Mass Measurement with a Single Field Mass Spectrometer

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IN the past, accurate mass measurements have been accomplished with "double focusing" mass spectrographs.[1-3] This method allows high precision, but requires that the measurements be made from a photographic plate which has previously been exposed in a vacuum to the ion beams.

If a single field mass spectrometer were capable of the requisite resolving power, then the accelerating potentials necessary to focus ions of different m/e should be inversely proportional to the masses of the ions from the familiar equation,

$$m/e = 4.8\times(10)^{-5}r^2H^2/V,$$

providing H is held constant. No record of the application of a single field mass spectrometer to this problem could be found in the literature.

An improved Nier-type, 60-degree mass spectrometer has been used in this manner to measure the doublet separation of $H^{1+}{}_2 - He^{4++}$. The mass spectrum of hydrogen and helium in the vicinity of mass 2 is shown in Fig. 1 to

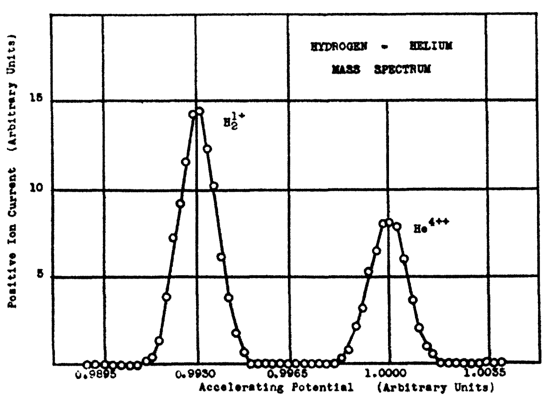

FIG. 1. The mass spectrum of hydrogen and helium in the vicinity of mass 2.

demonstrate the resolving power obtained. Voltages proportional to the accelerating voltages at which the $H^{1+}{}_2$ and He^{4++} ions were focused were measured with a Rubicon high precision type B potentiometer.

If R designates the ratio of the voltage corresponding to $H^{1+}{}_2$ to the voltage corresponding to He^{4++}, it can be shown that the mass ratio, $He^4/H^1{}_1$, is equal to $4R$ to within several parts in a million. An average of 56 measurements gives the value 3.97163 ± 0.00005 for the helium hydrogen mass ratio, where the error is the probable error in the measurement. Aston originally measured 3.97126 for this ratio,[4] but later revised this to 3.97166.[5] The agreement between the result reported here and Aston's value is well within the accuracy of our voltage measurement. This agreement with Aston's value is significant because it indicates that mass measurements can be made with a Nier type spectrometer providing the resolving power is sufficiently high. In the Nier type instrument it is customary to use an auxiliary magnetic field across the ion source in order to increase the intensity. It should be stated, however, that this magnetic field cannot be presented when mass measurements are made.

It is hoped that with some redesign of the ion source and with improved voltage measurements, greater precision can be obtained in future experiments.

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Influence of Intercrystalline Forces on Beta-Ray Absorption

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IT has been reported that a considerable difference between the absorption of beta-rays by cold-rolled and that by annealed aluminium has been found.[1] These measurements have been repeated with the following apparatus. The beta-rays emitted by a rad D+rad E source (0.3-cm diameter) obtained by anodic deposition of radiolead, are counted at a distance of 8 cm in coincidence Geiger counters with an effective aperture of 0.6-cm diameter and a total window thickness (bubble window+Al-foil) of about 0.1 g/cm^2. A mechanical counter preceded by a scale of eight registers the counts. The area of the absorber is limited to 0.7-cm diameter by a brass aperture plate which is at a distance of 2.5 cm from the source. The absorbers were cut two at a time from the same aluminium foil; one was used in the cold-rolled state while the other was annealed in vacuum at 350°C for 5 hours. (Table I.)

The differences in intensity of not more than 2 percent do not exceed the standard error sufficiently to be significant. It was, therefore, decided to check these results

TABLE I.

Absorption	Intensity of beta-rays Number per minute	
(1) Al 0.038 cm thick 0.102±0.0005 g cm^{-2} cold-rolled	573.6±5.6	
(2) Al same, annealed	562.4±5.6	
Difference	+11.2±8.0 =	2.0±1.4%
(3) Al 0.051 cm thick 0.136±0.0005 g cm^{-2} cold-rolled	303.2±3.2	
(4) Al same, annealed	308.8±3.2	
Difference	−5.6±5.6 =	−1.8±1.8%
Average		0.1±1.6%