LETTERS TO THE EDITORS

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Masses of Krypton-82, -84 and -86 and Xenon-129 and -132

In the course of our atomic mass measurement programme, we have recently had occasion to measure the masses of some of the isotopes of krypton and xenon by the mass-spectrographic doublet method. These measurements are briefly described below.

Krypton and xenon ions were obtained from a Nier-type of ion source[1] in which gas molecules are ionized by electron bombardment. The ionizing electrons were given energies of about 250 eV. This resulted in a copious production of the doubly-charged krypton and triply-charged xenon ions which were needed for the mass comparisons.

To obtain the mass of xenon-129, the triplet at mass number 43 consisting of singly-charged C_2OH_3 and C_3H_7 and triply-charged ^{129}Xe was photographed. The mass of xenon-132 was obtained from the triplet at mass number 44 consisting of singly-charged CO_2 and C_2OH_4 and triply-charged ^{132}Xe. The following packing fraction differences ($\times 10^4$) were obtained: $C_2OH_3 - {}^{129}Xe$, $\partial f = 11{\cdot}678 \pm 0{\cdot}03$; $C_3H_7 - {}^{129}Xe$, $\partial f = 20{\cdot}152 \pm 0{\cdot}03$; $C_2OH_4 - {}^{132}Xe$, $\partial f = 13{\cdot}083 \pm 0{\cdot}03$; and $CO_2 - {}^{132}Xe$, $\partial f = 4{\cdot}906 \pm 0{\cdot}02$. Assuming the masses of ^1H and ^{12}C to be $1{\cdot}008144 \pm 0{\cdot}000008$ and $12{\cdot}003798 \pm 0{\cdot}000025$, respectively, the packing fraction of xenon-129 is computed to be $-4{\cdot}230 \pm 0{\cdot}03$ from the $C_2OH_3 - {}^{129}Xe$ comparison, and $-4{\cdot}245 \pm 0{\cdot}04$ from the $C_3H_7 - {}^{129}Xe$ comparison. Similarly, two values for the packing fraction of xenon-132 are found: these are $-3{\cdot}953 \pm 0{\cdot}03$ from the $C_2OH_4 - {}^{132}Xe$ doublet, and $-4{\cdot}043 \pm 0{\cdot}03$ from the $CO_2 - {}^{132}Xe$ doublet. The errors which are assigned are probable errors based on the internal consistency of the measured values.

The masses of krypton-82 and -84 were obtained from doublets at mass numbers 41 and 42, the former consisting of singly-charged C_3H_5 and doubly-charged ^{82}Kr, and the latter consisting of singly-charged C_3H_6 and doubly-charged ^{84}Kr. The mass of krypton-86 was computed from the triplet at mass number 43, consisting of singly-charged C_2OH_3, doubly-charged ^{86}Kr and triply-charged ^{129}Xe. The following packing fraction differences ($\times 10^4$) were found: $C_3H_5 - {}^{82}Kr$, $\partial f = 20{\cdot}219 \pm 0{\cdot}03$; $C_3H_6 - {}^{84}Kr$, $\partial f = 21{\cdot}668 \pm 0{\cdot}03$; $C_2OH_3 - {}^{86}Kr$, $\partial f = 14{\cdot}805 \pm 0{\cdot}035$; and $^{129}Xe - {}^{86}Kr$, $\partial f = 3{\cdot}156 \pm 0{\cdot}03$. From these data the packing fraction of krypton-82 is computed to be $-7{\cdot}508 \pm 0{\cdot}035$, that of krypton-84 to be $-7{\cdot}321 \pm 0{\cdot}035$; and the two values for the packing fraction of krypton-86 are $-7{\cdot}357 \pm 0{\cdot}04$ from the $C_2OH_3 - {}^{86}Kr$ comparison, and $-7{\cdot}392 \pm 0{\cdot}04$ from the $^{129}Xe - {}^{86}Kr$ comparison, using as the packing fraction of xenon-129 the value found above.

Since three of these doublets were studied by Aston[2] in 1937, it is thought that readers of *Nature* may be interested in the comparisons shown in Table 1, in which Aston's values for these doublet separations are tabulated together with our values for the corresponding doublets. The two sets of values are seen to be in excellent agreement, a fact which probably should be regarded as a substantiation of both. We are aware of the conservative errors assigned by Aston to his measurements, and it may be that the smaller errors associated with the present measurements are more an indication of optimism than of increased precision. Regardless of the relative accuracies, it is a pleasure to see the pioneer work of Aston standing so well the test of time. It will be recalled in this connexion that Aston's value[3] for the mass of sulphur-32, although under a shadow for some years, has recently been shown[4–7] to be correct.

Table 1. Comparison between Present Values and Those of Aston (1937)

Doublet	Packing fraction difference $\times 10^4$	
	Aston	Present work
$C_3H_5 - {}^{82}Kr$	$20{\cdot}20 \pm 0{\cdot}15$	$20{\cdot}219 \pm 0{\cdot}03$
$C_3H_6 - {}^{84}Kr$	$21{\cdot}73 \pm 0{\cdot}15$	$21{\cdot}668 \pm 0{\cdot}03$
$C_3H_7 - {}^{129}Xe$	$20{\cdot}16 \pm 0{\cdot}1$	$20{\cdot}152 \pm 0{\cdot}03$

The new mass values resulting from the work described in this communication are shown in Table 2. Their relation to other current mass measurements will be discussed in the *Reviews of Modern Physics* in an article now in preparation by one of us (H. E. D.).

Table 2. List of New Mass Values

Nuclide	Packing fraction $\times 10^4$	Mass
^{82}Kr	$-7{\cdot}51 \pm 0{\cdot}04$	$81{\cdot}93843 \pm 0{\cdot}00029$
^{84}Kr	$-7{\cdot}32 \pm 0{\cdot}04$	$83{\cdot}93850 \pm 0{\cdot}00029$
^{86}Kr	$-7{\cdot}37 \pm 0{\cdot}03$	$85{\cdot}93658 \pm 0{\cdot}00024$
^{129}Xe	$-4{\cdot}236 \pm 0{\cdot}02$	$128{\cdot}94536 \pm 0{\cdot}00026$
^{132}Xe	$-4{\cdot}00 \pm 0{\cdot}05$	$131{\cdot}94727 \pm 0{\cdot}00060$

The present experiments have been done with a large Dempster-type double-focusing mass spectrograph[8]. The work has been supported by the United States Atomic Energy Commission.

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Measurement of Very Low Velocities of Water-flow

The need has been felt for some years past for an instrument which will measure low velocities of water-flow over the cross-section of an open channel or a pipe. The use of the Pitot tube, which has proved so valuable in the case of the flow of gases, becomes quite impracticable in the case of slow-moving liquids owing to the difficulty of measuring the extremely small pressure differences involved and also to the need for strict thermal control of the connecting tubes. Rotating-vane flow-meters are likewise impracticable at low flow values, because of uncertain spindle friction. Exposed hot wires accumulate gas bubbles around themselves, and the enclosed type becomes excessively slow in response as the velocity is decreased.

This same instrumental need is specially acute when research is attempted into the laws governing the transport of solid grains by water. Here the require-