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Letter to the Editor

On the Nuclear Transformation with the Absorption of the Orbital Electron

According to the present theory of β-disintegration, the nucleus of the atomic number Z transforms into its isobar of the atomic number $Z-1$ with the emission of a positron and a neutrino, if the difference ΔW of proper energies of these isobares are larger than the sum $mc^2+\mu c^2$, where m and μ are the masses of the electron and the neutrino respectively. On the contrary, the isobar $Z-1$ transforms into Z with the emission of an electron and an anti-neutrino, if ΔW is smaller than $-mc^2-\mu c^2$. Further, if ΔW is larger than $\mu c^2 - E$, where E is the total energy of an orbital electron of the isobar Z, the latter can change into $Z-1$ with the absorption of this electron. Thus, two isobares with adjacent atomic numbers are both stable, only if ΔW lies between $-mc^2+\mu c^2$ and $-mc^2+\mu c^2$. This condition will be satisfied very rarely, if the neutrino mass is small compared with the electronic mass. Since the existence of several pairs of such isobares was confirmed by experiment[1], it is quite important to compute the life time of the isobar Z theoretically, when $-mc^2+\mu c^2 < \Delta W < -mc^2+\mu c^2$. Moreover, in case, when

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~~We calculated~~ previously ΔW is larger than $mc^2 + \mu c^2$, the
~~isobar~~ nucleus Z can transform into Z−1 ~~by~~ with the positron emission
as well as ~~by the~~ with the capture of ~~the~~ an orbital electron.
~~The~~ relative importance of these processes. ~~Thus~~
~~The ca~~ ~~The determination of the~~ Thus, ~~it will be~~ is interesting to
compute) The present writers
~~These problems were~~ dealed with these subjects ~~in the~~ previously[2)]
Proc. Phys.-Math. Soc. Japan[1)] ~~(1935–1936)~~.[1)] As this journal
~~is not read wi~~ seems to have ~~not~~ been noticed little ~~read widely~~ ~~in~~, it will be permitted ~~we want~~ to
~~show~~ the results of ~~our~~ calculations.
give a brief account of ~~Table 1.~~ First ~~shows~~ the mean life time
of the ~~emission~~ nucleus Z ~~wi~~ due to the absorption
of the ~~orbital~~ K electrons ~~in~~ with $E = mc^2\sqrt{1-\alpha^2 Z^2}$, ~~where~~
~~α is the fine structure constant.~~ were calculated for the ~~assuming the neutrino~~
~~mass μ to be zero.~~ The calculations were made with
mean life times ~~The assumption.~~ The i and r columns of Table I show ~~correspond~~ to the
for the allowed transitions ~~due to~~ assuming interactions of ~~the ty~~ Fermi and Konopinski-
~~Their value~~ ~~results~~ ~~values~~ for several values of Z corresponding to the
Uhlenbeck types respectively. The mean life
~~time~~ The apparent discrepancy between ~~the~~ such short life times
and the ~~isobar~~ existence of stable ~~iso~~ pairs can be removed
only by ~~assuming either one of~~ ~~assuming one of the following assumptions~~ of the pair of stable isobars,
i) ~~The large difference of the~~ the ~~nuclear~~ spins ~~of~~ for each pair of stable one differs
~~nuclei isobars,~~ is large difference of ~~much from each other~~, for each
ii) ~~The~~ Neutrino mass is not small compared with the electron
mass ~~present~~ true wave function
iii) the ~~behaviour~~ of the electron in the neighborhood ~~inside~~ of the nucleus[4],
is ~~not~~ much smaller than ~~entirely different from~~ that of the current theory.
Next, the mean ~~life time of the~~ ratio σ of the probabilities of

~~a~~ ii) The neutrino must to be comparable with the electron mass.
or iii) the wave functions of the electron in the neighbourhood
of the nucleus to be much smaller than ~~that~~ those of the current
~~theory~~ by Dirac's theory. probabilities of
Next, the ratio σ of the positron emission and the K-electron
absorption was calculated on similar assumptions
as above, the results being summarized in Table 2.

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For ordinary

1) Bainbridge and Jordan, Phys. Rev. 50, 282, 1936.
2) Proc. Phys.-Math. Soc. Japan 17, 467, 1935; 18, 128, 1936.
See also Bethe and Bacher, Rev. Mod. Phys. 8, 82, 1936 ff.
Similar calculation was made recently by
Møller, Phys. Rev. 51, 84, 1937.

For the numerical calculation.
3) In the case of ~~Fermi~~ U. K.) interaction, the same coupling
constant ~~was~~ ~~is taken to be~~ as that of
Bethe and Bacher (l.c. p. 193 ff.) was employed.
4)

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