The m theory of the strong nuclear force and low energy nuclear reactions (LENR)

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3 Computation and discussion

3.1 Comparison of m space force and Coulomb force

First we compare the force of m theory with the Coulomb force. We used femtometers (10^{-15}m) as length units. This requires a re-scaling of formulas which is a bit tricky. For example in $d\text{m}(r)/dr$, $\text{m}(r)$ can be defined on a fm scale but differentiation produces a factor of 10^{15} in SI units. A similar problem occurred for the Coulomb potential. The radius of the Ni atom (3.78 fm) has been marked in the graphs.

Fig. 1 shows the total relativistic energy of a ^{64}Ni nucleus in m space, using p=0 (stationary atom, see Eq. (7)). The atomic mass of this isotope is 63.927967 a.m.u. The energy is constant outside the nuclear radius, starts decreasing near to the radius and goes to zero at the centre according to the m function. This means that the relativistic energy is not constant but impacted by m space.

Fig. 2 compares the force F of m theory (Eq. (15)) with the Coulomb force of a point charge at $r = 0$. It is seen that F outperforms the Coulomb force by a multiple at the nuclear radius. Inside the nucleus, we should have a different Coulomb force, this picture is only for demonstrating the size relations. The same graphs are shown in Fig. 3 with different scaling. In addition, the Coulomb force of m space,

$$F_1(r) = \sqrt{\text{m}(r)}\frac{28\,e^2}{4\pi\epsilon_0 r^2}, \tag{22}$$

has been graphed, using

$$\text{m}(r) = 2 - \exp\left(\log(2)\exp(-\frac{r}{R})\right) \tag{23}$$

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as in previous papers. It is seen that the m function reduces the Coulomb force but this is by far not enough to bring the Coulomb barrier at the nuclear radius to zero (observe the different exponential scale factors in this graph).

3.2 Resonant m force and Woods-Saxon force

The nuclear Woods-Saxon potential, Eq. (14), is graphed in Fig. 4, together with the resulting force, Eq. (15). The parameters were chosen as $R = r_{Ni}$, $a_N = r_{Ni}/20$ and U_0 was set to unity or scaled to other curves, respectively. The Woods-Saxon force only appears in the surface region of the nucleus whose thickness is defined by a_N. We used three different forms of the m function to model a resonant behaviour of the m force:

$$\mathrm{m}_1(r) = 2 - \exp\left(\log(2)\exp(-\frac{r}{R})\right), \tag{24}$$

$$\mathrm{m}_2(r) = 1 - \frac{1}{\exp\left(\frac{r-R}{a_N}\right) + 1}, \tag{25}$$

$$\mathrm{m}_3(r) = \begin{cases} \frac{r^2}{2R^2} & \text{for } r < R, \\ 1 - \frac{R}{4\left(r-\frac{R}{2}\right)} & \text{for } r \geq R. \end{cases} \tag{26}$$

The first m function is the usual model we used so far and not resonant. The second is an adaptation of the Woods-Saxon potential and the third is a form already introduced in UFT 417. It was found that $\mathrm{m}(r) \propto r^2$ leads to an infinite force. All three functions are graphed in Fig. 5. The three forces arising from these functions via Eq. (8):

$$F(r) = -\frac{d\mathrm{m}_i(r)}{dr} \frac{\mathrm{m}_i(r)}{2\mathrm{m}_i(r) - r\frac{d\mathrm{m}_i(r)}{dr}} mc^2 \tag{27}$$

are graphed in Fig. 6. F_1 is the m force of Fig. 2 which - although not resonant - is already sufficient to outperform the Coulomb barrier as discussed above. F_2 makes up a pole so has a resonance near to the nuclear radius. To shift the pole to the radius, the parameter R had to be modified to a value different from the nuclear radius. This type of resonance does the job outside the nucleus. The unsteady jump of the force may be a hint that the model is somewhat simplistic. A high positive force just below the radius could result in an unstable transition when a proton passes the Coulomb barrier.

The third alternative form $\mathrm{m}_3(r)$ gives resonance enhancement at the correct radial position. The force is infinite in the internal region by construction but could be modified to give a constant or vanishing force in the interior.

As explained in section 2, equating the force of m theory with the Woods-Saxon force leads to a differential equation for $\mathrm{m}(r)$, see Eq. (16). This equation is quite complicated and has no analytical solution. One can restrict consideration to the region $r \approx R$ which leads to the simplified equation (21). For this equation computer algebra delivers a quasi-solution

$$-\frac{4a_N m\, c^2\ \mathrm{m}(r) - U_0 r}{2a_N\sqrt{\mathrm{m}(r)}} = C \tag{28}$$

where C is an integration constant with dimension of an energy. Developing this equation leads to a quadratic equation for $\mathrm{m}(r)$. The two solutions are (with $C = U_1$):

$$\mathrm{m}(r) = \frac{1}{8a_N m^2 c^4} \left(2U_0 r m c^2 - U_1^2 a_N \pm \sqrt{4U_0 a_N m c^2 r + {U_1}^2 {a_N}^2} \right). \quad (29)$$

This is an equation of type

$$\mathrm{m}(r) = ar \pm \sqrt{br}. \quad (30)$$

This function is nearly linear, at least for the parameter sets we have tested. An example is graphed in Fig. 7. By definition this approach is only valid in the region $r \approx R$.

3.3 Solution of the wave equation

Solutions of the wave equation

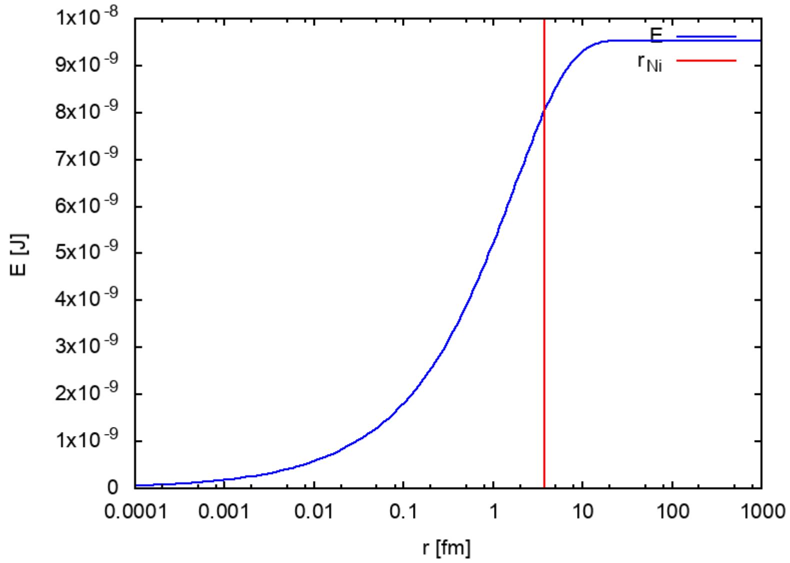

Figure 1: Relativistic energy of ^{64}Ni nucleus.

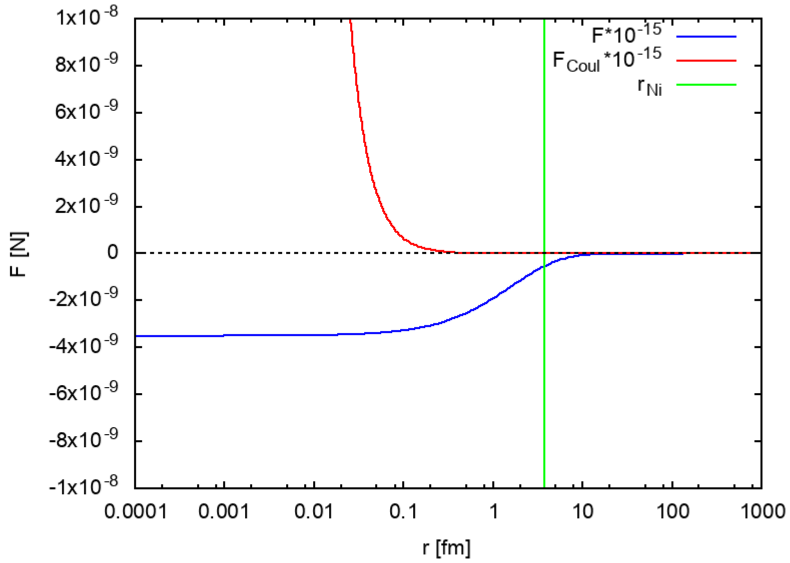

Figure 2: Force of m theory and Coulomb force.

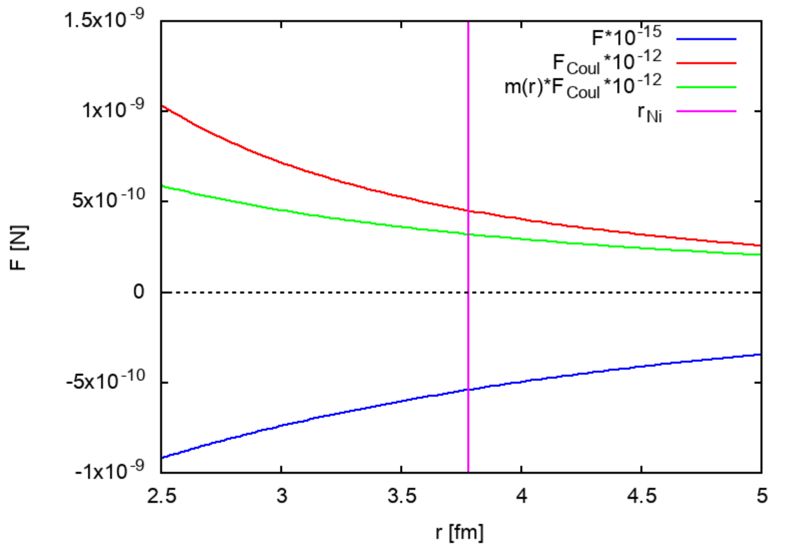

Figure 3: Force of m theory and Coulomb force, smaller radial scale. Observe the exponential factors when comparing.

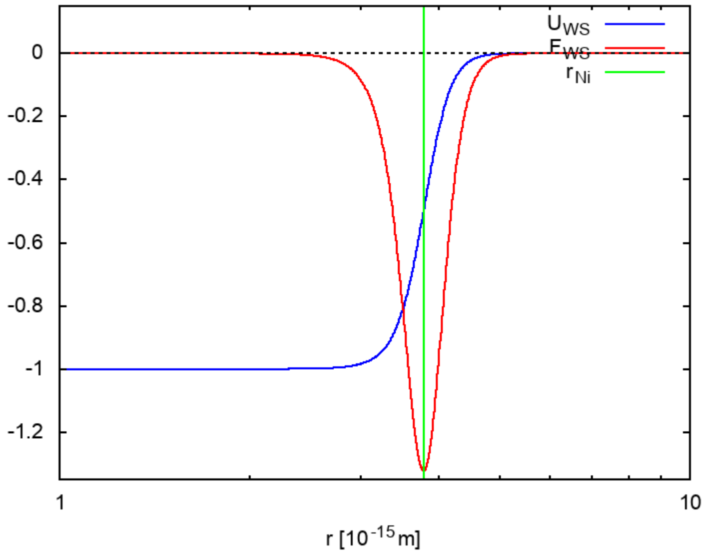

Figure 4: Woods-Saxon potential and corresponding force.

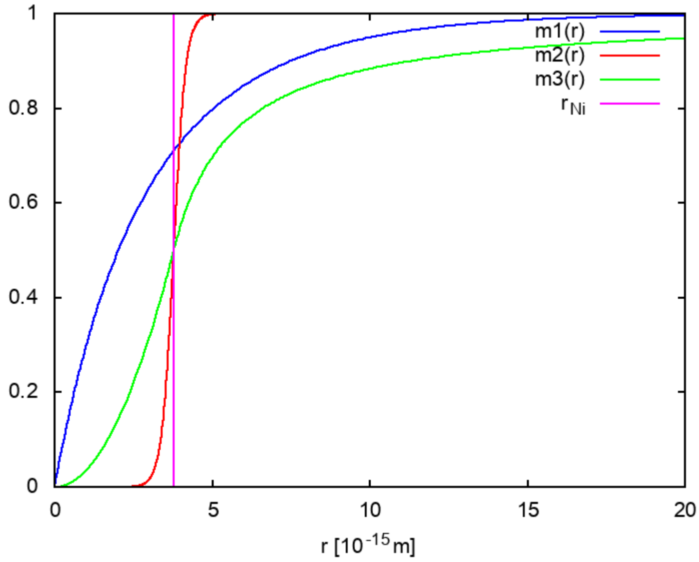

Figure 5: Three models of m functions.

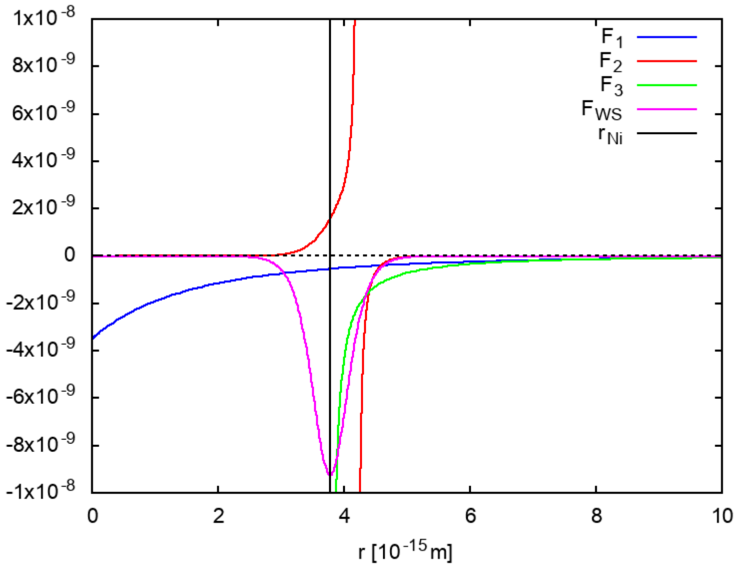

Figure 6: Resonance solutions for m space force.

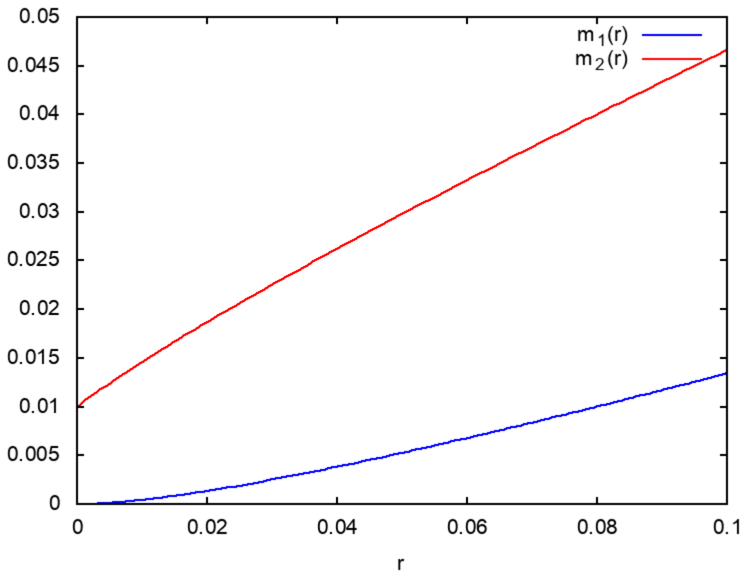

Figure 7: Solutions of m(r) for the approach $r \approx R$.