LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveres in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the twentieth of the preceding month; for the second issue, the fifth of the month. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

X-Ray Wavelength Scales

(1) In a recent paper the author[1] presented a new method for obtaining x-ray terms and discussed the experiments of Kretschmar and of Robinson, Andrews and Irons, on the energies of photoelectrons ejected by x-rays, in the hope of deciding between the crystal and ruled grating wavelength scales. The discussion was based on current values of the universal constants and the result was this: Measured energies of photoelectrons are 0.36 percent higher than those computed from crystal values of x-ray wavelengths, which in turn are 0.25 percent higher than values deduced from grating measurements. Thus the photoelectric measurements appeared to support the validity of the crystal scale, but it was specifically stated that errors in the values of universal constants might be large enough to reverse such a conclusion.

New experiments by Bearden and Shaw[2] show that refractive index measurements yield wavelengths in agreement with unruled grating values, and Bäcklin[3] finds that the ruled grating wavelength of Al $K\alpha$ exceeds the crystal value by the *same percentage discrepancy* which Beardon has consistently found for lines of much shorter wavelength. These experiments indicate very strongly that ruled grating wavelengths are essentially correct and that crystal wavelengths differ from them by a constant factor because of the use of an incorrect value of the calcite spacing, d. This spacing is connected with the electronic charge e by the equation

$$d = fe^{1/3}, \tag{1}$$

where f is a factor containing quantities which are accurately known. It will conduce to clarity if we remind the reader that there are really three scales to be considered, based on three methods of obtaining d, as follows:

(I) The so-called crystal scale; $d_a = 3027.85 \cdot 10^{-11}$ cm at 18°C. This value is obtained by using $e = 4.7668 \cdot 10^{-11}$ e.s.u.
(II) Conventional scale of Siegbahn. Wavelengths are expressed in X. U., and by definition the calcite spacing d_c is 3029.45 X. U.
(III) The grating scale. Using Bragg's law and grating wavelengths, one obtains a value d_g for the calcite spacing. Eq. (1) then gives the corresponding value of e.

Using the third method, Bäcklin gets

$e = 4.805 \cdot 10^{-10}$ e.s.u. (Precision not stated.)

in agreement with Bearden's[4] value $(4.806 \pm 0.003)\ 10^{-10}$ e.s.u.

(2) Adoption of d_g removes, of course, the discrepancy between grating and crystal wavelengths. The purpose of this note is to show that *if we adopt the Bearden-Bäcklin value of* e *and the Shane-Spedding*[5] *value,* $e/m = (1.7579 \pm 0.0003)\ 10^7$ e.m.u./g., *then the puzzling discrepancy between measured photoelectron energies and those computed from x-ray wavelengths is entirely explained.*

The argument depends on the fact that

$$e^{5/3}/h = (R_\infty c^2/2\pi^2)^{1/3}(e/m)^{1/3}. \tag{2}$$

The factors in the first parentheses are accurately known, and $e^{5/3}/h$ is relatively insensitive to errors in e/m, so we know its value very well indeed. The consequence is, that in the writer's above-mentioned paper we should decrease e/m by 0.07 percent, and e/h by 0.56 percent, which means that ν/R values of photoelectrons are decreased by approximately 0.63 percent.

After my paper had gone to press, Professor Robinson applied an average correction of -0.15 percent to his photoelectron energies, because of a recalibration of his apparatus. This means that the discrepancy between the Robinson-Kretschmar photoelectron energies and those obtained from ruled grating wavelengths should have been given as 0.54 percent. Finally, use of the new values of e and e/m brings the photoelectron energies to a position 0.09 percent below ruled grating values. The probable errors of the experiments involved are quite sufficient to account for this small residual; indeed, its sign is what one would expect as a result of retardation of photoelectrons in the films from which they are ejected and work function of the films (a suggestion which I owe to Professor Paul Kirkpatrick).

(3) Ruark and Maxfield[6] have computed a new set of term values for the radioactive elements and have applied them to problems of beta- and gamma-ray spectra. These terms, expressed in international electron volts, must all be reduced by 0.27 percent if we employ the new values of e and e/m. However, *voltage* values for secondary beta-rays (roughly proportional to e/m) are reduced by only 0.07 percent. The data in Table II should be recomputed, but so far as I can see all the physical results of the paper are unaltered.

(4) On the basis of the new values of e and e/m, the reciprocal of the fine-structure constant assumes the value 137.04; I shall not attempt to discuss its probable error.

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[1] Ruark, Phys. Rev. **45**, 827 (1934).
[2] Bearden and Shaw, Phys. Rev. **46**, 759 (1934).
[3] Bäcklin, Nature **135**, 32 (1935).
[4] Bearden, Phys. Rev. **37**, 1210 (1931).
[5] Shane and Spedding, Phys. Rev. **47**, 33 (1935).
[6] Ruark and Maxfield, Phys. Rev. **47**, 107 (1935).