parameter b and free from the errors which Rolf[5] made by using the Sommerfeld 'numerical distance'.

Rolf used equation (1) with the lower sign reversed on the integral for computing the field intensity from a distant radio transmitter. Correcting this error in sign, I have found that the following empirical formula for the field intensity may be determined from equation (1):

$$F = \frac{c}{r}\sqrt{P}\left[f(p_0) - \sin b\sqrt{\frac{p_0}{2}}\,e^{-\frac{5}{8}p_0}\right] \ldots\ldots (2)$$

This formula gives the field intensity, F, in microvolts per metre when the radiated power from the transmitter is P kilowatts and is applicable for $b < 30°$, that is, for frequencies less than about 10,000 kc./s. for transmission over ground of average conductivity about 10^{-13} E.M.U. The quantity in the square brackets is the 'attenuation factor' and reduces to $f(p_0)$ in the case $|k_2^2| >> k_1^2$. This was the case discussed by Sommerfeld, and values for $f(p_0)$ are given by Rolf in his first paper—van der Pol[6] also gives the following empirical formula for $f(p_0)$:

$$f(p_0) = \frac{2 + 0{\cdot}3p_0}{2 + p_0 + 0{\cdot}6p_0^2} \ldots\ldots\ldots (3)$$

Formula (2) is limited in this application to a plane earth, the actual ground wave field intensity being influenced by the curvature of the earth at the greater distances, this effect being the predominating influence at sufficiently low frequencies.

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Federal Communications Commission,
Washington, D.C.
March 8.

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[2] Ingeniors Vetenskaps Akademiens, Handlingar No. 96; 1929. *Proc. I.R.E.*, **18**, 391; 1930.
[3] *Ann. Phys.*, **81**, 1135; 1926.
[4] *Ann. Phys.*, **6**, 273; 1930.
[5] See criticism by W. H. Wise, *Proc. I.R.E.*, **18**, 1971; 1930.
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Band Spectroscopic Observations of the Isotopes of Zinc and Cadmium

ACCORDING to earlier mass-spectroscopic investigations by Aston[1], cadmium has the following isotopes arranged in order of their abundances: 114, 112, 110, 111, 113, 116. Later, two additional isotopes, 108 and 118, were observed by one of us[2], as a result of an investigation of the band spectrum of cadmium hydride.

Recently, Aston[3] has reported the discovery of three new cadmium isotopes, 106, 108, 115, but no evidence of the existence of Cd^{118} was obtained. As Cd^{106} appeared to be more intense than Cd^{108}, and the former isotope had not been mentioned by Svensson, Aston concludes that these results are not reliable; in particular, that the existence of Cd^{118} must be considered as rather dubious.

Our spectrograms, on which the above mentioned observations were based, did really give indications of lines corresponding to Cd^{106}, but were not published because of their spurious appearance as compared to the lines of $Cd^{108,118}$ which were present in some thousands of groups in the spectrum. As may be seen from Fig. 1 (*a*) representing the group at λ 4728 A. and corresponding to R_2 ($18\frac{1}{2}$) in ($v'=0$; $v''=3$) of the $^2\Sigma \rightarrow {}^2\Sigma$ transition, Cd^{106} is present, although having decidedly less intensity than $Cd^{108,118}$. This intensity relation seems to hold throughout the observed spectrum. The existence of odd isotopes in cadmium could not be verified[2] on account of insufficient separation of the even components in a group.

The isotopes of zinc have also been the subject of several investigations, contradictory results having been obtained. Thus according to Aston[4], the following isotopes are present: 64, 65, 66, 67, 68, 69, 70. Bainbridge[5], however, was unable to observe $Zn^{65,69}$. From an unpublished investigation on the band spectrum of zinc hydride, one of us (G. S.) observed the following isotopes: 64, 66, 68, 67, 65, 63, 70, their abundances being in the order in which the numbers are given. Thus agreement is found with the results of Aston regarding Zn^{65} (not observed by Bainbridge) and vice versa regarding Zn^{69}. Our new isotope Zn^{63} is clearly visible in Fig. 1 (*b*),

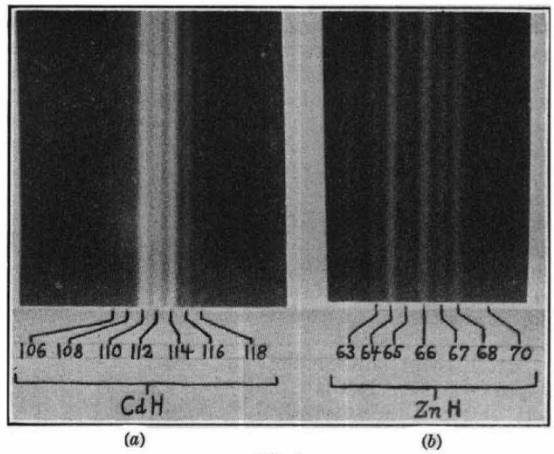

FIG. 1.

representing the group at λ 4035·0 A. and corresponding to R_1 ($33\frac{1}{2}$) in ($v'=0$; $v''=0$) of the $^2\Pi_{3/2} \rightarrow {}^2\Sigma$ transition. The line corresponding to Zn^{63} is far more intense than that of Zn^{70}, which is too faint to appear on the reproduction, although clearly visible on the original plates.

Our statements regarding the isotopes of zinc and cadmium are based on observations of extensive regions in the spectra of their hydrides. Some thousands of line groups have been measured in each spectrum, the isotope separations being in perfect agreement with the theory of isotope effects in band spectra. We would suggest, therefore, that the disagreement between band spectroscopic and mass-spectroscopic observations regarding the existence of isotopes does not indicate the unreliability of the former method but must be explained in some other way.

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March 20.

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