendition: otherwise he wrote with vigour on either the reverse or on both faces of each card, and sometimes in the margins. Some of the cards give his name, address and appointment, but the card mentioned above is one of those which carries only his name.

fol. 136

|| Personale

des

Dr. Georg Cantor.

Ordentl. Professor d. Mathematik

a. d. Univ.

Halle-Wittenberg

fol. 137

|| geb. 19 Febr. alten Styls 1845 in St. Petersburg.

Mein Vater ein geborener Däne aus Kopenhagen kam als Kind nach St. Petersburg, war altlutherisch und siedelte aus Gesundheitsrücksichten 1856 nach Süddeutschland, zuletzt Frankfurt a/Main. Er starb, im Jahre 1863 in Heidelberg, wo er begraben ist. Meine sel.

¹¹⁶ *Merseburg/Halle Univ.*, no. 34, vol. XX, ff. 137–145 verso. For discussion of this document in our narrative, see foot-note 75 and text.

- fol. 138 Mutter Maria geb. Böhm, eine in St. Petersburg geborene Ungar. Deutsche || (N. B. Forts. I) war röm. Katholisch, lebte seit Herbst 1863 mit ihren Kindern in Berlin (zuletzt in der Schellingstr.), wo sie im Herbst 1896 gestorben ist; sie ruht auf dem St. Hedwigs-kirchhofe hier. Ihr Vater Louis Böhm war Violinvirtuose, ebenso ihre Mutter Maria geb. Marowek Violinvirtuosin an der Kais. Hofoper in St. Petersburg unter Czar Nikolaus I. || (N. B. Forts. II) Ihre Stiefmutter Frau Sophie Böhm, geb. Marowek, ebenso Ihre Tante Frau Justine von Czerwena geb. Marowek waren beide in langjährigen Diensten der Kaiserl. Russischen Dynastie als treu Kammerfrauen Ihrer Kais. Hoheit, der Grossfürstin Maria Nikolajewna, die in erster Ehe mit einem Fürsten von Lauchtenberg in zweiter mit einem Grafen Stroganoff verheiratet war. || (N. B. Forts. III) Mein jüngerer Bruder Constantin Cantor, der in Januar dieses Jahres in Capri gestorben ist, war Officier in einem Grossen Hessischen Dragonerregiment, hat im Kriege von 1870–71 mit Auszeichnung gekämpft. Er zog nach seiner Verheirathung mit einer Baronesse von der Capellen sich als Rittermeister in's Privatleben zurück, verlor früh || (N. B. Forts. IV) seine Frau, blieb dann in Italien und heirathete später eine junge Capreserin, nach dem er sie in einem Kloster hatte erziehen lassen, die als Wittwe mit dem einzigen Töchterchen Assunta Maria in Capri lebt. Ich bin ebenso wie meine Frau Vally geb. Guttmann (aus Ratibor) und unsere sechs Kinder: Else, Gertrud, Erich, Anna-Marie, Margarethe, Rudolf, evangelisch! Unsere Ehe ist am 9 Aug. 1874 geschlossen worden. In Halle lebe ich als Univ. Lehrer seit 1869. Mein Gehalt als Prof.: 6000Mk. || z. Z. Adresse C. Berlin, An der Nikolaikirche 4–5^{II}. 10 Novemb. 1899.

F. Ph. L. Georg Cantor

- fol. 142 giebt sich die Ehre dem Königl Preuss. Ministerium der Auswart. Angelegenheiten seine Dienste als Historiker, auf || Grund funfzehn-jähriger Studien der Geheimgeschichte des 16^{ten}, 17^{ten} und 18^{ten} Jahrhunderts anzubieten. Ich bin jederzeit bereit, der Prüfung meiner Qualification mich zu unterziehen.

F. Ph. L. Georg Cantor.

- fol. 143 || (N. B. 1^{te} Fortsetzung.) Die Ursache meines Entschlusses, dem deutschen Professorenstande *definitiv* zu entsagen, habe ich vor einer Woche *ausführlich* dem Director dem Geh. Kanzler des Cultus-ministeriums Herrn Geh. Rechnungsrath Hess ausein- || ander gesetzt, durch den S. Excellenz der Kgl. Preuss. Kultusminister Herr von Studt orientirt ist. Die von mir nachgesuchte Audienz bei Sr. Excellenz wird *nach dessen Rückkehr* erfolgen.

- fol. 144 Ich bitte darum baldigst Herrn Geh. Rechnungsrath Hess zu vernehmen || (N. B. 2^{te} Forts.) Gehörsamte Bitte wenn möglich heute oder morgen über mein Gesuch zu entscheiden, da ich event. die Anwesenheit der Kais. Russ. Diplomatie in Potsdam-Berlin || benutzen würde, um als geborener Russe nach *dreiundvierzigjähriger* Abwesenheit von meiner alten geliebten Heimrath Sr. Majestät dem

Czaar Nicolaus II
meine diplomat.schen Dienste anzubieten.

- fol. 145 || der Geh. Rechnungsrath Hess, *vielmehr* der *Geh. Rechnungsrath Schulze*, Director des Central Bureaus im Cultusministerium ist meine
 fol. 145 Vertrauensperson.¹¹⁷ || In dem von mir eingereichten Gesuch findet
 verso sich eine irrthümliche Angabe nicht.

DOCUMENT VII. *Letter from Cantor to Klein, 31 December 1899: the death of Rudolf.*¹¹⁸

The handwriting of this letter is very spiky and shows the characteristic of Cantor's elated states of mind that it tends to rise up the page as the line progresses.

1

|| Halle a.d. Saale 31^{ten} Dec. 1899.

Lieber Freund und College,

Zugleich im Namen meiner Frau sende ich Ihnen, Ihrer Frau Gemahlin und dem jungen Brautpaar unsere herzlichen Glückwünsche zum grossen Ereignis in Ihrer Familie. Ich freute mich über die vorhin eingetroffene Nachricht von der Verlobung Ihrer ältesten Tochter umso mehr, als ich ja erst vor einigen Monaten Gelegenheit hatte, Sie im Kreise Ihrer blühenden Kinder nach längerer Zeit wiederzusehen. Wir sind vor vierzehn Tagen plötzlich in tiefste Trauer versetzt worden. Unser jüngster Kind *Rudolf* ist uns vier Tage vor seinem dreizehnten Geburtstage, auf dem Wege in einen Handarbeitsunterricht, dem er seit einiger Zeit besuchte, am 16^{ten} Dec. durch Herzschlag genommen worden. Ich war an jenen Tage zwecks || einer öffentlichen Vorlesung über die Bacon-Shakespearefrage im Hôtel zum Palmbaum in Leipzig, kehre am 9 Uhr Abends nach Hause zurück und erfahre, was uns um 3 Uhr Nachmittags widerfahren war. Der Junge war zwar in seinen ersten Jahren zart und schwächlich in Folge dessen unser Sorgenkind; allein seit sechs Jahren entwickelte er sich körperlich und geistig aufs Beste und war so liebevoll und liebenswürdig, dass er der ganzen Familie Liebling geworden ist. Er war ausserordentlich musikalisch begabt, daher ich mich der Hoffnung hingab, dass er in die Tradition meiner mütterlichen Familie *Böhm*, die aus Ungarn stammt, dereinst eintreten würde. Mein Grossvater *Franz Böhm* war ein grossartiger Violinvirtuose an der Kaiserl. Opernkapelle in St. Petersburg und dessen Brüder *Joseph Böhm*, mein Grossonkel ist der Begründer der modernen

¹¹⁷ Of the three officials named by Cantor in this letter, K. von Studt had newly been appointed *Kultusminister* (officially known as the *Minister der geistlichen, Unterrichts- und Medizinalangelegenheiten*), F. Hesse was the Director of the Chancery, and A. Schulze was the Director of the Central Bureau.

¹¹⁸ *Göttingen/Klein*, sect. VIII, letter 455. For discussion of this document in our narrative, see foot-note 78 and text.

3 Wiener Geigerschule und zählte Ernst, Hauser, Auer, Ed. Singer, G. Hellmesberger, Joachim, Rappoldi zu seinen Schülern. In Folge dessen habe ich selbst schon mit sechs Jahren angefangen Geige || zu spielen, brachte es darin auch ziemlich weit; nur der sonderbare Einfall, der mir in meinem sechzehnten Lebensjahre erkommen ist, ich weiss selbst nicht mehr wie, die Mathematik zu meinem Brotstudium zu machen, lenkte mich von diesem heitern Künstlerberuf ab und meine Violin liegt nun seit dreissig Jahren verlassen und verkümmert in ihrem staubigen Kasten, nur noch dazu da, um gelegentlich in mir den flüchtigen Zweifel zu wecken, ob ich nicht glücklicher geblieben wäre, wenn ich ihr die angestammte Treue bewahrt hätte. So entstand in mir der Wunsch, das nun *Rudolf* sich ganz der Musik widmen sollte, in der er schon in seiner Jugend das höchste Glück gefunden hatte—and nun ist auch diese Hoffnung hin!

4 In diesen Tagen schicke ich *Hilbert*, der mich seit lange dahin drängt, eine kurze Mitteilung für die „Nachrichten der Göttinger Ges. d. Wiss.“¹¹⁹ Es handelt sich um eine Sache, die ich schon lange habe, || eine Fortbildung, Klärung und in gewissem Sinne sogar Vollendung meines bisherigen Arbeit.

Den Grund meines Zögerns kennt *Hilbert*. Es waren Rücksichten auf einen sehr hochgeschätzten Collegen, mit dessen arithmetischen *Grundanschauungen* ich in diametralen Gegensatze stehe; dass wird durch diese Publication offenbar für jedermann werden.

Nun habe ich rücksichtsvoll diese Sache vor fünf Monaten demselben Collegen zuerst vorgelegt, in der Hoffnung, seine Einwände zu hören; er versprach mir auch, die Prüfung vorzunehmen und mir zu schreiben. Allein ich habe nicht von ihm zu hören bekommen.

Jedenfalls ist er durch mein offenes Handeln gründlichst auf die Publication des Gegensatzes vorbereitet und ich werde natürlich nicht verfehlten, *formel so zuvorkommend* zu blieben wie es einem um die Algebra und Arithmetik so verdienten Manne gegenüber, meine Pflicht ist.

Mit ergebenstem Gruss,
Ihr Georg Cantor.

DOCUMENT VIII. *Selected contributions by Cantor to circular notices of the Philosophical Faculty of Halle University, for its sittings of 30 May and 16 July 1902: protests against Faculty procedures.*¹²⁰

These two paragraphs from Cantor's contributions to Faculty administrative documents shows extremely well the doubtless exaggerated feelings of persecution which he felt upon himself from his colleagues. The handwriting is exceptionally vigorous, and words printed in heavy

¹¹⁹ There is no evidence that this paper was sent to Hilbert; but if it was, then it was certainly not published.

¹²⁰ *Halle/Circulare*, vol. 26. For discussion of documents of this type in our narrative, see foot-notes 72 and 85, and texts.

type here were underlined by Cantor three times. We note the reference at the end of the second quotation to Wissowa, who at this time was helping Cantor with the abortive second edition of his collection of the Rawley elegies.¹²¹

Dieses Protokoll erkläre ich heirmit für eine *dreiste Fälschung* des *Thatbestandes*, insofern als ein wesentlicher Theil unserer Facultätsverhandlung, nämlich *mein gestellter Gegenantrag* und *alle Thatsachen* und *Handlungen* welche mit ihm zusammenhingen, *offenbar absichtlich unterschlagen* werden, *unterschlagen* unter stillschweigender *Billigung aller Facultätscollegen*, die vor mir dieses Protokoll zu sehen bekommen haben.

Cantor.

Ich erkläre hiermit, dass ich die (ich weiss nicht von wem, vielleicht vom Ministerialdir. Althoff gestattete oder dekretirte) Abhaltung von Vorlesungen in diesen Sommersemester seitens *Nichtmitglieder* der Universität (nächstens werden sich *vielleicht Socialdemokraten* oder, was *noch schlimmer wäre Bismarksche Oddfellows*, oder *Hering'sche Simsas* dazu melden resp. Mitglieder der *weiblich-männlichen „Gemeinschaftsbewegung“* die doch durch Collegen „Uphues“, Collegen „Hering“ etc.¹²² hinreichend an unserer Univ. vertreten ist) prinzipiell nicht einverstanden bin, weil sie *entschieden ein Vergehen* gegen die *Kgl. Verordnung unserer Statuten* ist. Ich behalte mir vor, geeigneten Orts gegen diese Illegalität meinen *Protest einzureichen.*

Cantor.

P.S. Nach dieser Erklärung halte ich es nicht für nothig, mich an der vom verehrten College Wissowa verlangten Discussion d. Angelegenheit in d. Facultät zu betheiligen.

DOCUMENT IX. *Letter from Cantor to Jourdain, 29 March 1905: the writing of Ex Oriente Lux.*¹²³

Cantor wrote this letter in English, which we reproduce exactly. In 1915 Jourdain published his translation into English of Cantor's paper of 1895–97 on transfinite arithmetic, and in his introduction he quoted the sentence of the second paragraph concerning the meeting with

¹²¹ See foot-note 85 and text.

¹²² G. Uphues was an *ausserordentlicher Professor* of philosophy (with especial reference to psychology) in the Philosophical Faculty, while H. Hering was an *ordentlicher Professor* of practical theology in the Theological Faculty.

¹²³ Stockholm/Jourdain, note-book 1, p. 82. For discussion of this document in our narrative, see foot-note 88 and text. It appears also in I. Grattan-Guinness, 'The correspondence between Georg Cantor and Philip Jourdain' (forthcoming in *Jsbr. dtsch. Math.-Ver.*).

Weierstrass in 1873.¹²⁴ The handwriting in this letter is reasonably relaxed.

1

|| Naunhof bei Leipzig, 29. März, 1905.

My dear Mr. Jourdain,

It appears more probable to me, that the fatherly friend of my father, Mr. Charles Moberly, of whom I have a lively remembrance from my early youth, has been the *great grandfather* of your sister's friend Miss Moberly; but I know, that my father had most friendly and intimate relations also to the sons of old Ch. M. About the early developments of all my mathematical and metaphysical conceptions I will tell you all in detail, when we will meet together in England.

2

|| With Mr. Weierstrass I had good relations and I possess a most interesting correspondence with him, which I will show to you. Of the conception of enumerability of which he heared from me at Berlin on Christmas holydays 1873 he became at first quite amazed, but one or two days passed over, it became his own and helped him to an unexpected development of his wonderful theory of functions. In the captivity and solitude of the last winter (from 17 Sept. 1904 to the 1. March 1905) I have had an inspiration from above, which suggested to me a renewed study of our Bible with opened || eyes and with banishment of all previous preconceptions. So I received an unexpected enlightenment, which I put in the form of discourses between a Master and his disciple. The first of them I send you and hope to hear of your criticism about it. You can take this original into your possession, as your own because that I have a copy of it, made by one of my nieces.

3

With many kind regards

Yours sincerely

George Cantor.

4

I would be thankful, if you would translate the religious opuscule into Englisch and send me a copy of this translation.

In this spring I publish in the „Rendiconti || di Circolo matematico di Palermo“ a letter of Mr. Weierstrass to me, written the 26. Sept. 1891, of high scientific interest about the *solvability* of the problem of three material points moving after the Newtonian law in the form of analytical functions of the timequantity for the coordinates of the three points and you will hear from W., that he has send to Mr. Hermite and Mr. Mittag-Leffler copies of his demonstration for the *possibility* of such a solution of the problem, which had hitherto not succeeded to the pains of Mr. Poincaré.¹²⁵

¹²⁴ G. Cantor (trans. P. E. B. Jourdain), *Contributions to the founding of the theory of transfinite numbers*, Chicago, 1915, reprinted New York, 1955, p. 48.

¹²⁵ That is, G. Cantor (foot-note 93).

It is to be hoped, that Mr. MittagLeffler now will give to the public this remarkable performance of Weierstrass, hitherto unknown to all, except himself.¹²⁶

DOCUMENT X. *Letter from Cantor to Mrs. Young, 5 April 1905: Ex Oriente Lux and a visit to England.*¹²⁷

Like the previous letter to Jourdain, this one was also written in English, but its handwriting is markedly more agitated.

1

|| Naunhof, bei Leipzig, Götzestrasse,
5 d April 1905.

Dear Madam,

2

I am delighted to hear from you and yours. Has the book on Mengenlehre you had spoken of, from your husband yet appeared?¹²⁸ As you know, I had been hermetically secluded 5½ months (from 17 Sept to 1. March) from the world, except few visites from my family. But I can not say, that I am by this long fire-baptism embittered because I do know the great pressure, that has been practiced by the „Ministerium“ and the „amiable“ german || colleagues upon my wife and my children! Farther I had a great interest to study the quite unreasonable puerile treatment and soitdisant cure of the lamentable patients.

3

The Muse¹²⁹ afforded to me I employed to a renewed study of our Bible with opened eyes and postponing all prejudices. The result has been highly remarkable, as you will see by a little pamphlet (anonymous) of half a sheet, that I will || send you perhaps in a week; it is now in the printing office.

The title is:

„Ex Oriente Lux,
Gespräche eines Meisters mit seinem Schüler über
wesentliche Puncte des urkundlichen Christenthums.
Berichtet vom Schüler selbst.“

Erstes Gespräch.

4

I am longing for England and hope, that it will become possible to go then for several months in this spring, because, that I have no want to recommence my mathematical lectures in Halle in the next Sommersemester.

|| With many kind regards to you and all yours

Sincerely

yours

George Cantor.

¹²⁶ Mittag-Leffler published several letters from Weierstrass of the years 1883–89, as well as some manuscripts, on this problem in his ‘Zur Biographie von Weierstrass’, *Acta Math.*, 1912, 35, 29–65; and another note in ‘Eine Äusserung von Weierstrass an Mittag-Leffler über das Dreikörperproblem’, *ibid.*, 1923, 39, 257–258.

¹²⁷ London/Young. For discussion of this document in our narrative, see foot-note 89 and text.

¹²⁸ The book did not appear until 1906: the reference is given in foot-note 54 above.

¹²⁹ Cantor may be thinking here of the German word *Musse*—leisure.

APPENDIX. *The principal missing collections of documents concerning Cantor.*

We list below the most important sources of material concerning Cantor's life and work which we have so far been unable to trace. We describe their history as far as we can, and we would be most grateful for any information on their present location.

1. *Cantor's personal papers.*

Cantor kept all his personal documents, down even to the most fragmentary notes; and after his death in 1918 they were all retained by the family in his house, although the rapidly deteriorating economic situation in Germany caused his children to negotiate the sale of his magnificent library in 1921 for the paltry sum of 90,000 Marks. His descendants have continued to live in his house until the present day, but his papers remained there only until 1945, when during the circumstances at the end of the war almost all of them vanished.¹³⁰ The fragments that were saved were augmented by donations of documents by various members of the family into the collection on which we have drawn for this study. If the rest of the papers were not burnt in 1945, it is possible that they were taken away and are now kept in an archive.

2. *The Cantor-Dedekind correspondence.*

The letters that were published were from a collection made by Dedekind, consisting of Cantor's letters to him and copies of some of his replies; and it was presumably he who put them in the library of the *Technische Hochschule* at Brunswick. They were first noticed by Fraenkel, who drew on them for his 1930 biography of Cantor: extracts from the letters of 1899 were published in the 1932 edition of Cantor's papers prepared by E. Zermelo,¹³¹ while extracts from those of the remainder that were written between 1872 and 1882 appeared in 1937 under the editorship of E. Noether and J. Cavaillès.¹³² According to letters from Miss Noether to Cavaillès, it was she who obtained the correspondence from Brunswick and with assistance copied out the mathematical parts that were eventually published.¹³³ She sent these copies to Cavaillès in Paris in March 1933, and apparently he prepared them for publication, inserted the foot-note references and obtained permission for the publication to take place; but at no time did he use the letters themselves. Meanwhile Miss Noether had left Germany for the U.S.A. and died there

¹³⁰ See M. Peters, *op. cit.* (foot-note 26), p. 11.

¹³¹ G. Cantor, *Abhandlungen*, pp. 443–451.

¹³² The reference is given in foot-note 19.

¹³³ Paris/Cavaillès, E. Noether to Cavaillès, 4 October 1932.

in 1935, and any papers that she may have left have been completely lost; but in any case it is hardly likely that she did other than return the letters to Brunswick. Their fate since then, however, is unknown. Dedekind's main papers were given to Göttingen University in 1931 by two of his nephews,¹³⁴ but the correspondence with Cantor was never put among them.

Fraenkel described the collection at Brunswick as consisting of 36 'items' (*Stücke*);¹³⁵ but the size of an 'item' is not clear, as Zermelo included extracts from five letters in his edition of Cantor's papers, and Miss Noether and Cavaillès quoted from 37 others as well as from a series of annotations of 1873 by Dedekind to Cantor's letters. In addition, it is clear from the letters to Cavaillès from Miss Noether and from one of Dedekind's nephews that there existed a few letters and cards from the years 1877, 1880–82, 1887, 1889 and 1891 which have not been published at all, and that in all the unpublished sections there were not only discussions of Dedekind's possible call to Halle and his help in overcoming Kronecker's delay of the 1877 paper on theory of sets, which we described in our narrative, but also some matters concerning Felix Klein; and in the first letter from Cantor in 1899 apparently he mentioned the long break in their correspondence.¹³⁶ Thus it is clear that this collection of documents is of especial importance to the story of Cantor's life. It seems possible that, in view of their use by Zermelo and Miss Noether apart from anyone else, they may now be in several separated sections. Although Zermelo possessed the 1899 letters for some time after the preparation of his edition of Cantor's works,¹³⁷ they are not now to be found in his own collection of papers.¹³⁸

3. Stäckel's notes of a lecture by Cantor in 1897.

After Cantor had resumed cordial relations with Dedekind at the Zurich Congress of 1897, he gave a lecture at Brunswick on 24 September 1897, of which P. Stäckel took a set of lecture notes. Fraenkel borrowed these notes from Stäckel's widow when he prepared his 1930 biography and from the references to them he made in his text it is clear that Cantor gave his own history of the theory of sets, including his

¹³⁴ Göttingen/Dedekind.

¹³⁵ A. Fraenkel, *loc. cit.* (foot-note 2), p. 265.

¹³⁶ Paris/Cavaillès, E. Noether to Cavaillès, 4 October 1933, 9 November 1932 and 12 March 1933; H. Dedekind to Cavaillès, 3 August 1932.

¹³⁷ According to Paris/Cavaillès, E. Zermelo to Cavaillès, 23 June 1932.

¹³⁸ Communication from the Universitäts-Bibliothek, 78 Freiburg im Breisgau, W. Germany, where they are now kept.

personal relations and the affair of the manuscript of 1884 that was never published.¹³⁹ When Cavaillès was studying Cantor's work he wrote to Fraenkel in 1931 asking where he could find these notes:¹⁴⁰ unfortunately Fraenkel's reply has not been preserved, but in any case Cavaillès did not refer to the notes in his own writings and so presumably did not use them. We ourselves are hoping for greater fortune, but our enquiries to find manuscripts of Stäckel have so far been unsuccessful. Fraenkel referred neither to the notes nor to the Cantor–Dedekind letters in his autobiography.¹⁴¹

4. *The Cantor–Althoff correspondence.*

Among the few missing documents in the voluminous papers of F. Althoff are the letters he received from Cantor.¹⁴² These would be especially valuable for an assessment of Cantor's role in educational and university developments around the turn of the century and of his relations with the Ministry.

5. *Other collections of letters.*

We refer here in general to collections of letters that may have been preserved by some of many correspondents: his letters to fellow mathematicians are especially important. We have already drawn on some such collections for this study and have noted other smaller collections in the same archives; but there may well survive important sources in other locations. We have not yet found any, and their detection is hampered by the fact that the papers of many of his contemporaries were either not kept or else lost or destroyed: thus there appears to be few papers for Hermite, Kronecker, Kummer, Poincaré or Weierstrass, while Schönflies's were destroyed by bombing during the last war. But further information on these sources, both positive and negative, would be welcome.

¹³⁹ A. Fraenkel, *loc. cit.* (foot-note 2): see his reference to the documents on pp. 265–266, and his allusion to the manuscript on p. 213. The manuscript is also referred to in his *Abstract Set Theory*, 3rd edn., Amsterdam 1966, pp. 1–2 and 249; but in both cases Fraenkel asserted that the rejected paper was the first part of the 1895–97 paper that we cited in foot-note 50 above. Thus either Fraenkel misunderstood Stäckel's notes, or Stäckel misunderstood Cantor's lecture, or Cantor himself was obscure on the point.

¹⁴⁰ The letter is published in G. Ferrières, *Jean Cavaillès, philosophe et combattant*, Paris, 1950, p. 75.

¹⁴¹ A. Fraenkel, *Lebenskreise. Aus den Erinnerungen eines jüdischen Mathematikers*, Stuttgart, 1967.

¹⁴² They should be in *Merseburg/Althoff*, sect. B, no. 21: one letter from Cantor does survive in sect. B, no. 198, vol. 1, ff. 116–117, and drafts of two others in *Nachlass Cantor*, VIII, pp. 40 and 131–133.

INDEX OF NAMES

We give here the names and dates of those persons given more than incidental mention in the main text. We also indicate the relationships to Cantor.

- Althoff, Friedrich Theodor (1839–1908)
Bacon, Francis (1561–1626)
Bell, Eric Temple (1883–1960)
Böhm, Franz Louis (1798–1846) (*Grandfather*)
 Joseph (1795–1876) (*Great Uncle*)
 Maria (1798–1866) (*Grandmother*)
Borel, Emile Felix Edouard Justin (1871–1956)
Burali-Forti, Cesare (1861–1931)
Cantor, Anna-Marie (1881–1920) (*Daughter*)
 Constantin Carl (1849–1899) (*Brother*)
 Else (1875–1954) (*Daughter*)
 Erich (1879–1962) (*Son*)
 Georg Ferdinand Ludwig Philipp (1845–1918)
 Georg Woldemar (1814–1863) (*Father*)
 Gertrud (1877–1956) (*Daughter*)
 Louis (1846–1870) (*Brother*)
 Margrete Friederike (1885–1956) (*Daughter*)
 Maria Anna (1819–1896) (*Mother*)
 Moritz Benedikt (1829–1920)
 Rudolf (1886–1899) (*Son*)
 Sophie (1848–1931) (*Sister*)
 Vally Maria Sophie (1849–1923) (*Wife*)
Cavaillès, Jean (1903–1944)
Darmstaedter, Ludwig (1846–1927)
Dedekind, Julius Wilhelm Richard (1831–1916)
Enneper, Alfred (1830–1885)
Fraenkel, Abraham Adolf Halevi (1891–1965)
Gerbaldi, Francesco (1858–1935)
Hadamard, Jacques Salomon (1865–1963)
Heine, Eduard Heinrich (1821–1881)
Hering, Hermann (1838–1920)
Hermite, Charles (1822–1901)
Hesse, Franz Traugott (1845–1907)
Hettner, Georg (1854–1914)
Hilbert, David (1862–1943)
Hurwitz, Adolf (1859–1919)
Jordan, Marie Ennemond Camille (1838–1922)
Jourdain, Philip Edward Bertrand (1879–1919)

- Klein, Christian Felix (1849–1925)
Kowalewski, Sonja von (1850–1891)
Kronecker, Leopold (1823–1891)
Kummer, Ernst Eduard (1810–1893)
Lebesgue, Henri Leon (1875–1941)
Lejeune-Dirichlet, Peter Gustav (1805–1859)
Lobachevsky, Nicolai Ivanovich (1793–1856)
Mertens, Franz Carl Joseph (1840–1927)
Meschkowski, Herbert (1909–)
Mittag-Leffler, Magnus Gustav (1846–1927)
Noether, Emmy (1882–1935)
Noevius, Eduard Rudolf (1851–?)
Poincaré, Jules Henri (1854–1912)
Posadowsky-Wehner, Count Arthur Adolf von (1845–1932)
Randolph, Thomas (1605–1635)
Rawley, William (1588?–1667)
Riemann, Georg Friedrich Bernhard (1826–1866)
Russell, Hon. Bertrand Arthur William, Later Lord (1872–1970)
Schönflies, Arthur Moritz (1853–1928)
Schulze, William Martin August (1853–1911)
Schwarz, Karl Hermann Amandus (1843–1921)
Shakespeare, William (1564–1616)
Stäckel, Paul Gustav (1862–1919)
Studt, Konrad von (1838–1929)
Taylor, Alfred Edward (1869–1945)
Tolstoy, Leo (1828–1910)
Uphues, Goswin Karl (1841–1916)
Voss, Aurel (1845–1931)
Wangerin, Albert (1844–1933)
Weber, Ernst Heinrich (1842–1913)
Weierstrass, Karl Theodor Wilhelm (1815–1897)
Whitehead, Alfred North (1861–1947)
Wissowa, Georg (1859–1931)
Young, Grace Chisholm (1868–1944)
Young, William Henry (1863–1942)
Zermelo, Ernst (1871–1953)

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¹⁴³ See foot-notes 40, 82, 85, 99, 102 and 138.