INTRODUCTION TO VOLUME 9

I

The present volume of correspondence covers sixteen months in Albert Einstein's life, from January 1919 through April 1920. In number and breadth of topics, these letters attest to major transformations, brought about by changing personal and political circumstances, and, most significantly, by Einstein's meteoric rise to international renown in late fall of 1919.

Einstein's correspondence of about ten to twenty known letters per month during the years 1915 through 1917 doubled already during 1918, his first year as director of the Kaiser Wilhelm Institute of Physics (KWIP). By early 1919, with the publication of a call for research proposals and funding opportunities through the KWIP, the correspondence almost doubled again; it then rose dramatically in November 1919, when the results of the British eclipse expedition confirming the predictions of the theory of general relativity were made known to the professional and general public. Einstein's consequent fame both in Germany and abroad elicited wide newspaper coverage and a massive influx of letters of congratulations, invitations, and requests for articles, translations of his popular book on relativity, and action on behalf of various individuals and causes. Judging from this—inevitably incomplete—archival record, Einstein seems to have felt obliged to respond, if only politely, to every one of the letters he received.

In their wide-ranging diversity these letters touch upon numerous scientific topics, such as the results of the 29 May 1919 British eclipse expedition, the redshift test of general relativity, and the unification of gravitation and electromagnetism, as well as other miscellaneous scientific concerns, among them Einstein's attempts to reconcile quantum theory with relativity. Difficult family matters, including financial hardship, dominate his private correspondence, which revolves primarily around the wrenching last months in the life of Einstein's terminally ill mother, Pauline, but also the care of his sons, Hans Albert and Eduard, and that of his first wife, Mileva; the finalizing of his divorce; and his marriage to Elsa Löwenthal.

Einstein answered many letters requesting evaluations for academic appointments and inviting him to lecture and attend scientific and other events. He exchanged correspondence on political issues, particularly those of significance to him, such as international reconciliation, various humanitarian initiati matters, and the establishment of a Hebrew university in Jerusalem. F time, he became engaged with philosophers interested in the theory of relati

As director of the KWIP, Einstein received forty-two grant applications. The correspondence related to the application process and communications with the applicants, board of directors, board of trustees, financial officers, and banks responsible for disbursing the awards are abstracted in the Calendar. Representati amples of applications and of Einstein's responses are included as te Einstein's correspondence with publishers concerning the reprinting of his writings and their translation into English, French, and other languages has also been abstracted in the Calendar.

Four correspondents stand out for the intensity and candor with which Einstein writes to them and the breadth of subjects they cover. His exchanges with P Ehrenfest, Hendrik A. Lorentz, Max Born, and Heinrich Zangger discuss myriad issues, ranging from offers of academic appointments in Leyden and Zurich and his financial and health problems, to the scientific, political, and humanitarian endea ors that were of greatest interest or significance to him. His moving and witty letters to these friends impart the most vivid account of Einstein during these turb lent postwar months.

II

Einstein's concern for his ill mother and the shadow it cast on his personal life is a running theme throughout most of this volume. Pauline Einstein, who had suf a recurrence of cancer in the fall of 1918, began experiencing increased discomfort and pain in early 1919. With the first documents (Docs. 1–6) we f Elsa in Switzerland. He stayed there until mid-February, settling a f ment concerning shares held in common with his brother-in-law, Pa his uncle Jacob Koch. He visited his son Eduard in a sanatorium in Graubünden and delivered a lecture cycle on relativity at the University of Zurich.

A few months later, when Einstein traveled to Zurich again for a second c relativity lectures beginning in late June and lasting until mid-August, he arranged his visit so that he could commute weekly between Zurich and Lucerne for re visits to Pauline who, in mid-July, upon Einstein's urging, had been transferred to a private clinic (Doc. 70). As he wrote to his stepdaughters on his return to Berlin: "My trip consisted of all sorts of serious but also sad duties; this time I sa of beautiful Switzerland except a lecture hall and a hopeless sickbed" (Doc. 90).

Einstein had intended to take his mother back home with him to Berlin that summer, but the plan had to be postponed. Several letters in this volume document the obstacles connected to this move, ranging from the medical risks of a long and exhausting journey (Doc. 148), to finding appropriate accommodations for Pauline (Docs. 159, 194, 233). Due to financial setbacks in 1919, arising from the increasingly unfavorable exchange rate between the Swiss franc and the German mark, Einstein even tried to persuade Mileva and his two sons to relocate from Zurich to Baden, where he felt he would be better able to support them (Docs. 135, 166, 198, 242) and comply with the financial terms agreed upon in the divorce, which had been finalized in Zurich on 14 February 1919 (Doc. 6). Einstein was repeatedly offered academic positions with generous remuneration in Switzerland during this period. Although such an arrangement would have considerably alleviated his financial worries, Einstein declined, stating that, given the efforts that his Berlin colleagues, especially Fritz Haber, were making on his behalf to remain in Berlin, he would stay in Germany unless circumstances forced him to do otherwise (see Docs. 84, 103, 140).

Pauline eventually arrived in Berlin on 28 December 1919 and remained in the care of Elsa and Albert Einstein. She spent the last weeks of her life in Einstein's apartment, where she died on 20 February 1920 at the age of sixty-two.

III

The eclipse of 29 May 1919 was the single most important event affecting Einstein's life in the period covered by this volume.

The year 1919 was pivotal for the empirical confirmation of the theory of general relativity. Despite its conceptual innovations, the new theory of gravity incorporated, as a limiting case, the empirical content of Newtonian theory. For weak gravitational fields and slow motion, the new theory reproduced the known equations of Newtonian theory, a major heuristic requirement for Einstein in his search for a relativistic theory of gravitation.[1] He naturally felt compelled to look for observable consequences that escaped the Newtonian limit. He had identified three such tests as early as 1907, when he first formulated his equivalence principle, according to which the effects of gravitation and uniform acceleration are locally indistinguishable.

An excess advance of the perihelion of Mercury's planetary orbit that could not be satisfactorily explained by the Newtonian theory of gravitation had been observed at the end of the nineteenth century. Einstein's hope that a relativistic theory would account for this anomaly did not bear fruit until after his breakthrough to full general covariance in November 1915, giving his new theory crucial and influential empirical support.[2]

Light bending and gravitational redshift, the two other tests whose origins date back to 1907,[3] had both been the subject of observations even before 1915. But by the beginning of 1919, when the present volume starts, solar spectroscopists were nearly unanimous in their opinion that the prediction of a gra shift of light emerging from a massive body such as the Sun appeared to be incompatible with their measurements. In this situation of a tie, as it were, between the success of the explanation for the perihelion anomaly and the apparent f detect the expected redshift, measurements of light bending assumed a crucial role, since in this case no empirical data were available.

Earlier efforts to mount expeditions to observe the deflection of light passing through the Sun's gravitational field during an eclipse had failed. As it happened, the total solar eclipse due on 29 May 1919 would be ideal, since the Sun w be in the field of the Hyades, the star cluster closest to Earth, when se stars would be visible close to the Sun during totality.

On the basis of the equivalence principle alone, Einstein had predicted in 1911 a bending of 0.83 arc seconds for starlight that grazes the edge of the Sun. izing that the effect might be observable, he urged astronomers, both in print and correspondence, to devote themselves to this test.[5] In 1915, with the completion of general relativity, the predicted value had become 1.7 arc seconds, twice the v ue obtained from the equivalence hypothesis.[6] In December of that year wrote to the astronomer Otto Naumann: "Now this consequence is the most interesting and astonishing of all, and probably also undoubtedly the theory' characteristic one; and precisely this consequence has not been subjected to an test."[7] Three weeks later he wrote even more emphatically to his colleague Karl Schwarzschild, one of Germany's leading astronomers: "The question of light deflection is now of the utmost importance."[8]

Already in 1914, Erwin Finlay Freundlich, the astronomer who collaborated most closely with Einstein, had considered ways to test the light bending prediction. After Einstein had helped to procure funding,[9] Freundlich led an e to the Crimea to observe the eclipse of 21 August 1914. But upon the outbreak of World War I, Freundlich was interned in Russia. Expeditions from neutral or allied countries were disappointed by cloudy conditions during that eclipse, while the failure to repatriate their equipment from Russia also hampered the subsequent efforts of the Lick Observatory of California team when it attempted to test Einstein' prediction at Goldendale, Washington State, in June 1918.[10]

Even though by June 1917 Freundlich was already well aware that this opportunity would be "unusually favorable,"[11] the devastating aftermath of the war put an end to any hope for a German expedition as far afield as South America or Central Africa, from where the total eclipse of 29 May 1919 would be visible. Britain, as one of the victorious Allies, was in a slightly better position and mounted not one, but two expeditions. Already in 1916, Willem de Sitter's papers in the journal of the Royal Astronomical Society had focused attention on the observational consequences of general relativity, and had made a distinct impression on the English astronomical community.[12] Arthur S. Eddington (see Illustration 4) immediately began to study the theory. His own accounts were widely read and highly influential.[13] In March 1917, the Astronomer Royal, Sir Frank Watson Dyson, noted that the eclipse of 1919 would be ideal for the test. The Royal Society's and Royal Astronomical Society's Joint Permanent Eclipse Committee (JPEC) formed a subgroup with the task of planning the expedition. But only with the end of the war in November 1918 did an expedition actually seem feasible, and shortly thereafter the British astronomers focused their entire efforts on this task.[14]

Two expeditions were sent. The first consisted of Charles R. Davidson and Andrew Claude de la Cherois Crommelin, both from Dyson's own Greenwich Observatory; the second of Edwin Turner Cottingham and Eddington himself. The Greenwich pair went to Sobral in northeastern Brazil, taking as their main instrument the 13-inch astrographic lens of the Greenwich Observatory and, as a backup instrument, a 4-inch telescope obtained on loan from the Royal Irish Academy. Eddington traveled to the island of Principe in the Gulf of Guinea, off the west coast of Central Africa, equipped with the astrographic lens of the Oxford Observatory.

On 8 March 1919 the two expeditions departed Liverpool on board the S.S. *Anselm*, bound for Brazil. Eddington and Cottingham left the ship at Madeira and, after having to wait for a connecting ship to Principe, arrived on the island on 23 April. The Crommelin expedition reached Sobral at the end of April. Preparations went ahead at both locations during the month of May.

Upon mounting their equipment, the astronomers at Sobral discovered that the coelostat mirror used in conjunction with one of their lenses (the astrographic lens) suffered from serious astigmatism. In order to avoid this astigmatism, they stopped down the 13-inch aperture to 8 inches. But when they developed the first photographic plates after the eclipse, they noticed that the images were nevertheless blurred and apparently out of focus. Having initially contemplated leaving the site without taking comparison photographs of the same star field and relying instead on check plates of a neighboring set of stars, they now decided to stay in Brazil. At Sobral, the eclipse took place in the morning hours. In order to obtain comparison plates with a similar scale, the astronomers would have to wait for an additional month after the eclipse, when the Hyades star field would become visible in the night sky at the same altitude.

On Principe, where totality occurred in mid-afternoon, Eddington w had to wait for several months for the eclipse star field to be visible at night at the same altitude. Therefore, in late May, he took check plates of a star f turus to be used for comparison with plates of that same field, and with plates of the eclipse field taken at Oxford before departure.

As he awaited the expeditions' results, Einstein surmised on 19 August 1919 (Doc. 93) that the reason for the delay in making an announcement w British astronomers "may be waiting about half a year in order to tak exposures of the relevant sky region with the same instrument." As it turned out, the principal reason for the delay between the eclipse and the announcement of the results was the complexity of the data reduction and analysis.

The British expedition is first mentioned in the correspondence presented in this volume in a letter to Einstein of 9 April 1919 (Doc. 19) in which Arnold Berliner the editor of *Die Naturwissenschaften*, reports on an article by Crommelin that had appeared in *Nature* the previous month, describing the aims of the eclipse e tion. Einstein and his colleagues in Germany may have been aware of plans for an English expedition as early as late 1917, following an article in *Die Naturwissenschaften* that gave details of the eclipse and of the British plans.[15] The widely read journal repeatedly published brief notes and summaries of articles from British scientific journals. In any case, the upcoming event and the planned observ mentioned by Einstein both in his university lectures and in popular talks. 29 May, Einstein, along with many other physicists, anxiously a nouncement of the results.

The first available news was scanty but promising. On 4 June, Eddington, in a telegram to Dyson, reported that conditions had been cloudy but that he w ful" of obtaining useful results. The next day, Crommelin informed Dyson in a cable that no clouds had hindered the observations at Sobral.[17] Brief notes appeared the following day in both the London *Times* and *Nature*. A second tele Crommelin, sent after developing the plates, indicated that all stars of interest were actually visible. But, in addition to the astigmatism detected before the eclipse, he reported further problems with their main instrument, the astrographic lens. On 10 June a note about the expeditions appeared in a Dutch newspaper days later by Dyson's official report of the telegrams received at a meeting of the Royal Astronomical Society.[18]

Einstein himself first mentioned the promising initial reports in a letter of 16 June to his mother (Doc. 61), and expected that final results should be a within six weeks. But for some time, no further news was forthcoming.

Though convinced that his results tended to support the general relativistic prediction, the paucity of images he had secured made it impossible for Eddington to reach a firm conclusion. He left Principe on 12 June, apprehensive that a steamship strike would strand him on the island, and arrived in Liverpool on 14 July. The Sobral team remained in Brazil for over a month afterwards in order to take photographs of the eclipse star field. Although favored with good weather, the team had to wrestle with their primary instrument, the astrographic lens from their own observatory fed by a 16-inch coelostat mirror that had performed unsatisfactorily during the eclipse. Having lost focus, in all likelihood as a result of the change of temperature during totality, they were ultimately obliged to rely on the plates obtained with their secondary instrument, the 4-inch lens. They reached England on 25 August and spent the month of September reducing their data at Greenwich.

Meanwhile, at the annual meeting of the British Association for the Advancement of Science on 12 September, Eddington and Cottingham presented spectacular pictures of the dramatic solar prominence that coincided with the eclipse (see Illustration 5). Eddington added that his own data reduction for the deflection of starlight pointed to a numerical result that fell between Einstein's two theoretical predictions of 0.83 and 1.7 arc seconds deflection at the limb of the Sun.[19] This annual BAAS meeting had brought together some 1,500 scientists of all disciplines in Bournemouth.[20] From among them, Balthasar van der Pol, a Dutch participant, reported Eddington's preliminary results to Hendrik A. Lorentz, who, in a now famous telegram, passed them on to Einstein on 22 September (Doc. 110). A published account of Eddington's presentation did not appear until early 1920, owing perhaps to the by-laws of the JPEC that required results to be announced at joint meetings of the Royal Society and Royal Astronomical Society.[21] Upon ascertaining that no further details on the results had appeared in print, Lorentz elaborated on van der Pol's account in a subsequent letter to Einstein (Doc. 127). He there characterizes as tentative Eddington's comments at the meeting, but also stresses that the "reality of the phenomenon was established beyond doubt."

Shortly after a newspaper article appeared in the Berlin press, Einstein himself sent a brief note on the confirmation of his theory to the editor of *Die Naturwissenschaften* that was published on 17 October (Vol. 7, Doc. 23). As he had commented earlier in the month to his mother (Doc. 99), he was "very frequently asked about the result, both in conversation and in writing."[22] Einstein's note was, indeed, picked up by the daily press.[23]

The same numbers, but supplemented by a mention of a preliminary result close to 1.75 arc seconds obtained by the Sobral team, were first announced by Eddington on 22 October at a private gathering of physicist and mathematician members of the $\nabla^2 V$-Club in Cambridge.[24] The next day, Dyson called for a joint meeting of the Royal Society and Royal Astronomical Society to take place on 6 November, where the final results of the data reduction would be reported. For the photographs taken with the astrographic lens, Dyson's Greenwich team found v 0.93 or 1.52 arc seconds deflection at the limb, depending on the method of data reduction. Yet, since the images were found to be out of focus, systematic errors could not be excluded. Photographs obtained with the 4-inch lens yielded much more satisfactory results: here the final value was announced to be 1.98 arc seconds, with a probable error of 0.12 arc seconds. Eddington reported a f 1.60 arc seconds from the photographs taken at Principe, with a probable error of 0.3 arc seconds.

The mean of the values obtained was very close to Einstein's prediction of 1.75 arc seconds. As an article in *Nature* on 13 November reported on the joint meeting, "It was generally acknowledged at the meeting that this agreement, combined with the explanation of Mercury, went far to establish his theory as an objecti Great admiration was expressed by participants for the quality of the w the eclipse teams (Docs. 168 and 185).

While the establishment of the final results took some time, and while ne the ongoing process reached Einstein and his German colleagues only gradually through intermediary conduits, the press coverage of the joint meeting of the Ro Society and Royal Astronomical Society of 6 November 1919 signaled Einstein' international rise to fame. The excitement generated in the English scientif munity by the announcement that Einstein's theory had triumphed o rapidly spilled over into the English press and fired the imagination of the English public.[25] While the German press was slower to respond and did so in less dramatic language,[26] Einstein acquired great notoriety, attested to b ceived in November and December from friends and admirers, as well as b own complaints of having little time to spare, given the demands of reporters and the burden of responding to a deluge of mail (see Docs. 187 and 295).

Nevertheless, some physicists and astronomers remained skeptical, most v among them being Ludwig Silberstein, who disputed Eddington and Dyson' clusions. But even he professed great admiration for many elements of Einstein' theory (Doc. 348). Lorentz too investigated an alternative explanation of the data. In Doc. 127, he performed a thorough calculation to show how the observ tion might be explained by a refraction of an extended solar atmosphere. F rarefied solar atmosphere, one can still obtain a deflection of the right size at the limb by assuming that the density gradient is large, so that the atmosphere becomes rapidly more rarefied with increasing distance from the Sun. But this assumption then leads to a rapid decline in the deflection as one moves radially a Sun, which is inconsistent with Einstein's prediction and the observ

With respect to the remaining numerical discrepancies among the final values, skeptics and believers alike now looked forward to the eclipse of 1923 as a further opportunity for confirming or refuting the new results.

IV

With the confirmation of the second test of general relativity, issues revolving around its third empirical consequence, the gravitational redshift, became all the more acute. If a light source emits light at the Sun with a frequency ν_0, measured locally, the frequency of the light received and measured at the Earth is ν, and the relative shift in frequency is

$$\frac{\nu_0 - \nu}{\nu_0} = \frac{\Phi}{c^2} = 2.10^{-6},$$

where Φ is the (negative) gravitational potential difference between the points of emission and detection at the surface of the Sun and the Earth, respectively, and c is the velocity of light.

Skeptics objected that relativity could not be correct if it failed this crucial test, a view shared by Einstein himself. As he remarked to Eddington: “If it were proved that this effect did not exist in nature, then the whole theory would have to be abandoned” (Doc. 216). But whereas outspoken critics such as Silberstein were certain that the evidence from observations of the Sun’s spectrum was overwhelmingly against the “Einstein effect,” Einstein himself remained sanguine.

Like the perihelion advance of Mercury, the redshift of spectral lines in the Sun had been of interest to astronomers before the advent of relativity theory. That the majority of solar spectral lines show a distinct, but small, shift to the red when compared to laboratory spectra had first been ascertained in the late 1890s by Henry A. Rowland and Lewis E. Jewell.[27] A pressure-dependent line shift in the spectra of arc lamps initially suggested some similar effect for the Sun, but subsequent research showed that high pressure in the solar atmosphere could not account for the appearance of the lines. Willem H. Julius tried to explain the shift in terms of the anomalous dispersion of light in certain optically active substances in the solar atmosphere, but his theory never enjoyed wide acceptance among solar physicists, and by 1919 most of them rejected it outright.[28] The other principal candidates for an explanation of the solar redshift were Doppler shifting due to the motion of solar gases along the line of sight, and the Einstein effect.

The Doppler effect, depending upon motion along the line of sight, was perfectly suited to explain the solar redshift observed in gases located near the center of the

Sun’s disk. But the solar redshift was also observed along the limb of the Sun, where it was in fact stronger than at its center. The difference between these tw redshifts at the center and at the edge of the Sun was known as the “limb ef Since comparisons of the lines observed from these two places could be carried out without a laboratory spectrum as reference, a procedure which introduced considerable technical difficulties, the measurement of the limb effect played a lar in observations made prior to 1919. Because no reasonable model could be found for the line-of-sight motion away from the Earth, the effect was dif on the Doppler hypothesis. In desperation, John Evershed even searched for observational evidence of the Earth repelling the gases of the solar atmosphere, a proposal that was called “nonsense” by Paul Ehrenfest in Doc. 203.

Thus, an effect of about the right size existed, for which no other e cept that of a relativistic redshift was available. Nevertheless, most astronomers resisted. In 1914, Karl Schwarzschild had argued that the evidence ag itational redshift was quite strong.[29] A few years later, because of mismatches between the observed dependency of the shift on frequency and intensity predictions of the theory of relativity, Charles E. St. John and Ev whom worked at leading solar observatories, also came out against the Einstein effect. Much attention was given to the cyanogen spectral band, so called because its dominant lines were produced by the free radical CN, cyanogen. Its relati sitivity to the effects of pressure in arc lamps made it suitable for comparati yses. Yet Schwarzschild, St. John, and Evershed found that the redshift v line to line in a manner that appeared incompatible with the gravitational redshift.

Another notable feature of existing observations was the difference between the limb effects of faint lines and those of greater intensity (see Doc. 232). The strong lines tended to show a significant redshift, more compatible with Einstein’ tion, while the weak lines often showed no redshift at all. Moreover tity of lines created confusion when individual lines were superposed, or blended. St. John, who preferred to analyze weak lines for which, he argued, blending w be less likely, measured the limb redshift as near zero, thus strongly refuting the relativistic prediction. Evershed preferred to measure strong lines and forcefully criticized St. John’s approach.[30] Yet both agreed that the data did not support general relativity.

Although the British eclipse expeditions turned the tide in favor of general relativity, skeptics pointed to the failure to observe the gravitational redshift and remained confident of the theory’s eventual overthrow, perhaps after further eclipse expeditions. Supporters explored an alternative theory that could incorporate most of the features of general relativity without the redshift prediction. In Doc. 75, Adriaan Fokker, one of Einstein’s few collaborators during the de general relativity, proposed to Einstein that Hermann Weyl's unified field theory of gravity and electromagnetism might be such an alternative. He was not alone. Eddington and Arnold Sommerfeld wrote to Weyl himself in a similar vein (Doc. 75, note 18).

Even though he maintained the position that a negative result would be fatal for his theory, Einstein retained confidence that, in the long run, it would be vindicated. He drew reassurance from other observational results. In 1919, his collaborator Freundlich examined the spectra of fixed stars in an attempt to gather statistical evidence for the existence of a gravitational redshift. If most nearby stars show a noticeable redshift, it would indicate that their gravitational fields themselves are responsible for the effect, rather than the unlikely scenario in which these stars are all being repelled by the Earth, as would be required by the Doppler shift hypothesis. Earlier attempts by Freundlich in this direction had drawn criticism, but Einstein welcomed Freundlich's investigations of the spectra of bright stars of spectral type B and O, especially those in the Orion Nebula.[31] Einstein's knowledge of astrophysics had apparently become quite sophisticated. His reading of a review of Eddington's new stellar theory in early 1919 convinced him that giant stars of types B and O should have a very pronounced redshift due to their rather high densities (Doc. 8). Freundlich's work in this area, described in Doc. 14, seems to have greatly encouraged Einstein (see his reply, Doc. 15).

Of much greater significance, however, for both Einstein and the astrophysics community, was the work of Leonhard Grebe (see Illustration 3) and Albert Bachem. In response to the public announcement of funding opportunities through the Kaiser Wilhelm Institute of Physics (see the Appendix), Grebe applied for financial help for their work (Doc. 25). It is hardly surprising that Einstein chose to support their research and that he made the additional offer that they use Freundlich's photometer (see entry for 26 April 1919 in Calendar). By June 1919, Grebe informed Einstein (Doc. 57) that asymmetrical broadenings of lines in the cyanogen band had in some cases been misinterpreted as a shift toward the blue. This had resulted in an underreporting of the redshift in some lines. By the end of 1919, Grebe and Bachem also pointed out that in some instances the absence of redshift is simply the result of a misidentification of the lines (Doc. 232). Einstein's excitement at this fresh evidence is palpable in a series of letters written to colleagues shortly thereafter (Docs. 235, 254, 256, 293).

Although the balance was about to tip in favor of the Einstein effect, change came only gradually, unlike in the case of the eclipse expedition. The reception accorded Grebe and Bachem's work was not uncritical. Eddington himself responded in reserved fashion, both to Einstein personally (Doc. 352), and in print.[32] Robert Lawson forwarded Einstein's brief comment endorsing Grebe and Bachem's work (see Doc. 234) to *Nature*, thus drawing fire from St. John,[33] who remained disapproving of the Einstein effect (see Doc. 352).[34] In a letter to *The Observatory* Edouard Guillaume, an old colleague and a critic of special relativity to whose less well informed remarks Einstein had patiently replied (Docs. 280 and 305), pointed out the failures of redshift measurements in an article which immediately dre riposte from Eddington.[35] Einstein himself coolly foretold Guillaume that "in tw years there will be no more doubts" (Doc. 305). His prediction w prescient, forecasting roughly the time when the previously implacable St. John would reverse his position on the Einstein effect.[36] But the observ mation of the gravitational redshift would remain a topic of debate for man to come.

V

Einstein's confidence in the outcome of his own predictions is a recurring theme in letters written by close friends and colleagues after the eclipse announcement. Max Planck (Doc. 121), Heinrich Zangger (Doc. 148), and Paul Epstein (Doc. all remark upon it. Even the very young seem to have sensed this inclination, as suggested by Ehrenfest's description of a drawing made by his daughter Einstein is depicted sitting calmly amidst the general excitement surrounding the eclipse, saying, "Oh well—I know it—I did calculate it" (Doc. 175 and Illustration 6).

According to a much later recollection by Ilse Rosenthal-Schneider the time casually showed her the famous Lorentz telegram (Doc. 110) and insisted that even without the observational confirmation he was certain of his theory' correctness.[37] A letter from Einstein to Schneider, then a student at Berlin Uni sity, dated a week earlier and inviting her to visit his house "next week" (Doc. 104), lends some credence to her claim to have been present shortly after the tele arrived. Even if Einstein's confident attitude on the issue of observ mation of general relativity may at times have been a pose, man gained the impression that it was genuine. This remarkable certainty not indicate indifference to experiment, nor that Einstein at the time re pirical tests as superfluous to the scientific method. His intense desire to see the e perimental test carried out, and his insistence on the vulnerability of his theory to disproof, are amply attested to in these volumes.

Einstein's confidence in the empirical status of his theory did not k constantly looking for improvements. Before the 1914 eclipse ex already expressed his certitude (Vol. 5, Doc. 506) "regardless of whether the observation of the solar eclipse will succeed or not" (Vol. 5, Doc. 514). Y after he completely revised the theory he held at the time, and, with it, his prediction of the magnitude of light bending. Neither was Einstein averse to modifying even the field equations of general relativity, once it had been completed, as when he introduced the cosmological constant. In April 1919, Einstein published a paper that advanced yet another modification of his gravitational equations. Motivated by concerns to account for the structure of matter, he introduced modified gravitational field equations that are trace free rather than having vanishing covariant divergence (Vol. 7, Doc. 17). With respect to gravitational light bending, the equations were equivalent to the ones with cosmological constant which did not appreciably alter the predicted light bending for light passing near the sun. The modification amounted to adding a gravitational term to the electromagnetic field energy that was interpreted as a negative pressure term and was to account for the stability of a charge-carrying particle, in analogy to a theory by Henri Poincaré, who had introduced a similar pressure term to account for the stability of the Lorentz electron. Einstein commented on this work in a distinctly ambivalent way: on 22 March he was "urgently preoccupied with a problem in general relativity which does not give me peace, day or night" (Doc. 10). A few days later he wrote: "I have found an interesting idea in general relativity. Let's hope it stands up; in such cases, after a short while, criticism and dejection generally set in!" (Doc. 16). On the day of the eclipse itself, he sent a copy of his paper to Theodor Kaluza, commenting that, "short of something better," it would adhere to the dualistic conception but that it may nevertheless be of a certain interest (Doc. 48). A few days later, he expressed doubts as to whether he had found "the right thing" (Docs. 52 and 59).

In the immediate aftermath of the eclipse announcement, Einstein wrote a short newspaper article on "Induction and Deduction in Physics" (Vol. 7, Doc. 28). In what appears to be a direct reflection on the recent confirmation of his gravitational light-bending prediction, he writes that the actual course of science rests on a hypothetical-deductive method rather than upon a model of progress by induction. In this brief piece Einstein puts forth some explicit falsificationist contentions, namely, that while "*the truth* of a theory can never be proven," the theory itself can be proven wrong by experiment.

Even with two empirical triumphs, and confident in the ultimate success of a third, Einstein remained on the lookout for further tests. In late 1919 and early 1920 he pursued with Freundlich the possibility that the rotation of very large scale gravitational systems, such as globular star clusters, might provide evidence for the existence of a nonzero cosmological constant (Docs. 197 and 240).[38]

In late 1919, Einstein received a proposal from Wilhelm Hort, an engineer, to test experimentally the Lense–Thirring effect (the "dragging of inertial frames") (Doc. 176). Einstein's theory was seen here as part of a Machian tradition, since

Hort refers to the work of the Friedlaender brothers in the 1890s, which attempted to find experimental evidence in favor of Mach's claim that the relati could explain the thought experiment known as Newton's bucket. siasts of relativity, many of them nonscientists, drew considerable comfort from the sudden and surprisingly swift triumph of general relativity over Ne lutism. In this case, however, Einstein had to inform Hort that there w of an experimental detection of the frame-dragging effect because the ef too small to observe (Doc 181).[40]

VI

Einstein's abhorrence of war and his pacifist inclinations were readily apparent during World War I, despite his reluctance to engage in public declarations. With military defeat and the collapse of the imperial regime in late 1918, and Einstein's growing conviction that under democratic rule Germans might be prepared to listen, his willingness to engage openly on matters of importance to him and others was reinforced by his rising standing both in Germany and abroad. This volume documents the emergence and the public articulation of Einstein' on various issues. While he clearly aligned himself with certain groups and opposed others, Einstein was not a member of any political party, although he at times had to defend himself against the perception that he was (Docs. 212 and 379). His moral political sensibility, mostly independent of any strident partisanship, w formed in the crucible of World War I and in turbulent postwar Europe, when Einstein, like others, reflected both on the causes of the war and its conduct, as well as its dramatic repercussions. It was also at this time that he began clarifying to himself, and to others, his position on Jewish matters.

Einstein's engagement with significant political and humanitarian causes came in a time of grave need, of hunger, strikes, revolution, and counter Germany, of the collapse of empires and the formation of new national entities across Europe. Due to his rising visibility, Einstein both initiated and w into numerous actions and appeals generated across Europe, often among intellectuals with humanistic and liberal outlooks. The letters reflect his vie ties on pacifism and his desire for international conciliation, including mitig of what he perceived as a rising vengeful spirit among the former w His concern for the survival and well-being of the new German Republic, his sympathy for some socialist goals, his support for some of the objecti are also palpable. Finally, he actively concerned himself with the education of Je ish students from Eastern Europe, the founding of the Academy for the Science of

Judaism in Berlin, the founding of the Hebrew University in Jerusalem, and other humanitarian matters, such as ending the blockade of Russia and freeing political prisoners.

In September and October 1916, Einstein had discussed the issue of German war atrocities with H. A. Lorentz, who, at that time, introduced Einstein to an effort initiated by Jean Massart to establish a mixed German-Belgian commission to investigate alleged atrocities committed by German troops in Belgium and in Lille, France, during the first phase of the war (Vol. 8, Doc. 269). In April 1919, Einstein, together with five other German civilians, joined a commission to investigate and document accusations against Germany's conduct of the war. The goal was to educate the German people and counteract the mentality of revenge against the Allies that seemed to be growing in Germany (Docs. 28 and 36). Lorentz declined to participate directly in this commission, but offered to collect documentary material and to discuss the matter with various colleagues in France and Belgium (Docs. 34 and 76). A few months later, a first version of the commission's findings was published in a booklet entitled *Lille*. Einstein had not had an opportunity to review the final text, even though he was listed as coauthor.[42] This version elicited sharp disapproval from Einstein, who requested the pamphlet's withdrawal from circulation and even urged a colleague to destroy existing copies (Docs. 108 and 163). He disagreed with the book's introduction, which takes a defensive tone on behalf of Germany. The book reproduced original German wartime documents about the occupation of the Lille area that deal with sanitary measures taken by the German military, primarily against prostitutes and their threat to the general health of the occupied French population and to that of the German troops. These documents, however, did not address the more serious and by then well-known charges contained in French documents that were part of the the protest statement drafted during the war by the intellectuals of Lille, although this protest statement was included. The documents described arrests of civilians, deportations, a forced march of ten thousand women, and other similar war crimes. By early 1920, a second version of the Lille booklet,[43] without Einstein's name but published with his consent, encountered hostility (Doc. 256). This version offered a deeper analysis of deportations, house searches of scholars, theft at scientific institutes, the use of children and the elderly in the line of fire, and the taking of hostages. While harshly critical of the German military's violations during the war, Einstein assigned blame evenhandedly, considering all former combatants to be partly guilty.

In autumn 1919, Einstein expressed his opinion that exclusion of German scholars from international meetings might teach them the "virtue of modesty" (Doc. 80) and that this period of postwar hardship "would be salutary for the internal development of [this] country … because it would be politically instructi sweep away luxury and moral weakness" (Doc. 94).

Of the various issues that Einstein pursued in the early postwar period, reconciliation among intellectuals and citizens of all countries seemed most signif him. He envisioned that the spirit of reconciliation would prevail, a hope matched by his initial optimism about the League of Nations and its promise to usher in a new age of political stability (Doc. 97). Militarism, reactionary conserv venge, and encroachments upon academic freedom were his chief concerns. He worried about the potential militarization of the Geodetic Institute in Potsdam (Docs. 130 and 133) and sought allies for a public statement to condemn the hate campaign against the pacifist professor Georg Friedrich Nicolai (Doc. 282).

When in late 1919 his fame moved beyond the physics community gan refining and expanding upon the pacifist and other political stances that he had started to assume during the war. Engaged to varying degrees with the League of the New Fatherland (Bund "Neues Vaterland"), the Council of Intellectual W (Rat geistiger Arbeiter) (Docs. 71 and 91), and the Clarté movement (Docs. 234 and 235), Einstein interacted with a number of political and cultural f new Weimar Republic such as Helene Stöcker (see Illustration 13), Geor von Arco, Paul Natorp, Elisabeth Rotten, Otto Lehmann-Russbüldt, Prussian Minister of Education Konrad Haenisch, Hellmut von Gerlach, Georg Friedrich Nicolai, Hans Delbrück, and Alexander Eliasberg. Against the backdrop of the v first year and a half of postwar Germany, including the murders of the re leaders Karl Liebknecht, Rosa Luxemburg, and Kurt Eisner, the rise and destruction of the Bavarian soviet republic, the dismay and anger of many revelation of the harsh terms of the Versailles Treaty, and the start and defeat of the reactionary militaristic Kapp Putsch, Einstein often voiced his opinions in letters otherwise devoted to scientific, professional, and personal matters.

Einstein signed and supported several appeals and manifestos, and recei quests that he support others (Docs. 20, 37, 64, 68, 91). He declined an in to head an international commission of the League of Monists (Monistenb (Doc. 260), explaining that, although being a "stalwart" ("unentwe tionalist and a supporter of the Monists' struggle for the freedom of the indi from the control of religious communities, nonetheless, in the current climate, he believed that the total elimination of religious organizations would lead to intellectual and spiritual impoverishment.

Einstein's humanitarian concerns extended beyond organizations to indi actions. As a strategy for undermining the spirit of militarism, Einstein, in correspondence with Elisabeth Rotten, explored the possibility of simultaneously making public information about war crimes carried out by opposing nations

(Doc. 126); he expressed his concern about the epidemics in Soviet Russia and the possibility that the current blockade of Russia might contribute to this suffering (Doc. 141), and involved his friend Heinrich Zangger, a prominent physician and university professor in Zurich, in this issue and in sending medical aid to Poland (Doc. 143). By early 1920, he suggested to Hellmut von Gerlach that they collaborate and take action on behalf of the release of Bavarian political prisoners (Doc. 246).

In spite of his sometimes critical assessment of his fellow countrymen, Einstein expressed empathy for the German population that was beset by economic hardships caused at least in part by the Allies' extension of the wartime blockade beyond the end of hostilities (Docs. 177, 198, 371). He supported initiatives to organize an international exchange of scholarly books and journals, and to create a library of English and American scholarly works in Central Europe, all in order to mitigate the effects of the continuing isolation of German scholars (Docs. 358 and 379).

VII

In the aftermath of war and revolution in Germany, Einstein confessed in March 1919 that the issue from which he derived most joy was "the realization of the Jewish state" (Doc. 10), a reaction most likely elicited by American president Woodrow Wilson's statement earlier that month that he supported the 1917 Balfour Declaration by which the British government had guaranteed the eventual foundation of a Jewish commonwealth in Palestine. During the months covered by this volume Einstein became increasingly involved with the Zionist movement and, specifically, with the plans for establishing the Hebrew University in Jerusalem, which were entering a crucial stage during this period.[44]

In early September 1919, a formal plan for the establishment of the Hebrew University was presented at a conference of the Zionist Organisation in London, where a newly formed "University Committee" was charged to organize a conference of Jewish scholars who would assist in planning the university. That month, Einstein wrote, regarding the "Jewish university," that the Zionist cause was "very near to my heart." Referring to recent meetings with Zionist leaders in Berlin, Einstein saw the development of the "Jewish colony" as "gratifying" and was "glad there will be a spot of earth on which our tribal comrades will not be foreigners" (Docs. 102 and 122).

The shift in the center of Zionist power from Berlin to London, which had taken place during the war under the leadership of Chaim Weizmann, was reflected in a decision that the liaison with the newly famous Einstein would be taken over by the

London bureau. In mid-October, the German Zionist Julius Berger recommended that the central office of the Zionist Organisation contact Einstein directly upon Hugo Bergmann, executive secretary of the Education Department of the Zionist Organisation in London, informed Einstein about the plan to hold a conference of Jewish scholars, most probably in Switzerland, and asked Einstein whether he, "whom the world rightly calls the greatest Jewish scholar," wa cept an invitation (Doc. 147).

Einstein expressed warm interest in the "new [Jewish] colony in P especially in the planned university. He offered to "do everything in [his] po behalf of this cause" and agreed to participate in the conference, "if circumstances allow" (Doc. 155). Only two days later, Bergmann sent Einstein clippings of the dramatic headlines of 7 November in the *Times* of London, announcing the v cation of the general theory of relativity. To Ehrenfest, Einstein reve his main reasons for supporting the cause of the Hebrew University: "This uni sity will be a factor in lessening the number of talented Jews, especially those from Poland and Russia, whose development would otherwise be miserably stunted" (Doc. 160).

One week later, Bergmann requested that a photograph of Einstein be sent urgently to London as he was "*the* hero of the day" and "all the ne "besieging" them for his picture. By late November, Einstein recei invitation to the scholars' conference on the Hebrew University from Shmarya Levin, head of the Zionist Organisation's Education Department in London (Doc. 179).

In early December 1919, Einstein was inclined to attend the planned conference, given that his "name, which since the eclipse expedition is in high f lized for the cause" (Doc. 207). The same month, he was named a member of a working committee to generate interest on behalf of the Hebrew uni German-speaking countries. While promising to attend the planned conference, Einstein was nevertheless doubtful of the effectiveness of such meetings, riddled, in his words, with "too much chatter and useless exhaustion" (Doc. 207). The scholars' conference was then suddenly postponed for various reasons, including poor communication between the Berlin and London bureaus. Members of the Zionist Executive had to remain in Paris for a planned peace conference with T and would thus be unable to attend, while academics would not be a winter break. Einstein continued to stay apprised of the ongoing plans for the university and was asked for a contribution to a "propaganda" brochure that w ther such efforts (Doc. 266).

During his own lectures at the University of Berlin, Einstein was witness to the obstacles faced by the students who might benefit from the establishment of a Hebrew university. On 12 February 1920, his lecture on relativity was interrupted by students protesting his open admission policy that allowed nonregistered auditors to attend (Docs. 311, 312, 315, 317, 320). While Einstein tried to diffuse newspaper reports of chaos and "uproar," he nevertheless acknowledged in an article published a day later that some personal animosity toward him, whose "undertone" could be "interpreted as anti-Semitic," had been voiced, and insisted that classes remain open (see Vol. 7, Doc. 33, and the editorial note "Einstein and the Jewish Question," pp. 221–236). A declaration signed by 294 students a week later (Doc. 320) expressed their regrets for the incident and asked Einstein to continue lecturing.

Einstein's wish to have the university restrictions against free attendance rescinded—a wish he had already expressed a year earlier while lecturing at the University of Zurich (see Doc. 4)—was now translated into concrete action. On 4 February he began a series of free evening lectures on mechanics and relativity theory under the auspices of the Volkshochschule Groß-Berlin. Two weeks later, he proposed to the minister of education, Konrad Haenisch, that two hundred foreign students from Eastern Europe, mostly Jews, who were unable to register at the university, be allowed to gain credits by attending lectures given by accredited Berlin university professors. The request was approved a few days later (Doc. 317 and Vol. 7, Doc. 33, n. 6). During the following weeks, Einstein composed two manuscripts on anti-Semitism (Vol. 7, Docs. 34 and 35) and published a third in the Swiss weekly *Israelitisches Wochenblatt* (see Vol. 7, Doc. 37).

Here again, as is the case in his scientific endeavors discussed earlier, the correspondence in this volume shows that Einstein expressed support for certain Zionist goals as well as other matters related to the education of Jews long before he would articulate such views in published writings.

VIII

As director of the Kaiser Wilhelm Institute of Physics (KWIP), Einstein was presented, during this period, with opportunities to fund independent scientific work that had been stalled, to support individuals whose careers had been interrupted by the Great War, and to encourage new directions in physics research. Founded in October 1917 with Einstein as chairman of its board of directors and Wilhelm von Siemens as chairman of the board of trustees, the KWIP had issued its first solicitation for research grant applications on 16 December 1917 (see Vol. 8, entry of that date in Calendar), and a second on 15 March 1919 (Appendix).[45] Incoming grant applications were submitted to the board of directors—in effect to Einstein—and then, if accepted, forwarded by him to the board of trustees for final appro

As of 31 March 1919, the KWIP disposed of more than 150,000 marks a from the previous and current fiscal year, compared to a budgeted allocation of 60,000 marks for 1919 for "scientific staff and equipment." Between 15 March 1919 and 17 April 1920, Einstein received a total of forty-one applications. F requests had been submitted during 1918 and early 1919, prior to the most recent announcement, and of these 16,030 marks were awarded to Peter Deb ber 1918 toward the purchase of X-ray instrumentation. From among the recent applications, twenty-eight requests were approved. The awards, ranging from 500 M (for cathode tubes to Walter Steubing) to 12,800 M (for spectroscopic instruments to Peter P. Koch), totaled 101,000 marks. While in 1918 Einstein had rejected Gino Mettler's application because the KWIP pursued exclusively theoretical research at the time (see Vol. 8, entry of 3 September 1918 in Calendar), in this period the majority of approved requests, including the ten awards of 5,000 marks or more, were allocated for the purchase of instruments and apparatus.

A preference for granting awards to larger projects can be noted after the directors' meeting of 25 April 1919. One trustee suggested that, in the future, priority should be given to more comprehensive projects that would place German science in a more favorable light on the international stage (see entry of 16 June 1919 in Calendar). Einstein did not, as a rule, comment on how decisions were made or priorities set. Spectroscopy in its widest sense outweighed other proposals, b haps only because the applicants themselves gave increasing attention to molecular and atomic structure.

IX

The one and a half years covered by the present volume fall within a f period[46] during which Einstein did not address quantum theory in his publications. This silence, however, does not attest to a loss of interest. On the contrary this was a period of struggle with quantum theoretical problems for Einstein.

In 1916, Einstein had looked upon Bohr's theory with sympathy: he thought that its basic idea must be maintained because of its great successes.[47] of 1919, when Walter Dällenbach invited him to lecture on quantum theory clined, writing that "I don't feel like lecturing on quantum theory. [M]uch as I ha labored over it, as little have I succeeded in gaining real insight into it. Besides, I have not sufficiently devoted myself to assembling the many details and tricks of which quantum theory is provisionally composed to enable me to gi exhaustive overview" (Doc. 66). Or, as he wrote to Max Born, "One actually ought to be ashamed of the successes [of quantum theory] because they have been won by the Jesuit axiom: 'Let not thy left hand know what thy right hand doeth' "(Doc. 56).

In the letters of this volume we find many hints of Einstein's curiosity and interest in the latest work in this field, even though most of the specific problems that he approached were raised by colleagues, correspondents, and friends. Thus, Paul Epstein conveyed his criticism of the Debye–Sommerfeld theory of dispersion (Doc. 136). He learned more about contemporary research in crystal structure from Hans Thirring (Doc. 146), and presented Max Born and Otto Stern's paper[48] on the same topic to the Prussian Academy of Sciences upon Max Born's request (Doc. 162). Adriaan Fokker informed him of how he had improved upon Kroo's theory of internal electron shells (Doc. 168); Michael Polányi relayed rumors that Einstein was interested in the rotational energy of gas molecules (Docs. 321 and 335), apparently in its connection with Bjerrum's spectrum and the specific heat of gases (Doc. 346). Einstein developed an interest in ion mobility, triggered by Born's investigations on this topic (Doc. 336). When Arnold Sommerfeld asked Einstein to present to the Deutsche Physikalische Gesellschaft a paper on the displacement law, which showed that singly ionized atoms exhibit spectral similarities to the atoms of their immediate neighbors in the periodic table, he assured Einstein that he would not have troubled him had he not been convinced that Einstein was interested in the question (Doc. 12).[49] Otherwise, Einstein and Sommerfeld hardly corresponded on quantum theoretical problems. Einstein felt uneasy with Sommerfeld, even though he could not clearly formulate why (Doc. 248).

Although we lack direct reports, Einstein was an active participant in the Berlin meetings of the Deutsche Physikalische Gesellschaft, and a regular attendant at the sessions of the Prussian Academy of Sciences in Berlin and of Heinrich Rubens's Wednesday colloquia at the University of Berlin. He was also a referee of journal articles and grant applications, and in high demand in all matters concerning academic appointments in physics—all of which provided ample opportunity to be exquisitely informed on recent scientific developments, including experimental and theoretical work related to quantum theory.

Einstein was involved in lively scientific exchanges while visiting Ehrenfest in Leyden, but on the basis of the scattered remarks in the letters exchanged, it is difficult to reconstruct the exact nature of the arguments made. Discussions of phenomena at low temperatures, such as anomalous behavior of specific heats or superconductivity and its destruction by a magnetic field, were of great interest (Doc. 371).

Einstein had high expectations for a personal encounter with Bohr (Doc. 10). In the second half of October 1919, before Einstein visited Leyden, Ehrenfest drew him a charming picture of Bohr: he is "a mind of the very first order, extremely critical and far-seeing, never losing sight of the overall picture" (Doc. 149); "a person of a deep probing mind through whom grand connections come ali 160). In Einstein, this kindled a great interest in Bohr's "kitchen of ideas" and he humbly set out to learn, or rather relearn, quantum theory from Lorentz' books, to reread Bohr's papers (Docs. 160, 165, 189), and to consult Sommerfeld' seminal book (Doc. 284).[50]

This effort did not, however, turn him into a supporter of Bohr' in January 1920 he was convinced that the quantum problem must be solv giving up the continuum, but by finding discrete solutions to f through overdetermination. Nor was he satisfied with statistical considerations: he was reluctant to give up strictly deterministic causality (Doc. 284). As he later explicitly wrote to Polányi, he did not think Bohr's model was correct (Doc. 335). Einstein and Bohr met for the first time in late April 1920.

From now on, Einstein would not consider the future of quantum theory separately from that of relativity. When he complained to Ehrenfest that he w no headway in relativity, he blamed the electromagnetic field that "thw effort" (Doc. 292); and, conversely, when, in his "spare time," he pondered quantum theory, he did so "from the relativistic point of view" (Doc. 284). By March, overdetermination had become a "pet idea" to which, however, he w give "tangible form" (Docs. 336, 371).

Despite frequent laments that in his science he had found nothing ne 189), that he was too busy to do serious work (Doc. 198), and that he felt "empty-handed" (Doc. 265), one gleans from the letters Einstein's preoccupation with a theme that would mature into published papers only very much later and occup him for much of his professional future: the construction of a unif

Einstein's work in this direction developed to some extent in reaction to W unified field theory, which geometrized the electromagnetic field b so-called length connection, i.e., a new geometric object that modif geometry. This work appeared as a competitor to his own endeavors, one that Einstein perceived with an ambivalence ranging from appreciation, through suspicion, to utter contempt. He admired Weyl's theory "as a chain of ideas"(Doc. 59), b a theory of physical reality it was to him "fanciful nonsense" (Doc. 294). By including general relativity into the third edition of his textbook on "Space-T Matter," Weyl had, according to Einstein, "messed it up" (Doc. 332).

Einstein became more seriously engaged in evaluating another proposal to unify gravitation and electromagnetism. In April 1919, Theodor Kaluza (see Illustration 9) sent him a manuscript in which he lays out his idea of extending space-time b an additional spacelike fifth dimension. Kaluza identified the g_{i5} components with the electromagnetic vector potential and showed how the Maxwell equations can be produced by identifying the electromagnetic field components with some of the Christoffel symbols. Einstein's initial reaction was very positive. He at first liked Kaluza's idea "very much," and considered it much more promising "from the physical point of view than the *mathematically* probing approach by Weyl" (Doc. 26). But after receiving the manuscript, and after discussion of some preliminary questions about its physical viability, he found a serious objection that Kaluza was unable to refute. With this objection, Einstein, for the time being, held back his submission of Kaluza's paper, despite his "respect for its beauty and daring" (Doc. 48).

While he dismissed Weyl's and Kaluza's theories on grounds of being, respectively, "removed from factual reality" (Doc. 332) and empirically inadequate, Einstein would nevertheless eventually elaborate on Weyl's theory in a publication of March 1921.[51] Likewise, Kaluza's approach would give rise to a later joint publication of Einstein and Jakob Grommer on the existence of regular, spherically symmetric solutions in the five-dimensional theory.[52]

By late 1919, Einstein was overwhelmed by public attention, and his scientific and administrative activities were trumped by public demands. The success of the eclipse expedition was hailed by those who, like Einstein and Eddington, sought postwar reconciliation in the international scientific community. His newly won fame could be put to good use. Yet the turmoil also extended to the unfortunate Royal Astronomical Society (RAS) gold medal "affair." In December 1919 the RAS voted to award its annual prize to Einstein. By January 1920, however, the confirming vote at the RAS council meeting failed to meet the required two-thirds majority, and as a result, no gold medal would be awarded. Eddington, who had earlier notified Einstein of the expected prize, was obliged to report the embarrassing reversal (Doc. 271). News of what would have been a remarkable distinction, given the political circumstances, had leaked as far as Vienna (Doc. 319), as did subsequent reports that it was not to be (Doc. 319). Eventually, as the German press attempted to come to grips with conflicting reports, at times taking the failed vote as evidence of British resentment toward Germany, Einstein was obliged to say publicly that he had not received a medal (see entry of 9 March 1920 in Calendar). The outcry for and against the award both in England and in Germany reflected the swiftly intensifying public interest in anything related to Einstein, as well as of the uncertain relations and perceptions between two former enemy nations.

Although the general public was not able to appreciate the complexity of Einstein's scientific achievement, the wide publicity accorded to him in the daily European press was contributing to the emergence of an "Einstein cult." Both Einstein and Elsa sensed the idolatry (Doc. 244 and Calendar entry of 10 December 1919): for the Allies, Einstein was a Swiss scholar, not to be barred from the international scientific community; in Germany, he was hailed as the representative of the

defeated nation. His pacifism during the war, his efforts on behalf of the less fortunate, and his concern about the dire conditions caused by the w
unique stature.

In December 1919, Einstein was already complaining that he could not w
amid all the fuss (Docs. 187, 189, 198, 207). It was a condition from which he would never again be entirely free.

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[1] For a discussion of Einstein's heuristics in his discovery of general relativity, see
1999, and for further information about the genesis of general relativity, see the references cited in this work.

[2] For Einstein's earliest attempts to account for the perihelion anomaly by means of a relati
theory of gravitation, see Einstein to Conrad Habicht, 24 July 1907 (Vol. 5, Doc. 69). F
compute the anomalous perihelion advance in the context of his "Entwurf" theory
14, and the editorial note, "The Einstein-Besso Manuscript on the Motion of the Perihelion of Mercury," Vol. 4, pp. 344–359. For the successful account of the anomaly in the final theory
Doc. 24. For further historical discussion of the problem of explaining the perihelion motion, see
man and Janssen 1993.

[3] See *Einstein 1907j* (Vol. 2, Doc. 47), §§19–20.

[4] See *Einstein 1911h* (Vol. 3, Doc. 23), p. 496.

[5] Ibid. and, e.g., Einstein to George E. Hale, 14 October 1913 (Vol. 5, Doc. 477).

[6] See *Einstein 1915h* (Vol. 6, Doc. 24), p. 834, and *Einstein 1916e* (Vol. 6, Doc. 30), §22.

[7] Einstein to Otto Naumann, 7 December 1915 (Vol 8, Doc. 160).

[8] Einstein to Karl Schwarzschild, 29 December 1915 (Vol. 8, Doc. 176).

[9] See Einstein to Erwin Freundlich, 7 December 1913, and ca. 20 January 1914 (V
and 506).

[10] See Docs. 105 and 106 for references by Freundlich and Einstein to the Lick e
report on that expedition was given at a meeting of the Royal Astronomical Society on 11 July 1919 (see *The Observatory* 42, 542 [August 1919]: 297–306), but its results were neve
sten 1983 and *Earman and Glymour 1980* provide accounts of the several pre-1919 Einstein eclipse expeditions.

[11] Erwin Freundlich to Einstein, 17 June 1917 (Vol. 8, Doc. 353).

[12] *De Sitter 1916a*, *1916b*, and *1917*. For Einstein's appreciation of De Sitter'
187.

[13] *Eddington 1917b*, *1918a*, and *1918b*.

[14] See *Dyson 1917* on the initial assessments of a test, and *Dyson et al. 1920*
the expeditions and their results. The following account of the chronology of the British eclipse e
ditions is based mostly on *Dyson et al. 1920*, as well as on *Crelinsten 1983*, *Earman and Glymour 1980a*, *Sponsel 2002*, and *Stanley 2003*.

[15] *Birck 1917*.

[16] See Vol. 7, Doc. 19, pp. 147–149, and this volume, entry of 15 April 1919 in Calendar

[17] Eddington's telegram read "Through cloud. Hopeful." Crommelin's first tele
splendid." The members of the British expedition had agreed on a code to be used for the tele
but Eddington had departed from the agreed conventions in saying that he was hopeful of obtaining good results.

[18] See Doc. 61, note 4, and "Meeting of the Royal Astronomical Society," *The Observatory*
541 (July 1919): 261–262.

[19] Einstein's 1911 prediction was often advertised by Eddington and others of the eclipse team as the Newtonian prediction, because it could be derived in the so-called Newtonian order of approximation of general relativity theory, as well as within the old Newtonian theory under th

of a corpuscular nature of light. Eddington gave slightly different numbers for Einstein's theoretical predictions (0.87″ and 1.75″); see Doc. 110, n. 3.

[20] See *Nature* 104, no. 2603 (September 18, 1919): 51 and *Report 1920*, p. lix.

[21] See *Sponsel 2002*, p. 455. The report of the meeting in the October issue of The Observatory only said that "it is impossible to give results yet," adding that the "Greenwich plates should be measured and reduced in a few weeks" (*The Observatory* 42, 544 (October 1919): 364). Accounts of the BAAS meetings that provided Eddington's numbers were published in *Report 1920*, pp. 156–157, and *Nature* 104, no. 2618 (January 1, 1920): 454–455.

[22] See also *Elton 1986*, p. 97, where it is suggested that Einstein's published note was in response to an article appearing in the German press, which somewhat overstated what was known about the eclipse results to that date.

[23] See, e.g., *Vossische Zeitung* of 15 October 1919.

[24] See *Sponsel 2002*, p. 456, for a discussion of Eddington's presentation, and n. 63 for a list of those present.

[25] *Moyer 1979*; *Crelinsten 1980a, 1980b*; *Sponsel 2002*.

[26] *Elton 1986*.

[27] For historical accounts of the solar redshift problem, see *Forbes 1961* and *Hentschel 1993*.

[28] For a discussion of Julius's theory of anomalous dispersion, see *Hentschel 1991a*.

[29] *Schwarzschild 1914*.

[30] See *St. John 1917* and Evershed 1918.

[31] See *Hentschel 1997*, chap. 4, for an account of the debate around Freundlich's initial statistical investigation of the solar redshift.

[32] *Eddington 1920a*.

[33] *St. John 1920b*.

[34] *St. John 1920a*.

[35] *Guillaume 1920* and *Eddington 1920c*.

[36] See *Hentschel 1993*.

[37] See Ilse Rosenthal-Schneider, ”Erinnerungen an Gespräche mit Einstein," typescript, 25 July 1957 [20 295], and *Rosenthal-Schneider 1980*, p. 74. See also *Hentschel 1998* for a discussion of this episode.

[38] See also *Einstein 1921f* (Vol. 7, Doc. 56).

[39] For a historical discussion of Mach's principle before Einstein, see *Norton 1995*.

[40] A somewhat similar prediction of relativity, known as the geodetic precession, appears for the first time in Einstein's correspondence in early 1919 (Doc. 10), following the work of the Dutch mathematician Jan Schouten.

[41] For Einstein's pacifism during World War I, see *Goenner and Castagnetti 1996*.

[42] See *Arco et al. 1919*.

[43] See *Geiger et al. 1920*.

[44] For a detailed account of the plans for extablishing the Hebrew University during this period, see *Lavsky 2000*.

[45] For historical accounts of the Kaiser Wilhelm Institute of Physics and Einstein's role, see *Schlüter 1995* and *Kant 1996*.

[46] From *Einstein 1917d* to *Einstein 1922*.

[47] *Einstein 1916f*.

[48] *Born and Stern 1919*.

[49] *Kossel and Sommerfeld 1919*.

[50] *Sommerfeld 1919*.

[51] *Einstein 1921e* (Vol. 7, Doc. 54).

[52] *Einstein and Grommer 1923*.