tained from tables on page 24 of Rutherford, Chadwick and Ellis' book "Radiations from Radioactive Substances". The observed values of λ for the γ-radiation were taken from tables in the same book.

The observed λ's in Table I are the longest wave-lengths listed for the elements concerned, and are the strongest, or one of the strongest lines in the γ-ray spectrum of those elements.

TABLE II. *γ-ray spark spectrum of AcX, AcX II.* $Z=2$; $t'=10$; $t_2=2$.

t_1	Cal. $\tilde{\nu}$	Cal. λ	Obs. λ	Int. obs.
3/4	$22.6\times10^8\text{cm}^{-1}$	44.2 X.U.	45.9 X.U.	130
7/8	15.63	64.0	61.7	25
15/16	13.1	76.3	78.6	80
31/32	12.0	83.3	80.6	180
1	11.10	90.1	86.0	155

The AcX lines in Table II include all the AcX lines listed by Rutherford, Chadwick and Ellis. The intensities listed are estimated intensities from the intensity of β-ray lines.

The agreement between the computed and observed λ's is good and most surprising, perhaps, is the fact that the AcX lines can be represented by a spectroscopic series formula where t_1 takes on values of 3/4, 7/8, 15/16, 31/32, · · · , 1. This is quite a different form from the series in optical spectra.

The intensities of the lines are peculiar.

Other radioactive spectra are being examined and a detailed report of all data will be published soon.

P. G. KRUGER
Department of Physics,
University of Illinois,
Urbana, Illinois,
March 24, 1932.

Probable Values of e, h, e/m and α,—An Addition

My complete article on this subject (to be denoted G. C. 1932) appears elsewhere in the present issue. The purpose of this letter is to make two corrections and also two additions.

(1) In discussing Bearden's grating measurements of x-rays, I used accidentally the values given by Bearden in a preliminary paper, footnote 30 of G. C. 1932. Fortunately the results given in his full paper[1] differ from the preliminary values by an entirely negligible amount.

(2) It was stated in G. C. 1932 that Bond, by using only my Eq. (1), failed to carry the new method to its logical conclusion as embodied in Eq. (2). It is true that Bond used only Eq. (1), but I overlooked the fact that, in a footnote, page 633 of reference 3, G. C. 1932, he remarked "By assuming a value of h, and plotting all the deduced values of e against $1/m$, the direct estimates of e could also be plotted at $1/m=0$. The increase in accuracy would, however, be negligible." This is essentially a statement of Eq. (2), which Professor Brode quite independently suggested to me, as noted in G. C. 1932.

(3) I remarked in G. C. 1932, that the true value of e/m might well be 1.760 or even lower but it seemed better to retain, for the present, the 1929 spectroscopic value of 1.761. Since this was written new evidence has appeared that favors such a lower value. Kirchner[2] corrects his previous determination, 1.7598 ±0.0025, to 1.7585±0.0012, and from new measurements obtains 1.7590±0.0015. In order to show explicitly the dependence of the various constants on the value adopted for e/m, I have made a new solution (to be called solution l) that is similar to my final solution k, except that one assumes $e/m=1.759\pm0.001$ in place of 1.761 ± 0.001. The resulting probable errors are again based on internal consistency ($r_e/r_i=0.571$), and are therefore identical with the errors of solution k, since the weights of the data are unchanged. The results are $h=6.5442\pm0.0091$, $e=4.7677\pm0.0040$, $1/\alpha=137.369\pm0.048$, $e/m=1.7591\pm0.0009$.

From solutions k and l one can now obtain, by mere linear interpolation, values of the constants that correspond to any intermediate value of e/m. The value of h is thus seen to be, over this range, almost independent of the

---

[1] J. A. Bearden, Phys. Rev. **37**, 1210 (1931).

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

value of e/m, and the various possible values of e all lie very close to the oil-drop value 4.768 ± 0.005. It may be of interest to note that the value $1/\alpha = 137.348$, given by the theory of ultimate rational units[3] corresponds to $e/m = 1.7597$.

(4) Dr. Bond has kindly sent me the advance proof of a paper that he presented to the London Physical Society on February 19, 1932. In this paper Bond discusses, among other things, Eddington's most recent theory[4] concerning the ratio of the mass of the proton to that of the electron ($M_P/m = R$). This theory, which was not mentioned in G.C. 1932, gives R as the ratio of the two roots of the equation $10x^2 - 136x + 1 = 0$. The coefficients 10 and 136 denote the number of degrees of freedom of certain elementary systems. The resulting value of R is 1847.599464. From this value one can calculate e/m, since $e/m = (R+1)F/\mathrm{H}^1$, where F is the Faraday, 9648.9 ± 0.7 abs. e.m. units, and H^1 is the atomic weight of the chief isotope of hydrogen. The value of H^1 is best calculated from Aston's measurement of the atomic mass, reduced to the chemical scale. Recent evidence from band spectra indicates that Aston's probable error can be taken conservatively as one-third his stated limit of error. The value of H^1 is thus 1.00756 ± 0.00005, and it was from this result that Birge and Menzel[5] predicted the existence of an isotope of hydrogen, of mass 2 and relative abundance $\mathrm{H}^1/\mathrm{H}^2 = 4500$. This isotope has subsequently been found,[6] with almost exactly the predicted abundance. The resulting value of e/m is 1.77031 ± 0.00014.

This value of e/m, used in connection with Bohr's formula for the Rydberg constant, gives one theoretical relation between e and h. Eddington's theory that $1/\alpha = 137$ yields a second relation between e and h. From these two theories one thus obtains $h = 6.5490 \pm 0.0011$, $e = 4.775855 \pm 0.000048$. The stated probable errors arise from the probable errors in F, H^1 and c. The error in R_∞ is negligible. In the Physical Society paper Bond calculates similar results, but he apparently did not consider the mass 2 isotope of hydrogen, so that his numerical results differ somewhat from mine. His probable error for $e(\pm 0.0004)$ is also much larger.

With these predicted values of e, h and e/m, one obtains $\sigma = 5.7365$, very close to my adopted value 5.735 ± 0.011, $c_2 = 1.4304$, fairly close to my adopted 1.432 ± 0.003, and $h_{3/3} = 6.5410$, close to 6.543, the best photoelectric result. Eddington's theories are, however, in definite disagreement with the newer experimental values of e/m, and in mild disagreement with the oil-drop value of e. The foregoing calculations have been made in order to show precisely the numerical consequences of these new theories, which Bond claims are in satisfactory agreement with existing data. The writer cannot, at this time, subscribe to such a conclusion.

Raymond T. Birge

University of California,
March 25, 1932.

---

[3] G. N. Lewis and E. Q. Adams, Phys. Rev. (2) **3**, 92 (1914).

[4] A. S. Eddington, Proc. Roy. Soc. **A134**, 524 (1931).

[5] R. T. Birge and D. H. Menzel, Phys. Rev. **37**, 1669 (1931).

[6] H. C. Urey, F. G. Brickwedde and G. M. Murphy, Phys. Rev. **39**, 164 (1932).