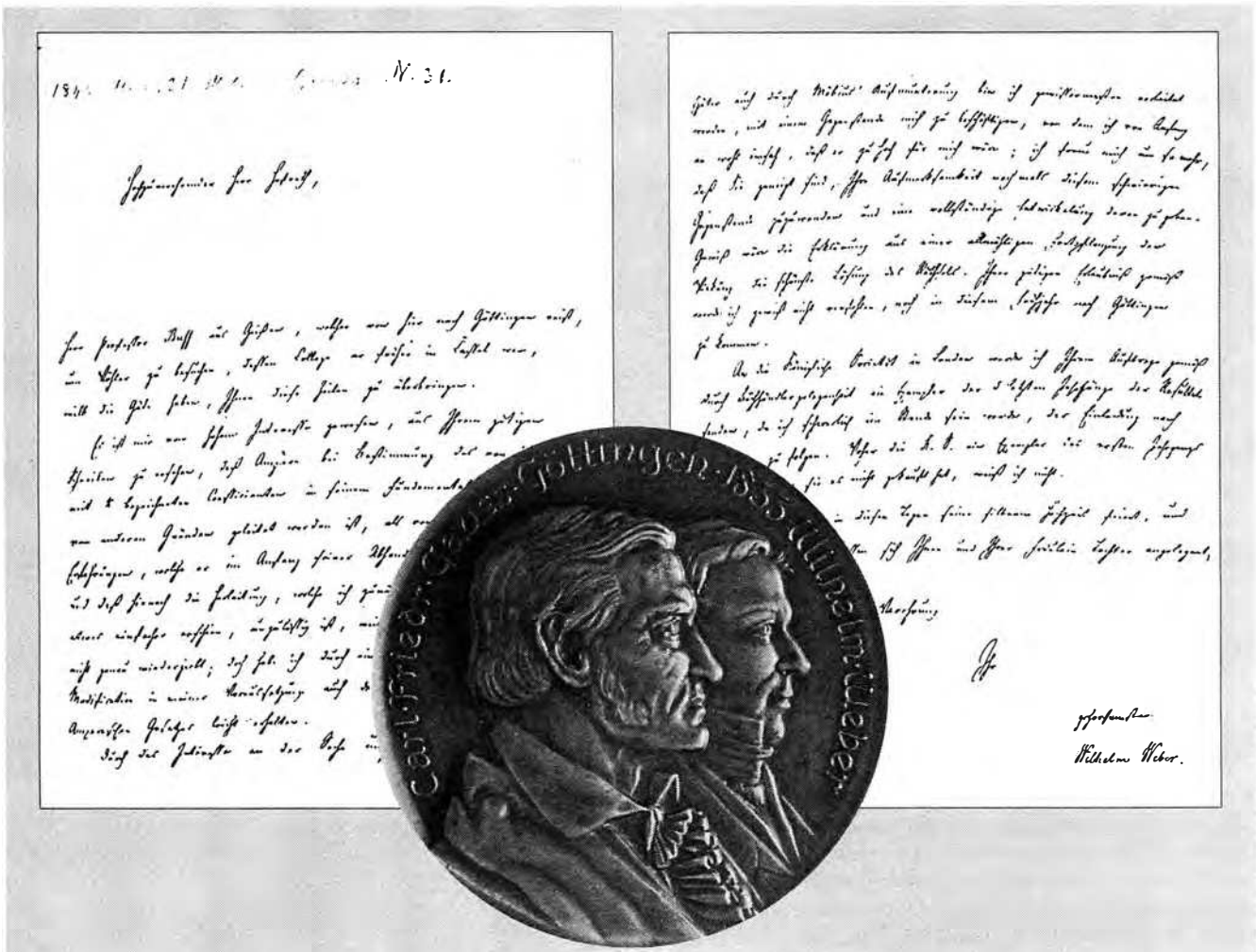


Courtesy of the George August Physics Institute at Göttingen University

Text of the Gauss-Weber 1845 Correspondence

EDITOR'S NOTE

The letters from Weber to Gauss, numbered 29 to 31, come from the Gauss manuscripts in the Manuscripts and Rare Books Division of the State and University Library of Lower Saxony, in Göttingen. They were transcribed from the German script by Karl Krause and Alexander Hartmann. The letter from Gauss to Weber of 19 March appears in Carl Friedrich Gauss, Werke, *Vol. V, pages 627-629. All the letters were translated into English by Susan P. Johnson. The words in brackets are added by the translator; the footnotes are by the editor.*

Above: Commemorative medal honoring Carl Friedrich Gauss and Wilhelm Weber, issued in 1933. In background is a facsimile of Weber's 31 May 1845 letter to Gauss.

Weber to Gauss,
No. 29, 18 January 1845

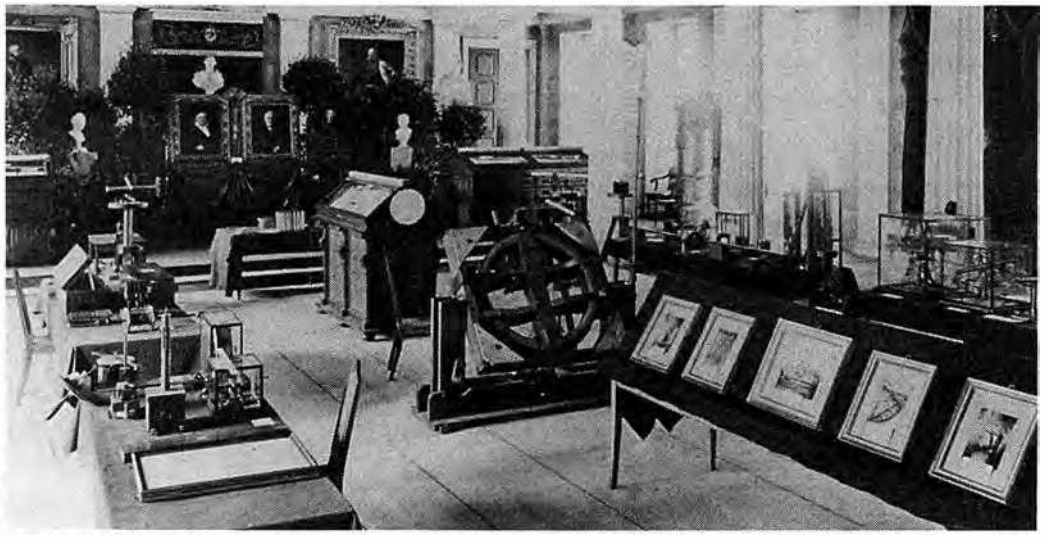
Highly honored Herr Hofrath:[1]

. . . For some time now, I have occupied myself with a treatise, which I would like to present to the Royal Society in Göttingen; now that I am finished, however, I do not dare to venture a sound judgment, either about its correctness in your eyes, or about whether it is worthy of being presented to the Society, and therefore I would by far prefer to leave both to your benevolent decision. Hence I submit them to you with the request, that you will be good enough to look at them at your convenience, when your time permits. . . .

With heartfelt affection and respect.

Leipzig, 1845, January 18

Your devoted,
Wilhelm Weber



Courtesy of the George August Physics Institute at Göttingen University

An exhibit honoring Gauss and Weber in June 1899 at Göttingen University. Portraits of the scientists are surrounded by their experimental apparatus and illustrations of their experiments. On the tables at left are various electrical and magnetic apparatus. The large coil in the center mounted on a wooden dolly is from the Earth inductor, which can still be seen today in the Gauss House at Göttingen.

* * *

Weber to Gauss,
No. 30, 1 February 1845

Highly honored Herr Hofrath:

I have just noticed, that in the manuscript I recently sent to you, there is apparently missing a note regarding Ampère's formula, which would be necessary in order to understand it. Namely, Ampère has given a more general expression, for the interaction of two current elements, than I introduce there, which I seek to justify, by means of the consideration that the empirically derived definition of the coefficient of the second term, which I have discarded, seems completely untrustworthy, because of the unreliability of the method, and hence that coefficient, so long as it lacks a more precise quantitative determination, by the same reasoning would have to be set = 0. If I am not in error, you yourself earlier expressed certain thoughts about discarding the negative value which Ampère assumed for that coefficient by means of which two current elements, one following the other, would have to mutually repel one another.

With heartfelt respect.

Leipzig, 1845, February 1

Your most devoted,
Wilhelm Weber

* * *

Gauss to Weber,
19 March 1845

Esteemed friend:

Since the beginning of this year, my time has been incessantly taken up and frittered away in so many ways, and on the other hand, the state of my health is so little favorable to sustained work, that up to now, I have not been in any position to go through the little treatise you were so good as to send me, and to which I just now have been able to give a first quick glance. This, however, has shown me that the subject belongs to the same investigations with which I very extensively occupied myself some 10 years ago (I mean especially in 1834-1836), and that in order to be able to express a thorough and exhaustive judgment upon your treatise, it does not suffice to read through *it,* but I would have to first plunge into study of my own work from that period, which would require all the more time, since, in the course of a preliminary survey of papers, I have found only some fragmentary snatches, although probably many more will be extant, even if not in completely ordered form.

However, if, having been removed from that subject for several years, I may permit myself to express a judgment based on recollection, I would think, to begin with, that, were Ampère still living, he would decidedly protest, when you express Ampère's law by means of the formula

$$-\frac{\alpha\alpha'}{rr} ii' \sin\theta \sin\theta' \cos\epsilon \qquad \textbf{(I)}$$

since that is contained in a wholly different formula, namely

$$-\frac{\alpha\alpha'}{rr} ii' \left(\tfrac{1}{2}\cos\theta \cos\theta' + \sin\theta \sin\theta' \cos\epsilon\right). \qquad \textbf{(II)}^2$$

Nor do I believe that Ampère would be satisfied by the appended note, which you mention in a later letter, namely, where you cast the difference in such a way, that Ampère's formula would be a *more general one,* just like

$$-\frac{\alpha\alpha'}{rr}(F\cos\theta \cos\theta' + G\sin\theta \sin\theta' \cos\epsilon)$$

where Ampère experimentally derived $F = {}^1/_2\, G$, while, because Ampère's experiments may not be very exact, you think that with equal correctness, you can claim that $F = 0$. In any other case than the present one, I would concede that in this discordance between you and Ampère, a third party would perhaps clarify the matter as follows, that:

whether one (with you) views this as merely a modification of Ampère's law, or

whether (as, in my estimation, Ampère would have to view the matter), this is nothing less than a complete overturning of Ampère's formula, and the introduction of an essentially different one,

is at bottom little more than idle word-play. As I said, in any other case I would gladly grant this, since no one can be *in*

verbis facilior [more easy-going in matters of verbal formulation] than I. However, in the present case the difference is a vital question, for Ampère's entire theory of the interchangeability of magnetism with galvanic currents depends absolutely on the correctness of Formula II and is wholly lost, if another is chosen in its place.

I cannot contradict you, when you pronounce Ampère's experiments to be not very conclusive, while, since I do not have Ampère's classic treatise at hand, nor do I recall the manner of his experiments at all, nonetheless I do not believe that Ampère, even if he himself were to admit the incompleteness of his experiments, would authorize the adoption of an entirely different formula (I), whereby his entire theory would fall to pieces, so long as this other formula were not reinforced by *completely decisive* experiments. You must have misunderstood the reservations which, according to your second letter, I myself have expressed. Early on I was convinced, and continued to be so, that the above-mentioned interchangeability *necessarily* requires the Ampère formula, and allows no other which is not identical with that one for a closed current, *if the effect is to occur in the direction of the straight lines connecting the two current elements;* that, however, if one relinquishes the just-expressed condition, one can choose countless other forms, which for a closed current, must always give the same end result as Ampère's formula. Furthermore, one can also add that, since for this purpose it is always a matter of effects at measurable distances, nothing would prevent us from presupposing that other components might possibly enter into the formula, which are only effective at immeasurably small distances (as molecular attraction takes the place of gravitation), and that thereby, the difficulty of the repulsion of two successive elements of the same current could be removed.

In order to avert misunderstanding, I will further remark, that the Formula II above can also be written

$$-\frac{\alpha\alpha'}{rr} ii' \left(-\tfrac{1}{2}\cos\theta\cos\theta' + \sin\theta\sin\theta'\cos\epsilon\right)$$

and that I do not know, whether Ampère (whose memoire, as I said, I do not have at hand) used the first or the second notation. Both of them signify the same thing, and one uses the first form, when one measures the angle θ, θ' with the same delimited straight line; thus, this line determines the side of the second angle in the opposite way, but determines the other form, when one is considering a straight line of indeterminate length, and, for the measurement of angle θ, θ', one resorts to that line twice, in one sense or another. And, likewise, one can place a + sign in front of the whole formula instead of the − sign, if one is considering as a positive effect, not repulsion, but attraction.

Perhaps I am in a position to again delve somewhat further into this subject, which has now grown so remote from me, by the time that you delight me with a visit, as you have given me hope that you will do at the end of April or the beginning of May. Without a doubt, I would have made my investigations public long ago, had it not been the case that at the point where I broke off, what I considered to be the actual keystone was lacking

Nil actum reputans si quid superesset agendum

[Discussions accomplish nothing, if work remains to be done]

namely, the *derivation* of the additional forces (which enter into the reciprocal action of electrical particles at rest, if they are in relative motion) from the action which is *not instantaneous,* but on the contrary (in a way comparable to light) propagates itself in time. At the time, I did not succeed; however, I recall enough of the investigation at the time, not to remain wholly without hope, that success could perhaps be attained later, although—if I remember correctly—with the subjective conviction, that it would first be necessary to make a constructible representation of the *way* in which the propagation occurs.

With hearty greetings to your brothers and sister and to Professor Möbius.

Göttingen, 19 March 1845

Ever yours,
C.F. Gauss

* * *

Weber to Gauss,
No. 31, 31 March 1845

Highly honored Herr Hofrath:

Professor Buff from Giessen, who is travelling from here to Göttingen, in order to visit Woehler, his former colleague in Cassel, will have the goodness to bring you these pages. It has been of great interest to me to learn from what you were kind enough to write, that Ampère, in the definition of the coefficient he calls *k* in his fundamental law, was guided by other reasons, than the ones from immediate empirical experience which he cites at the beginning of his treatise, and that hence the derivation, which I first gave, because it seemed somewhat simpler, is inadmissible, because it does not reproduce Ampère's law with exactness; yet, by means of what seems to me to be a slight modification in my premise, I have easily obtained the exact expression of Ampère's law.

Through the interest taken in the matter, and through the encouragement of Fechner and later Möbius, I have been induced to occupy myself up to a point, with a subject which I conceived from the start might well be beyond me; I am all the happier that you are inclined to turn your attention once more to this arduous subject, and to give a complete development of it. Certainly, the explanation derived from a gradual propagation of the effect would be the most beautiful solution of the riddle. In response to your kind invitation, I will certainly not fail to come to Göttingen by the end of this spring.

In conformity with your instructions, I will send to the Royal Society in London a copy of the five last annual summaries of the *Resultate,* by way of the book dealer, since it will be difficult for me to pursue the invitation to Cambridge. Whence the Royal Society has obtained a copy of the first annual summary, I do not know, since they did not buy it.

Möbius, who is now celebrating his silver wedding anniversary, and my sister, remember themselves to you and your daughter with the greatest regard.

With the most heartfelt respect.

Leipzig, 1845, March 31

Your most devoted,
Wilhelm Weber

Notes

1. The title by which Weber addressed Gauss is approximately translated as "Mr. Court Councillor."
2. This seems to be Gauss's only error of memory: The epsilon should be an omega.