amount of K electron capture may be made if the K x-rays observed in the absorption experiments are corrected for the contribution from internal conversion of the gamma-ray. If the L electron vacancies resulting from the K vacancies are subtracted from the total calculated from the absorption experiments, a further estimate of the amount of L electron capture is obtained. When these are related to the number of beta-particles, a decay scheme may be postulated in which the relative abundances of beta-decay and electron captures should be correct to ±20 percent (Fig. 2).

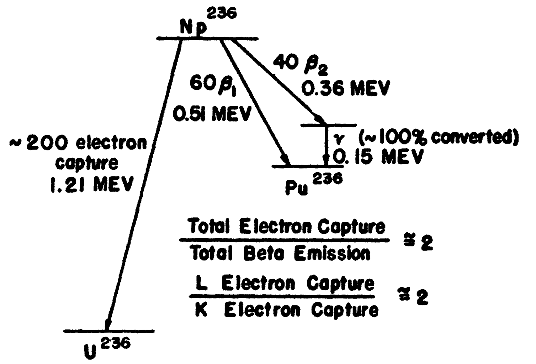

FIG. 2. Decay scheme of Np^{236}.

Apparently there is a considerable amount of L electron capture, even at this large disintegration energy of about 1.2 Mev. However, other heavy nuclides such as Am^{242m}, U^{231}, and Np^{235} have demonstrated predominant capture of L electrons[6-8] at lower transition energies.

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The Splitting of l-Shells in Heavy Nuclei by the Tensor Interaction

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TO explain the nuclear "magic numbers,"[1] a strong spin-orbit interaction favoring single-particle states of total angular momentum $j=l+\frac{1}{2}$ is needed. A study has been made of the contribution to this splitting of a tensor interaction

$$V=\Sigma_j J(r_{oj})T_{oj}=\Sigma_j J(r_{oj})[3(\boldsymbol{\sigma}_o\cdot\mathbf{r}_{oj}/r_{oj})(\boldsymbol{\sigma}_j\cdot\mathbf{r}_{oj}/r_{oj})-\boldsymbol{\sigma}_o\cdot\boldsymbol{\sigma}_j]$$

between the outer particle Q_o, and the particles Q_j of a spherically symmetrical spin-saturated core, regarded as moving independently in the states ψ_i of a spherical potential well.

The first-order perturbation energy is zero for all outer particle states and so can contribute nothing to the splitting. The second-order perturbation energy is $\Sigma_i(o|V|i)(i|V|o)/(E_o-E_i)$. A Fermi-Thomas approximation and other crude approximations to the part of this energy dependent on the spin of the outer particle give zero, and a direct evaluation of the above expression incorporating complete antisymmetry is required. The isotopic spin plays no essential role. The only feasible way of treating the denominators in the above summation is to expand them about a mean excitation energy, $\bar{\epsilon}$, and to deal with the first two terms of the expansion,

$$\frac{1}{E_o-E_i}=-\frac{1}{\bar{\epsilon}}+\frac{E_i-\bar{E}_i}{\bar{\epsilon}^2}\cdots.$$

For the spin-dependent part of the perturbation, the first term of the expansion gives

$$\begin{aligned}(\Delta\epsilon)_1=\frac{-18i}{\bar{\epsilon}}\Sigma_\sigma\int\psi_o{}^*(\mathbf{r}_1)\chi_o(\sigma)\Big\{&\boldsymbol{\sigma}\cdot\left(\frac{\mathbf{r}_{12}}{r_{12}}\times\frac{\mathbf{r}_{12}{}'}{r_{12}{}'}\right)\left(\frac{\mathbf{r}_{12}}{r_{12}}\cdot\frac{\mathbf{r}_{12}{}'}{r_{12}{}'}\right)\\ &\times J(r_{12})J(r_{12}{}')[\delta(\mathbf{r}_1-\mathbf{r}_1{}')-\rho_c(\mathbf{r}_1,\mathbf{r}_1{}')][\delta(\mathbf{r}_2-\mathbf{r}_2{}')-\rho_c(\mathbf{r}_2,\mathbf{r}_2{}')]\\ &\times[\rho_c(\mathbf{r}_2,\mathbf{r}_2{}')\psi_o(\mathbf{r}_1{}')\chi_o(\sigma)-\rho_c(\mathbf{r}_2,\mathbf{r}_1{}')\psi_o(\mathbf{r}_2{}')\chi_o(\sigma)]\Big\}\\ &\times d\mathbf{r}_1d\mathbf{r}_2d\mathbf{r}_1{}'d\mathbf{r}_2{}'.\end{aligned}$$

The second term is similar in character.

The integrals are evaluated by expanding the wave functions ψ_o and the core matrix densities ρ_c about $\mathbf{r}_1$, say, chosen as the local coordinate and carrying out the local integrations. We then find that

$$\Delta\epsilon\rightarrow K(\chi_o\psi_o|\boldsymbol{\sigma}\cdot\mathbf{L}V(r)|\chi_o\psi_o),$$

where

$$V(r)=-(1/r)\rho_c(r)d\rho_c(r)/dr.$$

Contributions to the splitting of the correct sign can come only from a region of radially-increasing core density. If the outer particle spends most of its time in such a region and if the above approximations have validity, splitting of the needed sign and the magnitude could be available. The positive quantity K varies as $J_o{}^2/\bar{\epsilon}$, where J_o is the strength of the tensor interaction and $\bar{\epsilon}$ is the mean excitation energy of the nucleus. K also depends in a complicated way upon the range and form of the tensor interaction and the structure of the core density $\rho_c(\mathbf{r},\mathbf{r}')$. A rough approximation to the energy difference of the $j=l+\frac{1}{2}$ and $j=l-\frac{1}{2}$ levels of a particle moving about a moderately heavy core is given by

$$\epsilon_{l-\frac{1}{2}}-\epsilon_{l+\frac{1}{2}}\simeq(2l+1)J_o{}^2/(250\bar{\epsilon}).$$

Several particles outside the core will polarize it independently, and show a consequent individual preference for the appropriate j states. The particles will also be acted on by a change in potential due to the core polarization of the other exterior particles. These cross effects may be expected to be small and to tend to cancel as a new shell forms.

The details of this analysis are available in the author's Doctoral thesis, Department of Physics, Harvard University, June 1950.

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Radiations of Ag^{110}

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FROM studies of the radiations of the 225-day silver activity, Siegbahn[1] has proposed a decay scheme in which the activity originates in a metastable level 116 kev above the ground state. A small complex fraction of the beta-radiation, with end points of 2.86 and 2.12 Mev, is placed with its origin in the ground state and is presumed to be the beta-radiation of the well-known 24-sec activity. Siegbahn's data suggested that still other low intensity beta-rays may connect the Ag^{110} ground state with excited levels