The Challenge of Editing Einstein’s Scientific Manuscripts

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Abstract

Einstein’s research manuscripts provide important insights into his exceptional creativity. At the same time, they can present difficulties for a publication in the documentary edition of the Collected Papers of Albert Einstein (CPAE). The problems are illustrated by discussing how some important examples of Einstein’s research manuscripts have been included in previous volumes of the CPAE series: his Scratch Notebook from the years 1910–1914, his so-called Zurich Notebook from 1912, documenting his early search for a generally covariant theory of gravitation, and the Einstein-Besso manuscript from 1913, containing calculations of Mercury’s perihelion advance on the basis of the Einstein-Grossmann equations. Another category of research notes are small and disconnected “back-of-an-envelope” calculations. A major challenge for future volumes of the CPAE series are Einstein’s Berlin and Princeton research manuscripts on a unified field theory. This batch of some 1700 undated manuscript pages presents a formidable challenge also for historians of science. Although the web provides new possibilities for the editorial task, such as the publication of facsimiles on the Einstein Archives Online website, it is argued that a satisfactory solution of the editorial problems posed by these manuscripts depends on scholarly efforts to reconstruct and understand the content of Einstein’s manuscripts.

1 The Einstein Papers Project

The Einstein Papers Project is a long-term editorial project devoted to publishing the Collected Papers of Albert Einstein (CPAE).1 The first volume was published by Princeton University Press in 1987 [CPAE1], followed by eight

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1For general information about the Einstein Papers Project, see the “Publisher’s Foreword” and the “General Introduction” in Volume 1 of the series [CPAE1], as well as [Bailey 1989, Stachel 1987, Buchwald 2004]. The project’s website is at www.einstein.caltech.edu.
more volumes to date CPAE2 – CPAE9. To complete the series, some twenty more volumes are anticipated during the next 30–40 years. The documentary edition of the CPAE is supplemented by an English translation series. In addition to these publications in book format, the project has launched a website jointly with the Albert Einstein Archives of the Hebrew University of Jerusalem. Known as Einstein Archives Online (www.alberteinstein.info), the site presently provides over 3,000 high-quality facsimiles from Einstein’s autograph writings, a finding-aid to the Albert Einstein Archives, and an itemized database of some 43,000 records.

The editorial project draws on the collection of the Albert Einstein Archives. The core of the archives was put together in Princeton after Einstein’s death by his long-time secretary Helen Dukas who acted as archivist in a devoted effort until her death in 1982. The “Dukas collection” comprises some 43,000 documents. The collection was microfilmed into 61 reels during the seventies, and a hardcopy duplicate archive was produced from the microfilm and collated with the originals for editorial purposes. Following Einstein’s will which bequeathed his literary estate to the Hebrew University of Jerusalem, the collection was shipped to Jerusalem after Helen Dukas’s death, and has been housed since then at the Jewish National and University Library. Since 1982 some 20,000 additional documents have been collected both by curators of the Albert Einstein Archives and by editors of the CPAE. These documents, mostly hard-copies from archives all over the world, were added to the original collection in a supplementary archive.

The documentary edition of the CPAE publishes all of Einstein’s scientific writings, both published and unpublished, as well as drafts, notebooks, scientific and personal correspondence, in chronological order. With the exception of the first volume, covering the early years 1879–1902, the published volumes have been divided into a Writings series CPAE2 CPAE3 CPAE4 CPAE6 CPAE7 and a Correspondence series CPAE5 CPAE8 CPAE9. The editorial method follows rigid standards of documentary editing. In the Writings volumes, published items are reproduced in facsimile; comparisons to drafts or versions are examined and detailed in the footnotes. Unpublished materials are transcribed, maintaining substantial faithfulness to the original text. No silent corrections of typographical or other errors are applied, and punctuation and style are reproduced, while errors of fact or calculation are explained in the annotation. Specific references to persons, places, literature, scientific developments, organizations, and events are identified. Details of the annotation follow the general aim of “bridging the gap” of knowledge familiar to the author or intended audience and that of contemporary readers. An introduction to each volume and various editorial headnotes analyze major themes in Einstein’s life and work.

²Hence archival call numbers for items of the Einstein Archives are of a two-number format, e.g. 3-006, where the first number indicates the reel and the second number the sequentially numbered document in that reel.

³A detailed account of the editorial method is given in toto in CPAE1 with volume-specific supplements in subsequent volumes. Beginning with CPAE5 the full editorial method is reproduced in each volume.
The website *Einstein Archives Online* presently publishes high-quality facsimiles of all of Einstein’s autograph writings extant in the original Dukas collection. Presently, no correspondence is included, nor does the website present typescripts or third-party documents. Eight important autographs whose facsimiles are provided on the site but that are not part of the AEA belong to the Schwadron and Yahuuda Collections held at the Jewish National and University Library. The website also presents PDF versions of those 39 documents in the published volumes of the CPAE for which autographs are also presented in facsimile.

In addition to the original documents, the website provides a finding-aid to the original Einstein Archives. The finding-aid provided on the website is an HTML transform using XSL style sheets from an XML file incorporating the Encoded Archival Description (EAD) markup.\footnote{The EAD Document Type Definition (DTD) is a standard for encoding archival finding aids using the Standard Generalized Markup Language (SGML) and is maintained in the Network Development and MARC Standards Office of the Library of Congress, in partnership with the Society of American Archivists.}

The itemized archival database that is made accessible on the website is a subset of a master archival database that is jointly maintained by both the Albert Einstein Archives and the Einstein Papers Project. It provides basic information on author, receiver, dating, title, language, location, and physical description of a document. If applicable, the database also provides publication information in the CPAE. The archival database covers all items of the original Dukas collection plus those items of the “supplementary archives” that have already been published in the CPAE series (634 records). The archival database information displayed on the website is intended to facilitate general access to the holdings of the Einstein Archives. In contrast to the editorial apparatus in the documentary edition, where every effort is made to check the accuracy of any information against the original sources, no guarantee is given as to the accuracy, consistency, or completeness of the information displayed in the database records. In fact, the database records are continuously revised and periodically updated as additional research is carried out at both the Albert Einstein Archives and the Einstein Papers Project.

Neither the *Collected Papers of Albert Einstein* nor the *Einstein Archives Online* is concerned with non-textual material in the strict sense. The Einstein Papers Project does not edit any audio material unless as transcripts, nor does it include pictures or images, other than select images for illustrative purposes. There are no concerns about material witnesses like experimental setups, astrographical plates, or the like. There is, however, a category of textual material that is of central importance for the edition and that defies to some extent standard procedures of documentary editing, i.e. Einstein’s research manuscripts.
2 Einstein’s Scientific Manuscripts

Albert Einstein (1879–1955) is a household name, a synonym for scientific creativity and responsibility. He was honored as “person of the 20th century” by *TIME* magazine. In 2005, all over the world numerous conferences, lectures, exhibitions, and other events are being planned for the centennial anniversary of his “miracle year.” It was in 1905 when Einstein, an unknown technical expert at the Swiss Federal patent office in Bern, published, within a few months, a series of five papers, each of which had a profound and lasting impact on the development of twentieth century physics. The papers deal with the determination of molecular dimensions, give an explanation of the phenomenon of Brownian motion, expound what we now call the Special Theory of Relativity, including the equivalence of mass and energy captured in the famous equation $E = mc^2$, and present an explanation of the photoelectric effect by putting forward the light quantum hypothesis. The latter contribution alone later earned Einstein the Nobel Prize for 1921.

Ten years later, Einstein had risen up through the ranks of academic hierarchy as *Privatdozent* in Bern, Extraordinary and Full Professor in Zurich and Prague, and in 1914 had accepted a position without teaching obligations as member of the Prussian Academy of Science in Berlin. It was then that Einstein crowned his earlier scientific contributions with another conceptual breakthrough that came after years of strenuous efforts to generalize the special theory of relativity to include gravitation. The General Theory of Relativity was completed with the publication of generally covariant field equations of gravitation in late 1915. It is these equations that even today are the basis for extensive research, both theoretical and experimental, e.g. with respect to finding evidence for gravitational waves.

In addition to his major contributions of 1905 and 1915, Einstein published numerous papers of significant importance in various fields of physics. These papers include theoretical investigations into the foundations of kinetic theory, statistical physics and radiation theory, work on the law of photochemical equivalence, on the specific heat of solids at low temperatures, on the phenomenon of opalescence, on the so-called Einstein-De Haas experiment to determine the relationship between magnetic moments and moments of inertia, a number of critical investigations into the foundations of quantum physics, and some ground-breaking investigations into the consequences of general relativity, such as gravitational waves, cosmological consequences, equations of motion, and gravitational lensing. During his later years, Einstein worked intensely on the problem of finding a unified field theory of gravitation and electromagnetism that would also account for the structure of matter and the quantum phenomena.

Given Einstein’s exceptional significance as a highly creative, successful, and productive scientist, a natural and significant interest for an edition of his works

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5 The papers are reprinted as facsimiles with extensive editorial annotation as Docs. 14, 15, 16, 23, and 24 in [CPAE2]. As an off-shoot of the editorial project the papers are also available, in English translation, as [Stachel 1998].
arises from the wish to better understand the working and circumstances of his productivity. His burst of creativity in his miracle year still provides a major challenge for a historical reconstruction that would in some sense explain his creativity of this year. Unfortunately any such attempts are hampered by the scarcity of documentary evidence even after publication of the respective volumes of the CPAE series [CPAE1, CPAE2, CPAE5]. The situation is much better for Einstein’s search for a General Theory of Relativity where much more pertinent documents have survived and are now available. It is in the context of the attempt to come to a better historical understanding of Einstein’s thinking that his research manuscripts acquire a special importance.

The term “research manuscript” here refers to a document that was written in the creative process of thinking about a scientific problem, mainly for the purpose of developing one’s own thoughts and of realizing implicit consequences inherent in a mathematical formalism. The manuscripts are written without any potential audience or readership in mind, other than the author himself. If the creative work involves two individuals that are collaborating, the manuscript may serve for communication between the researchers. A common characteristic of research manuscripts in Einstein’s case is an abundance of mathematical formulae without, or with only very few, explicit words. In most cases, the manuscripts are not dated, neither explicitly nor indirectly. In many cases, the calculations are on single sheets of paper but in a few cases they are contained in bound notebooks.

Research manuscripts are the most immediate written evidence of a creative process since they are produced without further reflection during that process. Later stages of writing about a scientific topic tend to be more organized or organized differently, and to the extent that the composer of the manuscript is aware of his addressing a potential audience, he begins to explicate the tokens of the abstract formalism and tries to convey the meaning of the mathematical expressions by linking it with words of natural or scientific language.

Given the significance of the creative process in Einstein’s case, his research manuscripts carry a unique value for historians of science. At the same time, they often pose a problem for the explicit rules of editorial procedure laid out in the editorial method. These problems pertain most importantly to the uncertainty of dating and to the uncertainty of the coherence and sequence of calculations.

In the following I will discuss four examples of research manuscripts that have already been published in the Collected Papers of Albert Einstein and one example of a batch of research manuscripts that poses a formidable problem for future volumes of the series.

2.1 Einstein’s Scratch Notebook, 1910–1914?

The first Writings volume of the CPAE series covers the years 1902–1909 [CPAE2]. It thus contains his very first published papers, all of his famous publications

6For a general perspective on the significance of research notes and notebooks for the history of science, see Holmes et al. 2003.
from his annus mirabilis 1905, as well as all later publications that he wrote while working at the Patent Office in Bern. Sadly, no manuscripts from this period are extant and all documents of this volume are reprinted facsimiles of his publications.

This situation changes with Volume 3 [CPAE3] which covers the years 1909–1911 when Einstein accepted his first call as an Extraordinary Professor at the University of Zurich and, a little later, another call as Full Professor at the German University of Prague. This volume reprints some twenty published documents but also publishes seven manuscripts. Most of these posed no problem for the editorial method. Three items are lecture notes that Einstein wrote in preparation of academic courses which he had to give as a professor in Zurich and Prague or for a lecture that he gave in Zurich in 1911. Two items are short manuscripts: one was a written response to a paper by Planck, another one was a statement written in response to a request by the Berlin autograph collector Darmstaedter. Another item are handwritten discussion remarks following lectures delivered at the first Solvay Congress in late 1911. These manuscripts, in each case, are perfectly coherent and datable documents.

The one research manuscript included in Volume 3 that did pose a problem to the editors was eventually printed in the appendix. The editors preface this appendix by the following comments:

This notebook was probably purchased by Einstein in 1909 when he began his appointment at the University of Zurich. It bears a sticker of the Zurich stationer Landolt and Arbenz. The last entries suggest that Einstein did not use the notebook after taking up a position in Berlin in 1914. The disparate nature and discontinuity of entries (e.g., diagrams, equations, notes on appointments, references to scientific literature, and addresses), as well as their disjointed chronological sequence, argue for preserving unity in the presentation of this notebook. It is printed here in its entirety in facsimile, with accompanying pages of transcription to make it readily accessible. [CPAE3, p. 563]

The notebook is then presented with facing pages in such a way that the top half of each page of the volume presents the facsimile of two facing pages of the Scratch Notebook. Below the facsimile, on the bottom half of each page, a conformal transcription of the page is given. Following the notebook, the editors provide a descriptive note and a list of the literature referenced in the notebook, in the order of appearance.

The context of a few significant pages of this scratch notebook that clearly contain research calculations was identified some time after its publication in the CPAE [Renn et al. 1997, Renn and Sauer 2003a]. It was shown that eight pages of the Scratch Notebook contain calculations that are fully equivalent to calculations that were only published by Einstein in 1936—some 24 years later—in a paper on what is now known as gravitational lensing (see Fig. 1).

The differences amount to mere differences of mathematical notation, and the pages could be dated, by reference to neighboring pages and historical con-
Figure 1: Einstein’s Scratch Notebook, 1910–1914?, was reproduced as facsimile with accompanying conformal transcription in [CPAE3, App. A]. This page [CPAE3, p. 585] shows Einstein’s earliest calculations about gravitational lensing. For a high-quality facsimile, see Doc. 3-013, images 23 and 24, of Einstein Archives Online at www.alberteinstein.info. © The Hebrew University of Jerusalem, Albert Einstein Archives.
text, to a week in April 1912. The reconstruction also confirmed a feature that was evident to readers of the documentary edition only through the descriptive note. One page of the notebook was a loose page inserted within the bound pages and was facsimilized together with the pages where it was physically found. It nevertheless contained a part of the calculation that was independent from the flow of the calculation in the bound part of the notebook. The phenomenon of gravitational lensing was first observationally confirmed in 1979 and today presents a highly active field of modern astrophysical research.

2.2 Research Notes on a Generalized Theory of Relativity

Volume 4 of the CPAE series covers the writings of the years 1912–1914, up until Einstein’s move to Berlin in April 1914 [CPAE4]. It is a period in which Einstein is deeply involved in a search for a generalized theory of relativity and a theory of gravitation. This search produced two research manuscripts that posed new problems for the editorial method. One is a bound notebook with research notes by Einstein, dealing mainly with the theory of gravitation. It is commonly referred to as the “Zurich Notebook” because it dates from Einstein’s time as a professor at the ETH Zürich. It documents Einstein’s search for a gravitational field equation from the first insight into the significance of the metric tensor in summer 1912 until he settled on a preliminary theory of gravitation that he published together with his friend and colleague Marcel Grossmann in an Entwurf, i.e. “Outline” of the theory of spring 1913 (see [CPAE4, Doc. 13]).

The other one is a research manuscript consisting of loose sheets, written partly by Einstein, partly by his friend and collaborator, Michele Besso, and deals with the problem of calculating the motion of the perihelion of Mercury on the basis of the preliminary Entwurf theory of gravitation.

The significance of the Zurich Notebook for a detailed understanding of Einstein’s path towards a general theory of relativity was first realized by John Stachel in the course of preparing the editorial project of the CPAE. It was then studied by John Norton who based some decisive arguments in his groundbreaking 1984 account of Einstein’s search for his gravitational field equations on a reconstruction of some pages of this document [Norton 1984]. While the content of a major portion of this notebook was thus clearly identified as dealing with the problem of gravitation and could be related on the basis of content and idiosyncratic notation quite unambiguously to Einstein’s publications between summer 1912 and spring 1913, many problems remained. Norton had based his 1984 account only on a reconstruction of a few individual pages of the notebook, and although some pages in the later part of the notebook could be reconstructed as coherent calculations that extended over several pages, the majority of the entries were still unidentified. Two other problems arose. First, entries were made in the bound notebook starting at two ends, with one page showing entries from both sides where the flows of entries met. This fact as well as indications of later corrections made a determination of the sequence of entries ambiguous despite the fact that the pages have a natural sequence in the bound notebook. Second, about a third of the entries in the notebook were apparently not dealing
with gravitation but with other problems of statistical physics and radiation
theory. Despite efforts by the editors to reconstruct the meaning of these parts
of the notebook, they remained unidentified.

The editors of Volume 4 of the series decided to publish only that portion
of the “Zurich Notebook” that deals with gravitation, and only mentioned and
briefly described the other part of the notebook in the descriptive note [CPAE4,
Doc. 10]. The part that deals with gravitation theory was presented in confor-
mal transcription. In order to facilitate access to the manuscript, the document
was prefaced by an editorial note that elaborates on the context and content
of the research notes. In a slight deviation of the general rules of presentation,
explanatory notes to the text were printed as footnotes rather than endnotes.
The annotation is sparse but does provide some information pertaining to a re-
construction of the calculations, reflecting the degree of understanding obtained
by the editors at that time.

The significance of the Zurich Notebook for the history of science lies in the
fact that it allows for unique insights into a crucial period of Einstein’s path
towards a general theory of relativity [Renn and Sauer 2003b]. The attention
that the notebook received in the course of preparing the pertinent volume of the
Collected Papers triggered a research effort of five historians of science, all of
them past or present editors of the project.7 The group embarked on a line-
by-line reconstruction of the gravitational parts of the notebook. They found
that it documents Einstein’s growing familiarity with an unknown formalism of
tensor calculus following his insight that the metric tensor would have to play
a crucial role in the formulation of the general theory of relativity. The notes,
in fact, document Einstein’s search for a gravitational field equation with the
investigation of a sequence of candidate equations that are being tested against
heuristic requirements. Among other things, it turned out that Einstein in-
vestigated the correct field equations of gravitation already in 1912, if only in
linear approximation, but at that time discarded them as unacceptable from a
physical point of view (see Fig. 2). The very same equations were nevertheless
published as the final field equations of gravitation in November 1915 [CPAE6,
Doc. 25], and this publication marks the breakthrough to the final theory of
general relativity, as we still accept it today. The reconstruction of this partic-
ular research notebook thus offers unparalleled insights into the considera-
tions of a creative scientific mind that were eventually crowned with remarkable suc-

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7See [Renn et al. forthcoming] and, for a preliminary account of results of this research
effort, [Renn and Sauer 1999].
Figure 2: Einstein’s so-called “Zurich Notebook” contains research notes on a relativistic theory of gravitation from the period of ca. August 1912 to spring 1913. This page shows “gravitational equations” (“Gravitationsgleichungen”) that are equivalent to the linearized form of the gravitational field equations of general relativity published by Einstein in late 1915. For a facsimile of this page, see Doc. 3-006, image 20, on Einstein Archives Online at http://www.alberteinstein.info; for an annotated transcription, see [CPAE4, Doc. 10, esp. pp. 247f.] © The Hebrew University of Jerusalem, Albert Einstein Archives.
notes. Among these documents the Zurich Notebook is perhaps the most elucidating but there are more research notes pertinent to this period. Another set of research manuscript pages that bears testimony to Einstein’s efforts of this period presented another editorial challenge to the editors of Volume 4 of the series. It is a document that consists of 51 manuscript pages plus additional text and calculations that were noted on a letter that Einstein received. This set of research notes deals with the problem of calculating the perihelion advance of Mercury on the basis of the Einstein-Grossmann Entwurf-theory of gravitation of summer 1913.

An anomalous secular advance of Mercury’s perihelion had been well established around the turn of the century, and since it could not easily be explained in the framework of Newtonian gravitation theory, this anomaly presented a touchstone for any alternative theory of gravitation. After settling on the field equations of his preliminary Entwurf-theory, Einstein set out to compute this problem together with his friend Michele Besso. The manuscript documents their collaboration. About half of the pages are written in Einstein’s hand, the other half in Besso’s hand. The manuscript consists of loose sheets and a determination of the proper sequence of the sheets presented a major problem of the editorial work. But the coherence of the notes made an almost complete reconstruction of the calculations possible and on the basis of this reconstruction a likely original sequence of the notes could well be established.

The full manuscript was presented in conformal transcription in Volume 4 [CPAE4, Doc. 14]. As in the case of the Zurich Notebook, the document was prefaced by an editorial note elaborating specifically on its context and content, and the pages were also annotated with footnotes rather than endnotes. In contrast to the Zurich Notebook the editors decided to complement the edition by a full facsimile of the manuscript in an appendix.

Again, this particular research manuscript was subject of intensive historical research. Its analysis helped explain why Einstein was very quick in computing the correct value of the perihelion precession two years later on the basis of his final field equations [Earman and Janssen 1993]. This question is an important aspect of the history of general relativity, since the successful explanation of the Mercury perihelion anomaly sealed Einstein’s breakthrough to general relativity in November 1915 and played an important role in convincing the physics community to accept the general theory of relativity.

No serious editorial challenges of this caliber were encountered for the other two Writings volumes that have already been published. Both volumes 6 and 7 also differ from earlier Writings volumes in that they present unpublished manuscripts by Einstein that are of a non-scientific nature, e.g. political statements. In addition to Einstein’s published papers, both volumes contain lecture notes, draft manuscripts intended for publications, and expert opinions. Volume 7 presents some small research manuscripts in an appendix [CPAE7 App. A] and [CPAE7 App. B]. Here five pages of calculations and graphical integration are reproduced in facsimile without further commentary, since they are clearly related to a published paper that is reprinted in the volume (Doc. 56). The five pages are identified as coming from different sources and are presented as
one document on the basis of their contentual relation to the published paper. The other manuscript appendix is a transcription of the first part of an autograph manuscript by Einstein’s collaborator Wander J. de Haas that de Haas attributes to Einstein as author together with a transcription of a page of calculations for this part in Einstein’s hand.

2.3 “Back-of-the-Envelope calculations”

Another category of research manuscripts that are encountered frequently in the Einstein Papers are small pieces of calculations or notes scribbled on the verso of letters, on the back of envelopes, etc. To the extent that these notes can be identified as being related to the main document they are either included in the edited text or transcribed, described, or discussed at the appropriate places in the annotation. In many cases, however, the notes defy a clear identification other than that they do not show any apparent relation to the main document. These research notes pose a problem particularly for the Correspondence volumes.

An example is given in Fig. 3. The calculations are found on the verso of
a letter by Anton Lampa, formerly a colleague of Einstein’s as professor at the
German University of Prague, who had recently accepted a position as Director
of Public Education at the School Department in Vienna. The letter discusses
a matter of appointment policy for a vacant chair in Vienna. The calculations
on the back are only mentioned in the descriptive note which reads:

On the verso of the document, Einstein calculated expressions in-
volving quantum numbers $n_1 = n$ and $n_2 = n + 1$ for a few values
of $n$, possibly related to Bjerrum’s explanation of rotational spectra
(see Doc. 335 and its note 9). [CPAE9 p. 397].

The calculations are too short to be identified unambiguously and they are
too short to be published separately either as a document of its own or in an
appendix. But the cross reference to another document in the volume indicates
that the editors saw a possible connection to a scientific problem that plays a
role elsewhere in Einstein’s correspondence. Clearly such description of material
that is omitted from the edition represents a compromise between the wish to
present as complete an edition as possible and to present only documents that
have been identified with respect to content and dating. It remains a judgment
call for the editors to decide on the level of detail to use in describing this
material.

2.4 The Berlin and Princeton Manuscripts on Unified Field
Theory

Presumably, many research manuscripts extant in the Einstein Archives will
pose no significant new problems from an editorial point of view, exciting and
illuminating as they might be for their content. There is, however, a signifi-
cant amount of material that does represent a challenge for the editors of future
volumes of the CPAE series: a batch of some 1750 manuscript pages with cal-
culations dealing mostly with Einstein’s search for a unified theory. Einstein
began thinking about the problem of a unified field theory of gravitation and
electromagnetism soon after the completion of the general theory of relativity,
and his first publications on this topic date from 1919. The problem remained
on his mind through the next three-and-a-half decades until his death in 1955
[Sauer 2004]. Some fifty publications from this period attest to his sustained
interest in this problem.

The manuscript pages are not part of the original Dukas collection. Ac-
cording to anecdotal information, the batch of manuscript pages, surprisingly,
turned up behind a filing cabinet when the archival offices used by the late
Helen Dukas at the Institute for Advanced Study in Princeton were cleared up
in preparation of sending the Einstein Estate to Jerusalem. The batch was
then added to the Einstein Archives and, after shipping to Jerusalem, it was
microfilmed into reels 62 and 63 and accordingly accessioned under archival call
numbers 62-001 through 63-416.

The manuscripts are undated pages, for the most part single sheets; see
Fig. 4 for an example. From the later years (reel 63), the paper of these sheets
appear to have been taken from loosely bound typewriter paper tablets, many of them of the same kind. Some of the sheets were bound together by means of paper clips. In some rare cases, the versos of letters or other paper was used. The manuscripts almost exclusively contain research calculations. They were made for Einstein’s own use, i.e. they very rarely contain explanatory remarks about the context or meaning of the calculations. In some rare cases, more elaborate parts of drafts of manuscripts are found in the set. Some pages contain calculations and comments that are not in Einstein’s hand.

The material poses a problem for the editorial project specifically in all of the aspects discussed so far, i.e. dating, coherence, and chronological as well as logical sequence of the pages. Two aspects of the material add to its being an editorial challenge. For one, the sheer amount of the material precludes any detailed or in-depth analysis without some global assessment of what is to be expected. Second, in contrast to Einstein’s manuscripts from his earlier years, these manuscripts do not document a productive creativity that eventually led to a successful theory. Hence, to this date historical interest in Einstein’s investigations into a unified field theory has been rather limited, some important exceptions notwithstanding.8

With respect to dating, a superficial survey of the material showed at least one example where calculations were found on an envelope that carries a post-stamp of 1919 (Call Nos. 62-052 and 62-053). Since this implies a terminus a quo that would perhaps render some of the material relevant for volumes of the CPAE series that are presently under preparation, a more detailed investigation of the whole set of pages was called for.

In order to better be able to deal with the material, copies extant in the duplicate Archives at the Einstein Papers Project were scanned in as images of low-resolution black-and-white quality. The pages were then looked at individually using the scanned version, and a multipurpose database application was used to establish a page-by-page catalog of the manuscript pages. The information recorded in this database pertained primarily to any legible word or phrase that could be deciphered on the page. In the example of the page reproduced in Fig. 4, the only legible phrase in this sense is in the fourth line and reads: “nur von $x_{1}$ abh.” The mathematical formulae and variables were generally completely ignored. In some cases, where it seemed useful to also enter a mathematical expression or formula, that expression or formula was transcribed using standard LaTeX-markup.9 Any obvious peculiarities of the manuscript pages, such as specifics of the paper or ink, or entries in a different hand, etc. were also added to the records. Most importantly, any information that is relevant for dating a particular page was noted. Such information comes from the use of dated sheets of paper, e.g. verso of letters or draft of letters or use of hotel

8For references to secondary literature on the history of unified field theory, see Goenner 2004 and Sauer 2004.
9The LaTeX-transcription provides a representational description not a contentual one. It also does not allow, in general, to search for specific mathematical expressions since the same mathematical expression can be represented in several ways using LaTeX-markup. As a simple example, the LaTeX-markups $x_{1}$ and $x_{1}^{(1)}$ are representationally equivalent.
Figure 4: A page of Einstein’s research notes on unified field theory (Call Nr. 62-007). This particular page can be identified as being related to a publication from 1929. There are more than 1700 undated pages of this kind in the Einstein Archives. This batch of research manuscripts presents a major challenge for future volumes of the Collected Papers of Albert Einstein. © The Hebrew University of Jerusalem, Albert Einstein Archives.
stationery; from an unambiguous identification of content of the material; from the appearance of a different handwriting or the mention of a collaborator of Einstein’s; from the mention of identification of specific literature; and similar hints.

The descriptive database of the set of manuscript pages in conjunction with scanned images of the manuscript pages represents a working tool for further analysis of the manuscripts. Thus, unidentified copies of certain manuscript pages extant in the supplementary archives could in part be identified with known ones by searching for the legible word or phrase content. Also, generic concordance tools of computational linguistics are applicable to create word indices for the manuscript pages. Despite the preliminary character of the database, some facts about the manuscript pages could already be established.

Putting together a survey of all dated or datable pages, it appears highly likely that none of the material dates any earlier than 1928. This is probably also true for the single instance of Call No 62-052 which remains undated but may well be much later than the post stamp of 1919. A very strong indication for taking 1928 as the earliest date for the whole manuscript set is given by the fact that, in general, independent hints for dating of different pages tend to corroborate each other for pages that are close in the sequence of sheets, and all those hints point to dates later than 1928. It also seems that the sequence of sheets in which they are preserved roughly reflects a chronological order, although exceptions are very well possible and in some cases even likely. Hence, the manuscript pages are removed from the immediate concerns of the editors of the CPAE series. Nevertheless, they continue to represent a major editorial challenge for future volumes.

3 Concluding Remarks

In order to be published as an individual document in a Writings volumes of the CPAE series, research manuscripts need to meet at least two criteria. They need to be dated with sufficient accuracy and they need to be sufficiently coherent so as to be identified as one document. In the case of the Scratch Notebook, 1910–1914?, the coherence was primarily suggested by the fact that the notes were entered in a physically bound notebook. But neither could the notes be dated accurately, nor could a unity of content be established. Hence, the notebook was reproduced in its entirety in an appendix. In the case of the Zurich Notebook, only a part of the entries in the bound notebook could be identified as a sufficiently coherent and datable set of research notes, and that set of pages was included as an edited document. The Einstein-Besso manuscript could be dated and identified as a coherent set of notes through a reconstruction of its content. Many small “back-of-the-envelope” calculations cannot be edited as texts because their meaning and significance cannot be identified. Since they are part of another document, they are in many instances at least described in the descriptive note of the respective document.

With our present understanding of Einstein’s Berlin and Princeton research
manuscripts on unified field theory, a considerable amount of scientific manuscripts left by Einstein defies the procedures of the documentary edition of the CPAE. Neither can we already date the material with sufficient accuracy, nor do we have a sufficient understanding of their coherence and of their chronological or logical sequence.

Does the launch of the Einstein Archives Online website change the situation by providing other ways of publishing important documents? High-quality images of both the Scratch Notebook as well as of the full Zurich Notebook are, in fact, now available online. The Einstein-Besso manuscript, however, is not included on the present website, since the original is not part of the holdings of the Albert Einstein Archives. And none of the small “back-of-an-envelope” calculations are presently available on the site since it does not include any correspondence. It would indeed be a natural expansion of the present website to include at least facsimiles of those letters that are not included in the respective Correspondence volumes. It is also conceivable that facsimile images of Einstein’s Berlin and Princeton manuscripts might be added to the document content of the Einstein Archives Online website before it is published in the documentary series.

Nevertheless, a mere publication of the manuscript images online does not represent a proper documentary editing of this important manuscript material. The database content that goes with the facsimiles of the documents on the website is far less explicative and not as reliable as the carefully established information in the documentary edition. More importantly, no transcription, no translation, and none of the editorial apparatus of the documentary edition is included. I hope to have shown that a successful response to the editorial challenge posed by Einstein’s research material goes hand in hand with a scholarly investigation into its content and context. Only by trying to understand the content and context of the manuscript will we be able to satisfactorily edit those manuscripts, be it in conventional large book format or electronically. We may also hope to get further exciting insights into the workings of a highly creative mind.

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