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SUMMARY OF RESEARCH PROGRESS MEETING OF SEPTEMBER 25, 1952

Sergey Shewchuck
December 18, 1952

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Berkeley, California
I. **Resonant Cavity Field Measurements.** S. Kitchen.

The details of this talk may be found in report UCRL-1947 of the same title by S. W. Kitchen and A. D. Shelberg, dated Sept. 11, 1952. The abstract is being quoted as follows:

"The application of perturbation techniques to the quantitative measurement of both relative electric and relative magnetic fields in resonant cavities is described. The apparatus, procedures, advantages, and limitations are discussed, and experimental results are compared with the calculable field distributions of a coaxial resonator. The theoretical shunt impedance and Q obtained empirically agree respectively within one and four percent of the calculated values."

II. **Energy Surface in the Trans-Lead Region, or, Evaluation of Parameters for the Bohr-Wheeler Parabolas in the Trans-Lead Region.** Richard A. Glass.

The energy surface in the trans-lead region is quite well known due to the fact that the nuclides are connected in a network of accurately measured alpha energies, beta energies, and neutron binding energies. From the energy data, which was largely gathered by the chemistry group at the radiation laboratory, it is possible to calculate the parameters for the Bohr-Wheeler parabolas in the trans-lead region. (N. Bohr and J. Wheeler, Phys. Rev. 56, 426 1939)

The dependence of the masses of isobars on $Z^2$ is shown in the following Bohr-Wheeler equation.

$$M(A, Z) = M(A, Z_A) + \frac{1}{2} B_A (Z - Z_A)^2 \pm \frac{1}{2} \delta_A (even \ A)$$

$$\pm \frac{1}{2} \delta'_A (odd \ A)$$

For a given $A$ there are three parameters: $Z_A$, the most stable $Z$ (not necessarily an integer) for the given $A$; $B_A$, which may be called the curvature
of the parabola; and $\delta_A$, or $\delta'_A$, which is the correction term necessary because in a given group of isobars there are different nuclear types, i.e., odd-odd and even-even nuclides for even $A$ and odd-even and even-odd nuclides for odd $A$. The equation indicates two parabolas separated by $\delta_A$ for even $A$ isobars and two parabolas separated by $\delta'_A$ for odd $A$ isobars. The parabolas are shown in Fig. 1. The term $\delta_A'$, as is evident, is considerably greater than $\delta_A$.

The above equation can be used to calculate beta disintegration energies:

$$E_\beta = M(Z, A) - M(Z-1, A)$$

$$= \frac{B_A}{A} \left[ \frac{|Z_A - Z| - 1/2}{Z_A - Z} \right] + \delta_A$$

and, it is in this form that the equation is used to calculate the parameters.

To calculate the three parameters for a given $A$ three beta disintegration energies between the isobars are needed. The beta energies used are either measured or are calculated from closed cycles. In many cases alpha energies estimated from alpha systematics have been used in the calculation of beta energies. For example, the beta energies for $A = 214$ are indicated as follows:

$$\begin{align*}
\text{Bi}^{210} & \xrightarrow{\alpha} \text{At}^{214} \\
\beta^- & 8.95 \text{ MeV}^m \\
\text{Pb}^{210} & \xrightarrow{\alpha} \text{Pb}^{214} \\
\beta^- & 7.83 \text{ MeV}^m
\end{align*}$$

$$\begin{align*}
\text{At}^{214} & \xrightarrow{\beta^-} \text{Bi}^{214} \\
\text{E.C.} & 1.05 \text{ MeV}^c \\
\text{Pb}^{214} & \xrightarrow{\beta^-} \text{Bi}^{214} \\
\beta^- & 3.17 \text{ MeV}^m
\end{align*}$$

$$\begin{align*}
m & = \text{measured} \\
c & = \text{calculated}
\end{align*}$$

In the present work, data for three consecutive beta decays was available in 31 cases in the range of mass numbers from 213 to 243. The parameters $\delta_A$ and $\delta'_A$ have been previously calculated for a few mass numbers in this region but never as extensively using all available closed cycle data.
The average values of the parameters are recorded in Table I along with the average deviations.

Table I

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Average</th>
<th>Average Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$B_A$</td>
<td>1.12 Mev</td>
<td>0.08</td>
</tr>
<tr>
<td>$\delta_A$</td>
<td>1.52 Mev</td>
<td>0.11</td>
</tr>
<tr>
<td>$\delta'_A$</td>
<td>0.18 Mev</td>
<td>0.07</td>
</tr>
</tbody>
</table>

The results of the $Z_A$ calculation agreed with what would be expected from a consideration of known beta stable nuclides. Although the parameters in the table are functions of $A$ the scatter of points in the plots against $A$ prevented the detection of any definite trends and so the averages were recorded. The agreement of the parameters with those calculated by the use of the Fermi-Weiszäcker semi-empirical mass equation was poor.

An interpretation of the relative positions of the odd-proton and odd neutron parabolas (odd $A$) may be advanced in terms of the "shell" model for the nucleus. Figure 2 depicts the breaking and forming of neutron and proton pairs during $\beta^-$ emission. Thus, it may be interpreted that the proton pairing energy is greater than the neutron pairing energy.
Figure 1.

Figure 2.