Parameters

$A := 16$ $Z := 8$ $Ro := 1.2$ $R := Ro \cdot A^{\frac{1}{3}}$ $R = 3.024$ $Vo := -40$ $a := 0.45$

Definitions and Formulas

$$Vc(r) := \begin{| Vc \leftarrow 1.44 \cdot \frac{Z}{r} \quad \text{if } r > R \\ Vc \leftarrow \frac{1.44}{2} \cdot \frac{Z}{R} \cdot \left(3 - \frac{r^2}{R^2}\right) \quad \text{if } r \le R \\ \text{return } Vc \end{|}$$

$$Vn(r) := \frac{Vo}{1 + e^{\frac{r-R}{a}}}$$

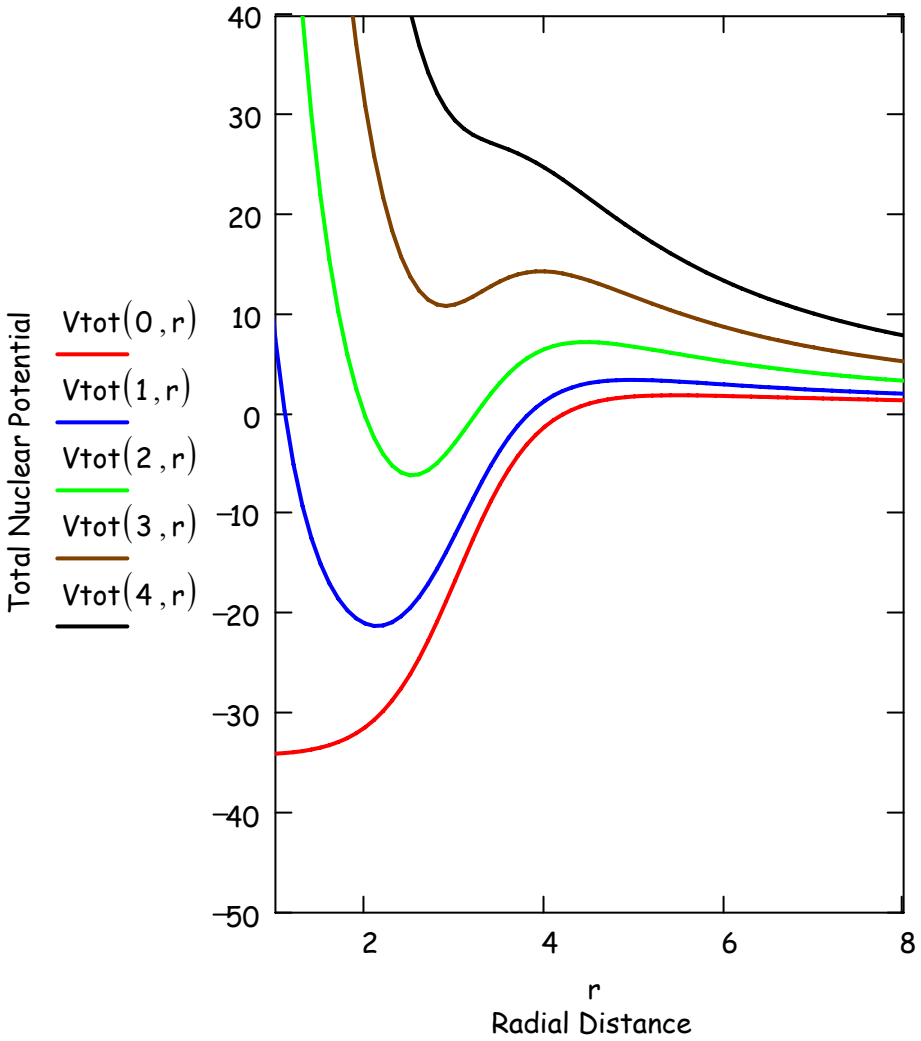
$$Vl(l,r) := 20.8 \cdot \frac{l \cdot (l+1)}{r^2}$$

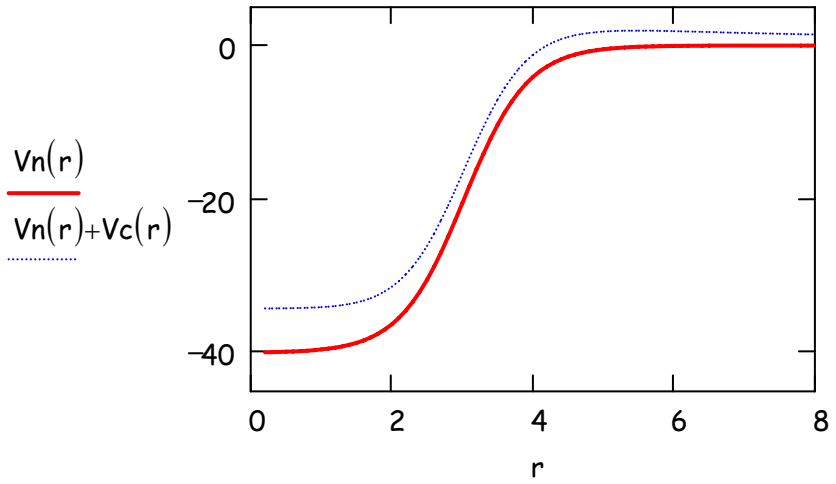
$$Vtot(l,r) := Vn(r) + Vc(r) + Vl(l,r)$$

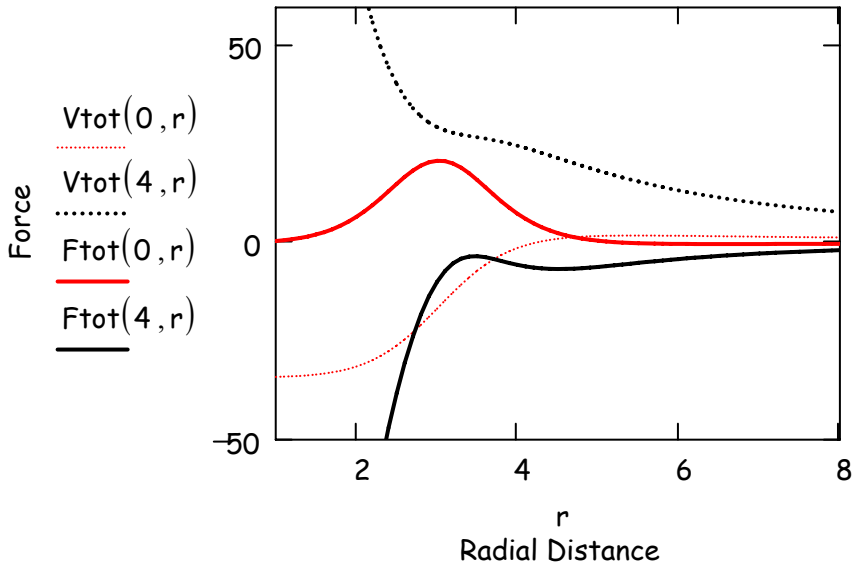
$$Ftot(l,r) := \frac{d}{dr} Vtot(l,r)$$

$r := 0.20, 0.30 .. 8$

Nuclear Potentials







Schroedinger Equation
Solutions through Runge-Kutta Integration

The radial Schroedinger equation has the form:

$$\frac{d^2u}{dr^2} = (V(r) - E)\cdot u$$

$$\text{Solution} := \begin{pmatrix} -17.412 & -4.292 & 10.6125 & 26.157682 \\ 13.126 & 27.244 & 44.458 & 64.130215 \\ 48.754 & 68.348 & 93.046 & 120.0436 \\ 99.976 & 125.05 & 156.75 & 190.8051 \end{pmatrix}$$

If $u(r) = X_0$ and $du/dr = X_1$ then the differential equation is equivalent to the following system:

$$dX_0/dr = X_1$$
$$dX_1/dr = (V(r)-E)X_0$$

$E :=$ 45

Using a fixed step Runge-Kutta method:

$r0 := R + 5a$ $\quad r1 := 0.1$ $\quad N := 500$ $\quad n := 1$ $\quad L := 0$ $\quad E := \text{Solution}_{n-1,L}$ $\quad E = -17.4120$

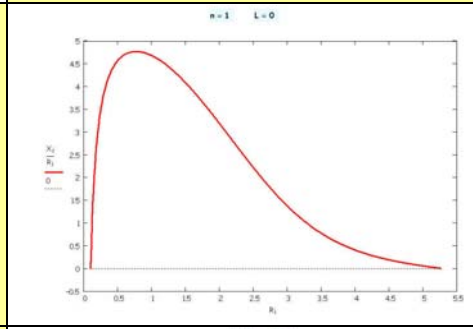
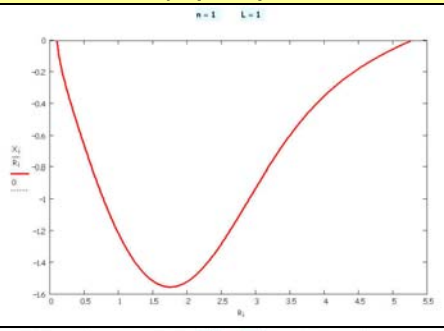
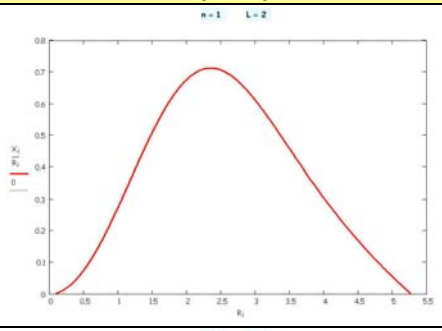
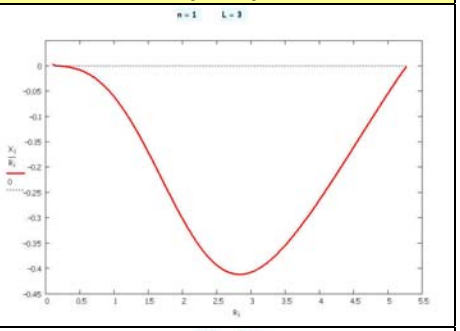
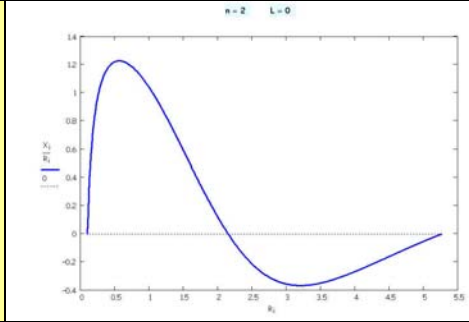
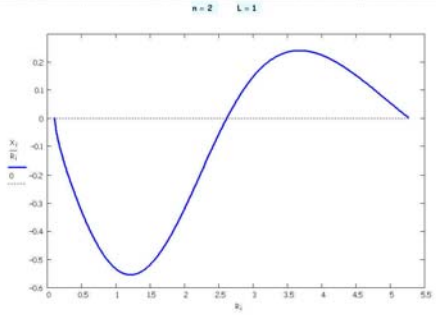
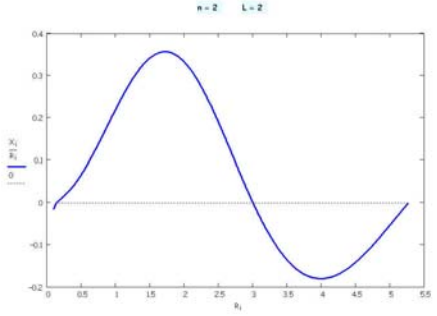
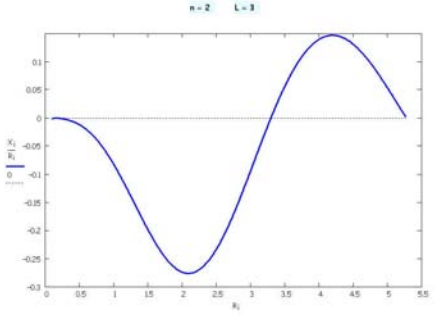
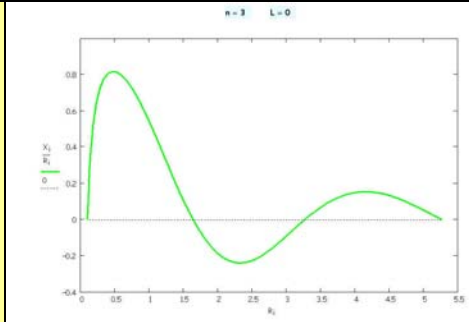
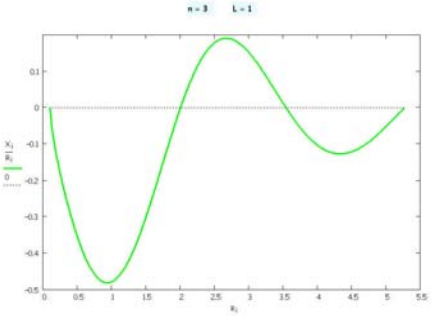
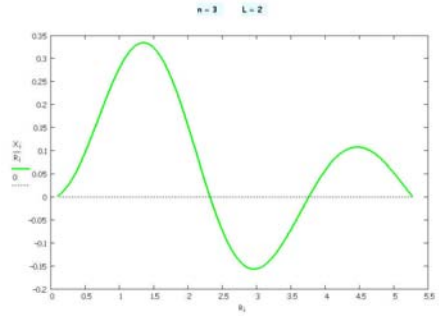
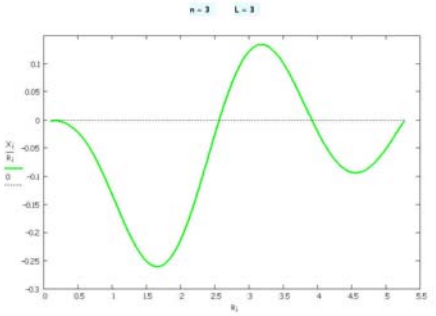
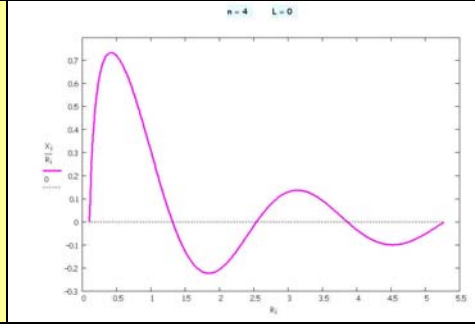
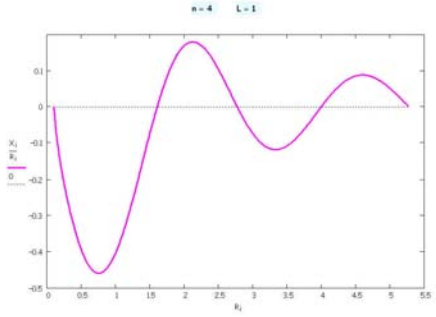
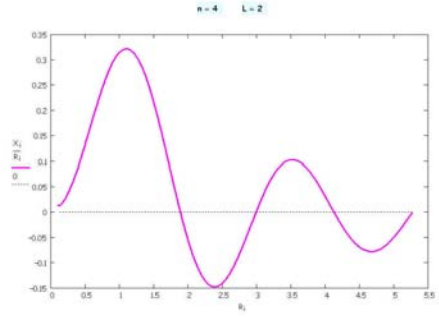
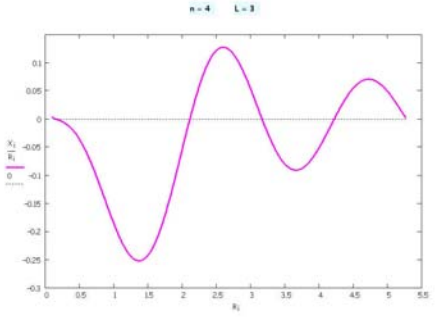
$$D(r, X) := \begin{bmatrix} X_1 \\ 0.05(Vtot(L, r) - E)\cdot X_0 \end{bmatrix} \qquad ic := \begin{bmatrix} 0 \\ (-1)^{n+L} \end{bmatrix}$$

$S := \text{rkfixed}(ic, r0, r1, N, D)$ $\quad Y := S^{\langle 2 \rangle}$ $\quad X := S^{\langle 1 \rangle}$ $\quad R := S^{\langle 0 \rangle}$

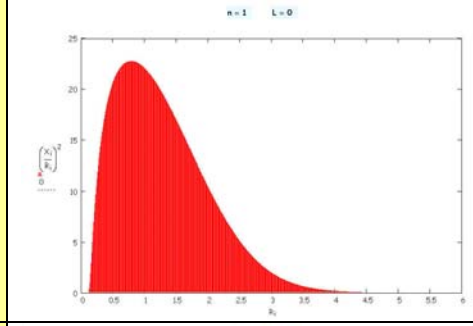
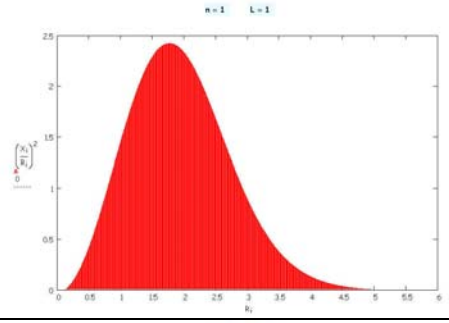
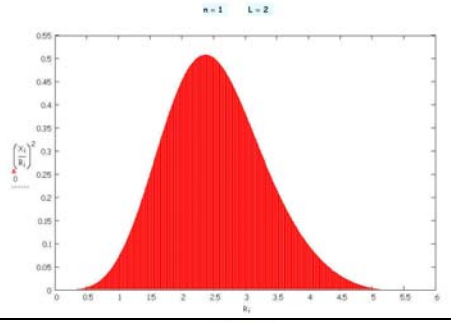
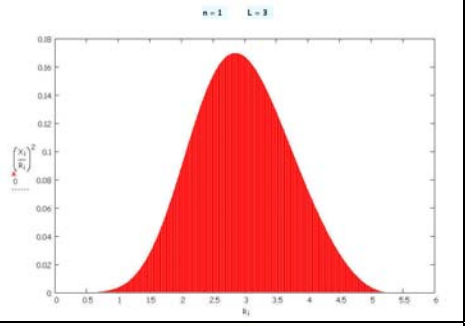
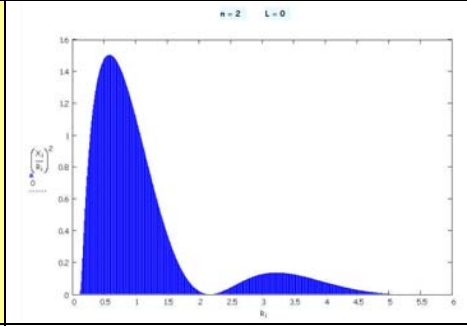
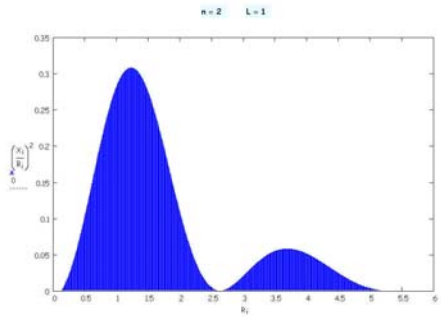
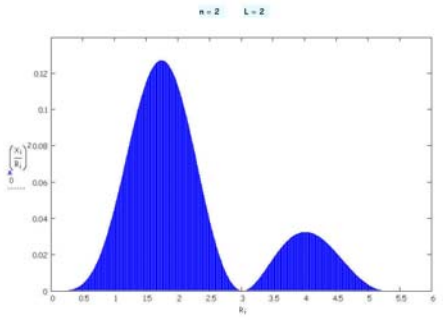
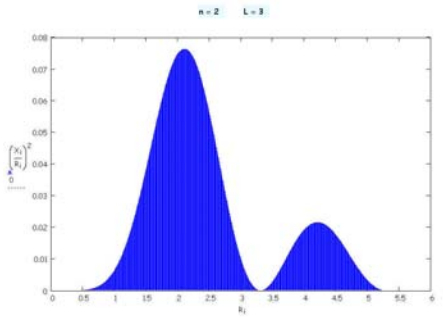
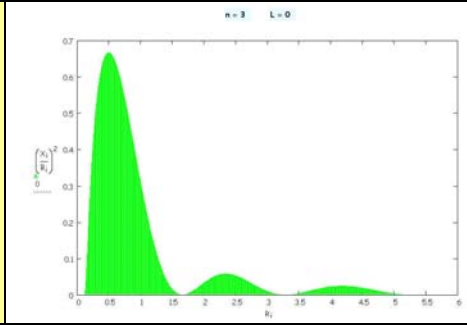
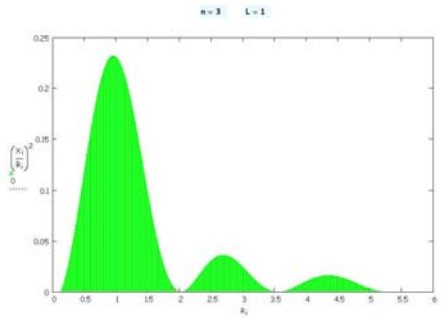
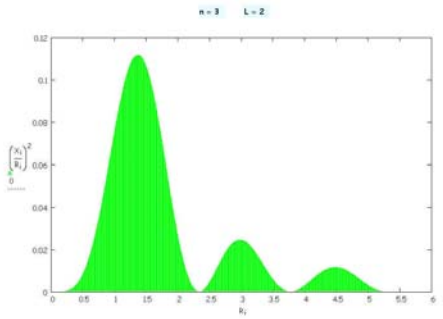
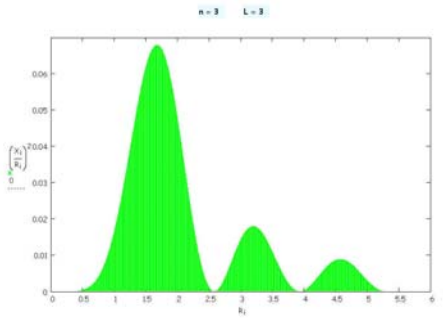
$X_N = -1.103 \times 10^{-5}$ $\quad i := 1..N$

```
Nuclear System
==============
A    =   16.00         Z     =    8.00
Vo   =  -40.00 MeV     Ro    =    1.20 fm      a     = 0.450000 fm
METH =       3         Nstep =     500         Eps   = 0.000010
E0   =  -35.00         Estep =    1.00         Rmin  = 0.100000

 1s  E =  -17.412013      R = 0.100000  Y = -0.238254E-11    40
 2s  E =   13.125914      R = 0.100000  Y = -0.363737E-12    40
 3s  E =   48.754078      R = 0.100000  Y =  0.267147E-13    40
 4s  E =   99.976101      R = 0.100000  Y = -0.104083E-15    40
 1p  E =  -4.2919695      R = 0.100000  Y =  0.190778E-10    40
 2p  E =   27.244009      R = 0.100000  Y = -0.257971E-12    40
 3p  E =   68.348222      R = 0.100000  Y = -0.908613E-12    40
 4p  E =   125.05098      R = 0.100000  Y = -0.566259E-12    40
 1d  E =   10.612524      R = 0.100000  Y =  0.177215E-09    40
 2d  E =   44.457701      R = 0.100000  Y =  0.321688E-10    40
 3d  E =   93.046222      R = 0.100000  Y = -0.272206E-11    40
 4d  E =   156.75264      R = 0.100000  Y =  0.182612E-11    40
 1f  E =   26.157704      R = 0.100000  Y = -0.154223E-08    40
 2f  E =   64.130295      R = 0.100000  Y =  0.404462E-09    40
 3f  E =   120.04376      R = 0.100000  Y =  0.299388E-10    40
 4f  E =   190.80527      R = 0.100000  Y =  0.180673E-10    40


Niveaux Scheme
==============


|  2p          27.2440 |
+----------------------+
|                      |
|  1f          26.1577 |
+----------------------+
|                      |
|                      |
|                      |
|                      |
|                      |
|                      |
|                      |
|                      |
|                      |
|                      |
|  2s          13.1259 |
+----------------------+
|  1d          10.6125 |
+----------------------+
|                      |
|                      |
|                      |
|                      |
|                      |
|                      |
|                      |
|                      |
|                      |
|                      |
|  1p          -4.2920 |
+----------------------+
|                      |
|                      |
|                      |
|                      |
|                      |
|                      |
|                      |
|                      |
|  1s         -17.4120 |
+======================+
```

Wave Functions

	s (L=0)	p (L=1)	d (L=2)	f (L=3)
n=1				
n=2				
n=3				
n=4				

Density Functions

	s (L=0)	p (L=1)	d (L=2)	f (L=3)
n=1				
n=2				
n=3				
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