falling on the cell.

Curve A (Fig. 2) was the curve obtained for the oscillating lines, while curve B was the curve obtained for the non-oscillating lines. At half maximum amplitudes the width of the oscillating $K\alpha_1$ line was found to be 0.600 mm, while the width of the non-oscillating $K\alpha_1$ line was found to be 0.540 mm. The values for the widths of the $K\alpha_2$ lines were practically the same at half amplitudes as those of the $K\alpha_1$ lines. If we take the area under the loops as proportional to the intensity of the lines, we find that the $K\alpha_1$ oscillating line is about 1.5 times as intense as the $K\alpha_1$ non-oscillating line, and that the $K\alpha_2$ oscillating line is about 1.5 times as intense as the $K\alpha_2$ non-oscillating line.

It is interesting to note that if we take $\Delta D/D$ to be $\frac{1}{4}$ the magnitude of dL/L where $\Delta D/D$ is to represent the elastic deformations of the plane spacings for the (1 1 0) set which is at right angles to the elastic deformations of magnitude dL/L; and substitute the value in the relation: $dS=2r(\Delta D/D)\tan\theta$, where r is the crystal-to-film distance, and θ is in our case 60.3°, we have for dS the following: $dS=0.0525$ mm. The oscillating lines were found to be 0.060 mm wider at half maximum amplitudes than the non-oscillating lines.

It is not at present known whether this effect obtained is due to extinction reduction solely or whether it is a combination of extinction reduction and elastic deformations of the plane spacings. Experiments are now in progress in which an attempt will be made to take Bragg reflections from quartz plates which are deformed mechanically and in a homogeneous fashion. A detailed account of the experiments performed in this laboratory and further conclusions will be given at an early date.

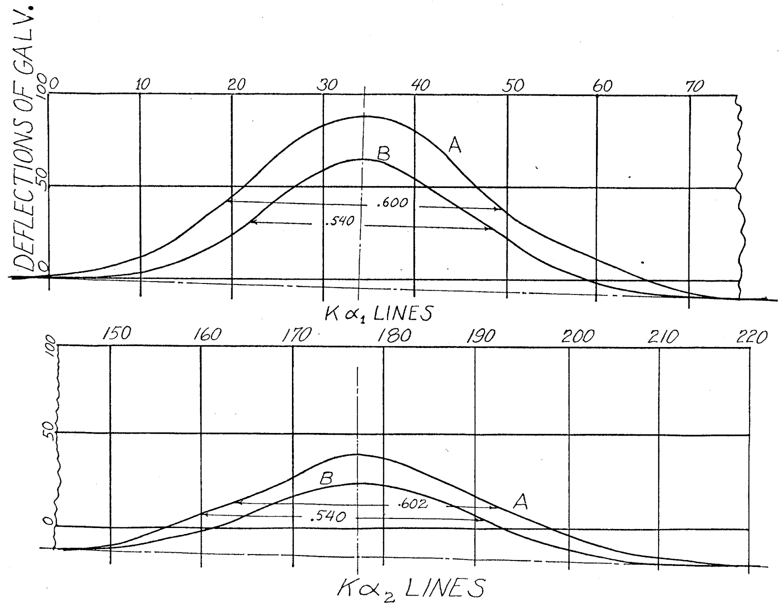

Fig. 2. Settings of ruling machine. One setting = 0.02 mm.

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Sidon Harris

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University of Texas,
November 8, 1932.

Determination of e/m for an Electron by a New Deflection Method

In spite of the many measurements which have been made of the specific charge of the electron, there is still some uncertainty especially in connection with the value obtained from free electron measurements. Although two recent measurements[1,2] on free electrons

[1] C. T. Perry and E. L. Chaffee, Phys. Rev. **36**, 904 (1930).

[2] F. Kirchner, Ann. d. Physik [5] **8**, 975 (1931) and [5] **12**, 503 (1932).

in which linear acceleration was used have yielded "low" values of e/m in fair agreement with the spectroscopic value $(1.761 \pm 0.001) \times 10^7$ *em* units, there remains the fact that the apparently very precise work of Wolf[3] using a deflection method gave a high value $(1.7689 \pm 0.0018) \times 10^7$ *em* units. Hence, it is important that a new deflection determination be made with an accuracy sufficient to determine if the discrepancy is real or due to some unknown sources of error. Secondly, an accurate value of e/m is needed in the very important method that has been developed by Bond[4] and Birge[5] of obtaining the most probable values of the physical constants e, h, e/m and α. Not only does the value of e/m influence the values obtained for the other constants but also the major portion of the uncertainty of the results is due to the uncertainty in e/m.

The new deflection method being used was conceived by Professor Ernest O. Lawrence and was most kindly offered to the author as a means of obtaining the results mentioned above. The success of this new determination was made possible by the important advantages of this method over previous ones. The method is essentially as follows. An evacuated brass box B contains six slits labeled A, S and D which are on a circle of radius r. The slits S and the outer slits at A and D are integral parts of the box, while the inner slits at A and D are separate from it and are connected to the output of a radio-frequency oscillator. The box is connected to the grounded side of the output. During the half of each cycle in which the box is positive, electrons are accelerated across the slits at A and leave the outer slit with velocities ranging from zero to that corresponding to the peak voltage of the oscillator. These electrons are bent in circles of various radii by a magnetic field having a direction into the plane of the sketch and produced by a pair of Helmholtz coils. For any given magnetic field H, electrons having a velocity v given by the radial force equation $mv^2/r = Hev$ (*em* units) will be bent around through the slits S and arrive at D where they will experience a further acceleration or deceleration depending on the time of arrival relative to the radio-frequency cycle. If a magnetic field is chosen with a related electron velocity such that the time required for the electrons to travel from A to D is one period, then the electrons in traversing the slits at D experience a deceleration exactly equal to the acceleration they received at A and consequently are stopped and fail to reach the collector C. For any other magnetic field a simple analysis shows that half of the electrons passing through the slits S will reach the collector. Hence e/m is determined by the conditions existing when the current to the collector is zero (in reality when it is a minimum). The electron velocity necessary to travel from A to D in one cycle is given by $v = r\theta/T$, where T is the period of the oscillator and θ the angle subtended by the path; or since the frequency $\nu = 1/T$ the velocity is given by $v = r\theta\nu$. Eliminating the velocity by combining this equation with that given above for the radial forces gives the relation

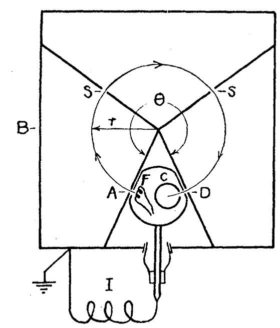

Fig. 1.

for obtaining e/m, namely $e/m = \theta\nu/H$ *em* units. Here θ is in radians and H is in gauss.

A most important advantage of this method over other free electron methods is that no accelerating voltage need be measured since it is not necessary to know the electron voltage. This feature combined with a modification in the method not described above (due to space limitations) *practically eliminates all errors due to contact potentials* except those due to stray electric fields in the deflecting regions of the box. Due to the construction the latter are necessarily small. Further, the observational precision which the method gives is very good. For example, fifty magnetic field readings (the frequency being held constant) were of such constancy that the observational probable error in e/m was only one part in 100,000.

[3] Fritz Wolf, Ann. d. Physik [4] **83**, 849 (1927).

[4] W. N. Bond, Phil. Mag. **10**, 994 (1930) and **12**, 632 (1931).

[5] R. T. Birge, Phys. Rev. **40**, 228 (1932).

The present results, although still of a preliminary nature, are of an accuracy comparable with present published values. Observations have been taken at two frequencies since constancy of results with change in frequency is of primary importance. With a change in frequency of about 30 percent two frequency runs made up of about 90 observations each gave results differing by only two parts in 10,000. The weighted value of e/m obtained from these two groups of observations with the calculated probable error is $e/m_0 = (1.7592 \pm 0.0006) \times 10^7$ *em* units. The major part of this probable error is due to allowance for possible errors in the magnetic field measurement. However, to allow for still other possible errors in the experiment the present result may be stated as $e/m_0 = (1.7592 \pm 0.0015) \times 10^7$ *em* units. This result is somewhat lower but not in disagreement with the accepted spectroscopic value. It is in good agreement with Kirchner's results.[3] A more detailed description of the method and results will be published soon.

The writer is indebted to Professor Ernest O. Lawrence not only for the method, as mentioned above, but also for many helpful discussions during the development of the method.

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University of California,
November 12, 1932.

The Value of e/m

During the past two years there have appeared four direct determinations of e/m, each of high accuracy. These results are:[1] (1) C. T. Perry and E. L. Chaffee,[2] $e/m = 1.761 \pm 0.001$, from electrostatic acceleration of free electrons. (2) F. Kirchner,[3] $e/m = 1.7585 \pm 0.0012$ and 1.7590 ± 0.0015, from two different investigations, by the same method as (1). The weighted average is 1.7587 ± 0.0009, with the probable error based on internal consistency. The probable error from external consistency is, by chance, only ± 0.00016. (3) J. S. Campbell and W. V. Houston,[4] $e/m = 1.7579 \pm 0.0025$, from Zeeman effect measurements. (4) F. G. Dunnington,[5] $e/m = 1.7592 \pm 0.0015$, from magnetic deflection of free electrons.

The weighted average of these four results, based on three radically different methods, is $e/m = 1.75953 \pm 0.00043$, from external consistency, or ± 0.00059 from internal consistency. This is a very satisfactory agreement and tends to indicate that the probable error assumed by each investigator is a reasonable estimate. In each case, however, this assumed error is essentially a personal estimate by the investigator, and includes an arbitrary allowance for possible systematic errors of various kinds. Each of the four investigations seems, from superficial examination, to be of essentially the same accuracy. With this new assumption one obtains for the (unweighted) average, $e/m = 1.75920 \pm 0.00044$. This happens to be identical with Dunnington's value. I think that $(1.759 \pm 0.001) \times 10^7$ *em* units may be taken as a conservative estimate of the present most probable direct evaluation of e/m.

I should like to take this occasion to call attention to a numerical error in my recent paper[6] on certain general constants. On page 257 the correct value of $e_{3/4}$, resulting from $h_{4/3} = 6.5431 \pm 0.0042$, is 4.7721 ± 0.0023, and not 4.7738 ± 0.0041 as given. This makes the results of solutions k and l incorrect. The correct results of solution k are $h = 6.5432 \pm 0.0083$, $e = 4.7683 \pm 0.0038$, $e/m = 1.7611 \pm 0.0011$, $1/\alpha = 137.310 \pm 0.048$. Solution l is based on $e/m = 1.759 \pm 0.001$, as now adopted for the best direct value. The resulting values of e, h, etc., in solution l, corrected for the above error, may accordingly be considered the present most probable values. These corrected results are,

$$-h = (6.5420 \pm 0.0083) \times 10^{-27} \text{ erg}\cdot\text{sec.},$$
$$e = (4.7668 \pm 0.0038) \times 10^{-10} \textit{ es} \text{ units},$$
$$e/m = (1.7592 \pm 0.0011) \times 10^7 \textit{ em} \text{ units},$$
$$1/\alpha = 137.374 \pm 0.048.$$

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University of California,
November 12, 1932.

[1] This list does not include a very recent value by G. G. Kretschmar (Chicago, November, 1932 meeting of the American Physical Society) of 1.7555 ± 0.0026, since his method requires a knowledge of other fundamental constants.

[2] C. T. Perry and E. L. Chaffee, Phys. Rev. **36**, 904 (1930).

[3] F. Kirchner, Ann. d. Physik **12**, 503 (1932).

[4] J. S. Campbell and W. V. Houston, Phys. Rev. **38**, 581 (1931).

[5] F. G. Dunnington, Phys. Rev. **42**, 739 (1932).

[6] R. T. Birge, Phys. Rev. **40**, 228 and 319 (1932).