3(1(b)): The m Theory of the Nuclear Strong Force

The Woods Saxon (WS) potential gives the nuclear strong force:

$$F = -\frac{U_0}{a_N} \frac{\exp\left(\frac{r-R}{a_N}\right)}{\left(1+\exp\left(\frac{r-R}{a_N}\right)\right)^2} \quad -(1)$$

by computer algebra. Here R is the radius of the nucleus, $a_N$ is its surface thickness and $U_0$ the potential amplitude defined by:

$$U = \frac{-U_0}{1+\exp\left(\frac{r-R_0}{a_N}\right)} \quad -(2)$$

Here:

$$F = -\frac{\partial U}{\partial r} \quad -(3)$$

The alternative m force for a particle such as a proton at rest is:

$$F = -\frac{dm(r)}{dr} \frac{m(r)\, mc^2}{2m(r) - r\frac{dm(r)}{dr}} \quad -(4)$$

From eqs. (1) and (4):

$$\boxed{\frac{dm(r)}{dr} \frac{m(r)}{2m(r) - r\frac{dm(r)}{dr}} = \frac{U_0}{a_N mc^2} f(r)} \quad -(5)$$

where $$f(r) = \frac{\exp\left(\frac{r-R}{a_N}\right)}{\left(1+\exp\left(\frac{r-R}{a_N}\right)\right)^2} \quad -(6)$$

Eq. (5) is a differential equation for $m(r)$ of the nuclear strong force between protons and neutrons. Eq. (5) can be solved by computer to give $m(r)$ in terms of $U_0$, $R$ and $a_N$. This is the $m(r)$ of the nuclear strong force. The latter does not exist in classical physics or special relativity.

From eq. (5) the strong force goes to infinity at the point:

$$2m(r) = r\frac{dm(r)}{dr} \quad -(7)$$

and at this point:

$$\boxed{a_N \rightarrow 0} \quad -(8)$$

i.e. the surface thickness goes to zero. The Woods Saxon potential is a mean field theory of the nucleus based on the shell model.

At the point:

$$r = R \quad -(9)$$

the WS force (1) reduces to:

3)

$$F = -\frac{U_0}{4 a_N} \quad (10)$$

and at this point:

$$\frac{U_0}{4 a_N m c^2} = \frac{dm(r)}{dr} \frac{m(r)}{2m(r) - R\frac{dm(r)}{dr}} \quad (11)$$

This is the differential equation:

$$m(r)\frac{dm(r)}{dr} = \left(2m(r) - R\frac{dm(r)}{dr}\right) x \quad (12)$$

where $x$ is the constant:

$$x = \frac{U_0}{4 a_N m c^2} \quad (13)$$

Eq. (12) can be solved by computer to find $m(r)$ at

$$r = R \quad (14)$$

i.e at the surface of the nucleus

Therefore the LENR reaction occurs when the surface thickness of the nucleus approaches zero. The laser experiments show that the surface thickness is about $10^{-16}$ m in a lead nucleus. The surface of the nucleus is made up of a very thin layer of neutrons. This is a hard shell surrounding a mixture of protons and neutrons. Google "surface thickness of a nucleus".