Chapter VIII

Applications of E. M. Separated Radioactive Isotopes

Applications of Electromagnetically Separated Radioactive Isotopes at the Nobel Institute of Physics

Part I

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With 2 Figures

The radioactive isotopes prepared with the E. M. isotope separator at the Nobel Institute of Physics [1] have been used in a large variety of investigations. Table 1 gives an idea of the problems which are of

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<th>Type of problem</th>
<th>Advantage of use of isotope separation</th>
<th>Isotopes of element</th>
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<td>A Short half-lives (ms-ns region)</td>
<td>Mass number determination</td>
<td>Bi, Pb, Tl, Cs, Xe, Br, Kr</td>
<td>2, 3, 4</td>
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<td></td>
<td>Decreased number of chance coinc.</td>
<td></td>
<td></td>
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<td>Decreased number of prompt coinc.</td>
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<td>B Very weak transitions such as “double quantum emission”</td>
<td>Possibilities of avoiding impurities of different elements which are difficult to separate chemically</td>
<td>Xe, Sr, Te</td>
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<td>C Heavy ion reactions (C^{12}, Ne^{20})</td>
<td>Mass number determination</td>
<td>Bi, At, Po</td>
<td>13, 14</td>
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<td>D Nuclear spectroscopy of fission products</td>
<td>Mass number determination</td>
<td>Sn, Sb, Te, I, Xe</td>
<td>6, 7</td>
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<td>Pure isotope sources</td>
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<tr>
<td>E Low energy (\beta)-spectroscopy</td>
<td>Thin sources</td>
<td>Bi, Pb, I</td>
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Table 1

M. J. Higatsberger et al., Electromagnetic Separation of Radioactive Isotopes
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current interest and those isotopes which have been separated. They fall mainly into five groups:

A. Measurements of short half-lives by use of delayed coincidences,
B. Search for very weak transitions, such as double quantum emission,
C. Mass determination of products obtained in heavy-ion reactions,
D. Nuclear spectroscopy of uranium fission products and
E. Low energy $\beta$-spectroscopy.

The elements separated are mainly grouped around the double filled shells $Z = 82$, $N = 126$ and $Z = 50$, $N = 82$. Not many separations have been made of the rare earth elements for example.

We shall now discuss mainly some details concerning the groups A, B, and C, while D and E will be considered in part II.

**A. Measurements of Short Half-Lives of Excited States**

In these investigations gamma-scintillation-spectroscopy has been used as this is the simplest and most efficient method for gamma-detection. The time resolution $2\tau$ obtainable is often not larger than a few ns for low energy gamma-rays. Most transitions will therefore appear as "prompt", i.e. they have a half-life shorter than can be detected.

As a certain isotope of interest cannot usually be produced isolated from other isotopes, the advantages of isotope separated samples in this case are manifold and often separation is essential. Firstly, one gets a mass number estimation of the isotope to be studied. Further, as the energy resolution of a scintillation spectrometer is relatively poor, one has often a very complex spectrum of unresolved lines if no isotope separation is performed. This complexity together with the ever present Compton background, is the cause that, even if the spectrometer is set on two photolines which should give a delayed coincidence curve, possible prompt coincidences from unresolved lines and Compton background from isotopes other than the one of interest, can completely mask the effect to be studied.

The third advantage of isotope separated samples in experiments of this type is that the ratio between true ($C_r$) and chance ($C_c$) coincidences can be increased considerably. As $C_r/C_c = (2\tau \cdot S)^{-1}$, where $S$ is the part of the source strength which corresponds to the focused energy interval used, one can, by E.M. separation, greatly decrease disturbing $\gamma$-rays and therefore increase the ratio $C_r/C_c$. This is of