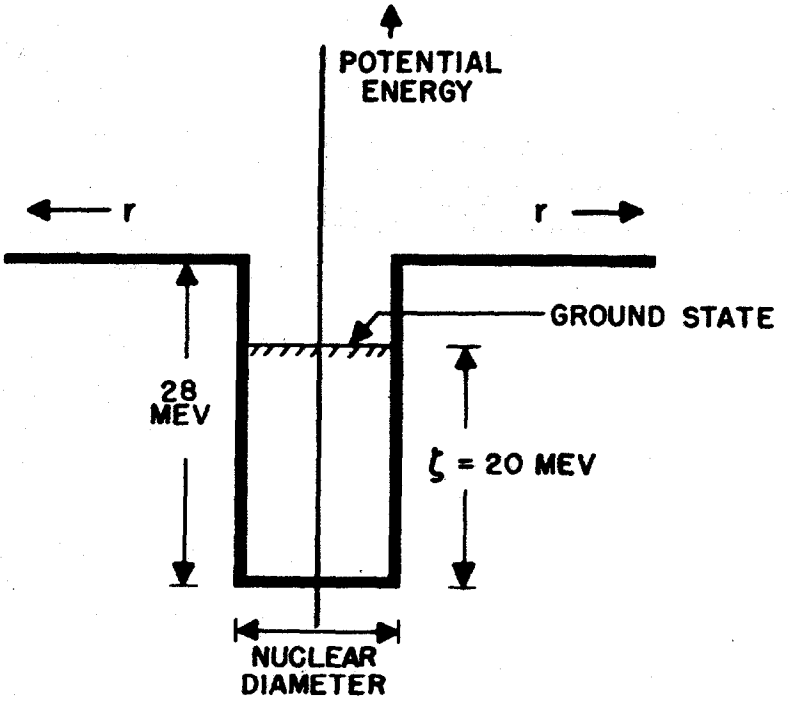

Figure 17. Fermi gas model: potential well

In the potential well chosen for the nuclear model, Figure 17, ζ is $\sim$ 20 Mev. Writing U as $a\tau^2$ the entropy S ($= \partial U/\partial\tau$) is just $2a\tau$ or $\pi\sqrt{AU/\zeta}$. The entropy is customarily written as log P + constant where P is the probability of the state in question or statistically the number of states per unit energy interval. Thus

$$S = \log P + \text{constant}$$

or

$$P = \text{constant} \cdot e^{S} = P_o e^{\pi\sqrt{AU/\zeta}}$$

with P_o the value of P at U = 0. Applying this to a medium nucleus with 8 Mev excitation ($A \sim 100$, $\zeta \sim 20$ Mev) shows that the density of states is $P_o e^{20}$ or $P_o \cdot 10^8$. That is the density of states (number of states per unit energy) at 8 Mev is 10^8 times what it is at the ground state. This is somewhat too high.

In conclusion it should be pointed out that the foregoing only indicates trends and should not be taken for more than it is worth. The essential idea is that the nucleus is a system with many degrees of freedom. Almost any approach shows logarithmic variation in level density. Achieving numerical consistency is an almost impossible task because of the lack of fundamental knowledge of nuclear forces and the lack of mathematical apparatus for handling what is essentially a many-body problem.

The reader is referred to Bethe's "Nuclear Physics, Part B" (Rev. Mod. Phys. 9(1937)) section 53, pages 79 to 90, for a summary of the various approaches to the problem of nuclear energy level distributions.

a-93-3