our results with the interferometer measures recently published by Meissner, Mundie, and Stelson,[1] we found agreement within our limits of error for all lines except one, *viz.*, λ4132. For this double line MMS give the center of gravity wave-length 4132.173A, while we find from several plates, consistently within ±0.02A, the value 4132.60. The difference of 0.43A is at least 10 times in excess of our limits of error.

As an explanation for this discrepancy, we suggest that the inaccuracy of the wave-length data available in the literature[2] has led MMS to choose an incorrect order number in the interpretation of the Fabry-Perot patterns of this line. It turns out that a correction of 4, 5, 10, and 18 fringes for the 8-, 10-, 20-, and 36-mm spacers, respectively, would bring the interferometer values in close agreement with our observations. This change would decrease the wave numbers given by MMS for $2\,^2P-5\,^2D$ by 2.500 cm^{-1}, a correction which is confirmed by applying a Ritz formula to the series $n\,^2D$. In fact, after fixing the series limit of the sharp and the diffuse series at $2\,^2P_{3/2}=28583.19\pm0.02$ cm^{-1}, the four levels 3, 4, 5, 6 $^2D_{5/2}$ are reproduced by the formula

$$T=109728.6(n-0.0019350+0.3762\cdot10^{-7}T)^{-2},$$

with an accuracy of ±0.002 cm^{-1}.

As a consequence of the above observation, the figures given in *Atomic Energy Levels*[3] for 5*d* $^2D_{3/2}$, 5*d* $^2D_{5/2}$, and the limit, should be changed to 39094.93, 39094.94, and 43487.19, respectively.

[1] K. W. Meissner, L. G. Mundie, and P. H. Stelson, Phys. Rev. **74**, 932 (1948). Hereinafter referred to as MMS.
[2] It should be noted, however, that a higher value, 4132.66A, was given by S. Werner, Dissertation (Copenhagen, 1927).
[3] Circular of the National Bureau of Standards 467, Washington D. C., 1948.

Erratum: Structure of the ^2D Terms of the Arc Spectrum of Lithium

[Phys. Rev. **74**, 932 (1948)]

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A COPY of the foregoing letter to the editor was kindly sent to us by Dr. Edlén. Thus I am able to comment without delay on the origin of the discrepancy they found.

The authors are quite right in their assumption that the wave-length data available in the literature has led us to select incorrect order numbers for the line 4132A. I should like to point out that the order numbers we employed were the only feasible ones if one assumed that the wave-length values given in the literature were correct within one- to two-tenths of an angstrom.

Two wave-length values were at our disposal, namely, Fowler's value given in the MIT tables, 4132.16A, and Datta's value, 4132.244A. These values suggested that the true wave-length was approximately 4132.2A. With this assumption the comparison of the different possible values obtained with 8-mm and 10-mm spacers, the smallest employed with the atomic beam source, was sufficient to select the only permissible value. The different possible values of the strong component resulting from Perot-Fabry patterns are given in Table I.

TABLE I. Possible values for the strong components resulting from Perot-Fabry patterns.

8 mm	10 mm
4132.6176	**4132.6173**
2.511	2.532
2.405	2.447
	2.362
2.298	2.277
4132.1917	**4132.1919**
2.085	2.107
1.979	2.022
	1.937
1.872	1.852
4131.7658	**4131.7666**

As one sees, only three pairs of these values agree with each other, namely 4132.617A and 4131.766A. Considering the close mutual agreement of the two values of the literature, we had to choose, consequently, the value 4132.192A and to discard the two other ones. If we had known the greater wave-length reported by Werner, the first one would have been possible too and a definite decision could have been obtained by employing another properly chosen spacer, e.g., a 3-mm.

Unfortunately, we were not able to carry out grating measurements of sufficiently high accuracy when we started our work since the Purdue Concave Grating mounting was not ready yet. After the receipt of Dr. Edlén's information, Mr. Wannlund and the writer carried out measurements with this instrument employing a lithium vacuum arc as light source. The grating employed is a concave grating with 15,000 lines per inch and a 30-ft. radius. The wave-length values obtained confirm the greater wave-length given by Edlén and Lidén. The average value of our grating measurements (center of gravity of the unresolved doublet) is 4132.61±0.01A, in close agreement with the value obtained by Edlén and Lidén with the hollow cathode source.

The interferometric wave-length values of the two components of 4132A reported in our paper for the atomic beam source and the vacuum arc have to be changed accordingly. The average values obtained from patterns with 8-, 10-, 20-, 36-, and 66-mm spacers are:

strong component: $\lambda=4132.618$A, $\nu=24\,190.940$ cm^{-1};
weak component: $\lambda=4132.562$A, $\nu=24\,191.268$ cm^{-1}.

It may be stated that the conclusion regardingthe structure of the D terms is not affected by this change.

A Note on the Determination of the Rates of Energy Loss of H^1 and H^2 Nuclei in Gold and Aluminum

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January 24, 1949

OUR laboratory is extending the previously reported measurements[1] of the energy loss of slow nuclear particles passing through thin metallic foils. In these experiments the nuclear particles are accelerated by a Cockroft-Walton set, magnetically selected and then scattered at 90° from a thin film of gold on a beryllium button to produce the monoenergetic beam incident on the foils. The beam energy is then measured by an electrostatic analyzer, once with the foil in the beam path, and twice with the foil withdrawn.

At present the accuracy of the measurements is limited by two factors: non-uniformity of the foils, and deposition of diffusion pump oil on the foil and on the target as was noted by Wilcox. In the newer measurements, we have given these factors more attention, using more efficient dry ice, acetone traps in an attempt to freeze out the oil before it could reach the foil, and measuring the loss through more foils in an attempt to average out the non-uniformity. Some of Wilcox' conclusions[1] must be changed.

Protons and deuterons of the same velocity were reported by Wilcox as having different rates of energy loss in gold, although he could find no such effect in aluminum. To check this point closely, we have admitted a mixture of hydrogen and deuterium gases to our ion source; the H_2^+ and the D^+ components are selected together magnetically from the accelerated beam and, after scattering from the target button, give a beam of mono-velocity H^+ and D^+. It is possible to study these protons and deuterons separately and almost simultaneously, since the analyzer selects each at a different voltage.[2]

The pairs of values obtained in this way never differed by more than 3 percent, and the difference was never consistently either more or less for the deuterons over the protons. This deviation is less than the dispersion of the proton points over the whole curve. Therefore, it can be concluded that the deuterons and protons both have the same rate of energy loss.

Wilcox suggested that "hard" atomic collisions might have accounted for his observed difference at low energies. However, Bohr[3] gives a formula for this effect:

$$\left.\frac{dE}{dx}\right|_{\text{"hard"}}=N\frac{4\pi e^4 Z_1^2 Z_2^2}{M_2 v^2}\log\left[\frac{M_1 M_2}{M_1+M_2}v^2\frac{a_{12}^{\text{scr}}}{Z_1 Z_2 e^2}\right]\text{erg/cm},$$

where N = atoms/cm^3 in the foil, M_1 = mass of incident nucleus, Z_1 = effective charge, M_2 = mass of foil nucleus, Z_2 = charge, v = velocity of incident nucleus, a_{12}^{scr} = internuclear distance: the distance where the electronic screening cancels the nuclear force, taken to be just the Bohr radius (a_0 = 0.53A) in this calculation. Actually a_{12}^{scr} is smaller than a_0 and the effect is even more negligible. Direct substitution shows that protons incident on gold at 100 kev would lose only 0.6 kev/mg/cm^2 or less due to hard sphere collisions, while deuterons would lose only about 20 percent more from the same cause. This mechanism could, therefore, hardly account for a 10 percent difference in the total loss rates, which are about 80 kev/mg/cm^2.

Preliminary results indicate that the rate of loss in aluminum is somewhat less (about 25 percent) than that reported by Wilcox, while the shape of the curve is substantially the same. The rather large discrepancy is presumably due to local non-uniformities in the foils used, and an attempt will be made to eliminate this source of error.

We hope to publish a complete report of these measurements soon, including beryllium as a stopping substance, and possibly including other incident nuclei. In acknowledgement, we would like to thank S. K. Allison for suggesting the work and for his help in its progress.

[1] H. A. Wilcox, Phys. Rev. **74**, 1743 (1948).

[2] One objection to this procedure is that the counted beam consists of deuterons or protons alone, while the input monitor beam contains both deuterons and protons so that a fluctuation in beam composition would affect the data. However, this could produce only random effects, and the consistency of our results makes it certain that no error has been introduced by this possibility. It is also possible to use the HD^+ beam obtained when our ion source is run on commercial deuterium gas; on scattering from the target, this beam breaks up into mono-velocity H^+ and D^+. While the use of this convenient two-component, mono-velocity beam would eliminate any monitoring question, we have not, because of technical difficulties, been able to run with it successfully.

[3] N. Bohr, Phys. Rev. **59**, 270 (1941).

Erratum: The Cosmic-Ray Intensity Above the Atmosphere

[Phys. Rev. **75**, 57 (1949)]

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On pages 67 and 68 the name of Pomerantz should be substituted for Primakoff. Inasmuch as Dr. Pomerantz' work appeared in the same issue of the Physical Review, reference 20 may be revised as follows:

[20] M. A. Pomerantz, Phys. Rev. **75**, 69 (1949).

On the Origin of Cosmic Rays

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The discovery of highly charged nuclei among cosmic rays makes it appear probable that cosmic rays are due to electromagnetic acceleration processes. The great total energy present in cosmic rays would require very efficient methods for the production of these rays if one assumes that cosmic rays are spread uniformly throughout the galaxy,[1] and even more so if they are spread uniformly throughout intergalactic space. One way out of this difficulty is to assume that cosmic rays are generated on or in the neighborhood of the sun and are kept near the solar system by extended magnetic fields. These fields could also account for the isotropy and constancy of cosmic rays by repeatedly reflecting and homogenizing the charged particles. The assumption of the presence of such a field considerably simplifies the problem of the generation of cosmic rays.

Feenberg and Primakoff[2] have shown that Compton scattering processes eliminate the faster electrons from cosmic rays that are evenly distributed through inter-