To illustrate the convenience of this representation and to show what data concerning neutron reactions can be obtained from the chart the part of the diagram near aluminum is reproduced in Figure 13. In the figure the single isotope of aluminum, Al^{27}, is outlined with heavy lines and the products of (n,γ), (n,p), (n,α) and (n,2n) reactions on Al^{27} indicated with auxiliary symbols. It turns out that all these reactions lead to unstable end products. Except for the product of the (n,2n) reaction these are all beta emitters. This is understandable, for example, in the case of the (n,p) reaction where when stability is finally achieved the net effect is the transformation of a neutron into a proton and an electron:

$$\begin{aligned} Al^{27} + n &\longrightarrow Mg^{27} + H^1 \\ Mg^{27} &\longrightarrow Al^{27} + \beta^- \end{aligned} \qquad (3\text{-}1)$$

The net effect can be written as $n \rightarrow p + \beta^-$. Conversely, there exist (p,n) reactions for which the net result is $p \rightarrow n + \beta^+$. As the neutron mass is greater than that of proton plus electron the transformation of a neutron is exothermic. The converse reaction is endothermic.

The (n,2n) reaction, not generally as common as the other three, amounts to the extraction of a neutron thereby producing a positron emitter and ultimately stable Mg^{26}. This latter illustrates the principle that unstable nuclei above the curve of maximum stability are generally beta emitters, those below positron emitters (or K-electron "capturers"). Any one of these processes - beta or positron emission or K-capture - produces an isobar of the unstable nucleus so that the processes are along isobaric lines of slope = -1 on the Segre Chart as indicated in Figure 12.

If aluminum is bombarded by neutrons of assorted energies, all the products may appear and some sort of chemical separation would be used to separate the activities. If the energy of the bombarding neutrons is controlable, it might be possible to favor the formation of one product over the others by using neutrons of appropriate energy. In any case isolation of any one of the beta-emitting products and examination of the energy spectrum of the emitted beta particles would reveal that the spectrum is continuous with the general shape shown in Figure 14. This is a somewhat unexpected result inasmuch as gamma emission (and alpha emission of the naturally radioactive nuclei) yields discrete spectra. The accepted explanation of this anomaly is that the emission of a beta particle is always accompanied by the emission of a "neutrino." Thus the decay of Mg^{27} can be written as:

$$Mg^{27} \rightarrow Al^{27} + \beta^- + \nu \; (\nu = \text{neutrino})$$

The energy balance is $E_\beta + E_\nu = E_o$, with E_o the energy of β- decay and equal to the maximum of the observed beta energy. For Mg^{27} this is 1.8 Mev. Since the energy E_o can be divided between the beta and the neutrino, it follows that there should be a continuous energy spectrum for the beta particles.

Before such a scheme is acceptable it is necessary to show that the maximum beta energy (E_o), and not, say, the average beta energy, is the energy lost per nucleus on beta decay. This can be readily shown in many instances. For example, consider the decay of Mg^{27} and the production of Mg^{27}:

$$\begin{aligned} Mg^{27} &\rightarrow Al^{27} + \beta^- + \nu + E_o \\ Al^{27} + n &\rightarrow Mg^{27} + H^1 + Q \\ \text{Adding: } n - (\beta^- + \nu + H^1) &= E_o + Q \end{aligned} \qquad (3\text{-}2)$$

Now the energy equivalence of the mass difference between neutron and hydrogen atom (proton plus electron) assuming neutrino mass to be negligible is 0.75 Mev so that $E_o + Q$ should be

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