Parameters

$A := 208$ $\quad Z := 82$ $\quad Ro := 1.2$ $\quad R := Ro \cdot A^{\frac{1}{3}}$ $\quad R = 7.11$ $\quad Vo := -50$ $\quad a := 0.6$ $\quad VLSo := -5.0$

Definitions and Formulas

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

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

$$Vl(l, r) := 20.75 \cdot \frac{l \cdot (l+1)}{r^2}$$

$$VLS(l, j, r) := \begin{array}{|l} VVV \leftarrow \frac{VLSo}{1 + e^{\frac{r-R}{a}}} \\ VLS \leftarrow 0 \quad \text{if } j = l \\ VLS \leftarrow 0.5 \cdot l\, VVV \quad \text{if } j > l \\ VLS \leftarrow -0.5 \cdot (l+1) \cdot VVV \quad \text{if } j < l \\ \text{return } VLS \end{array}$$

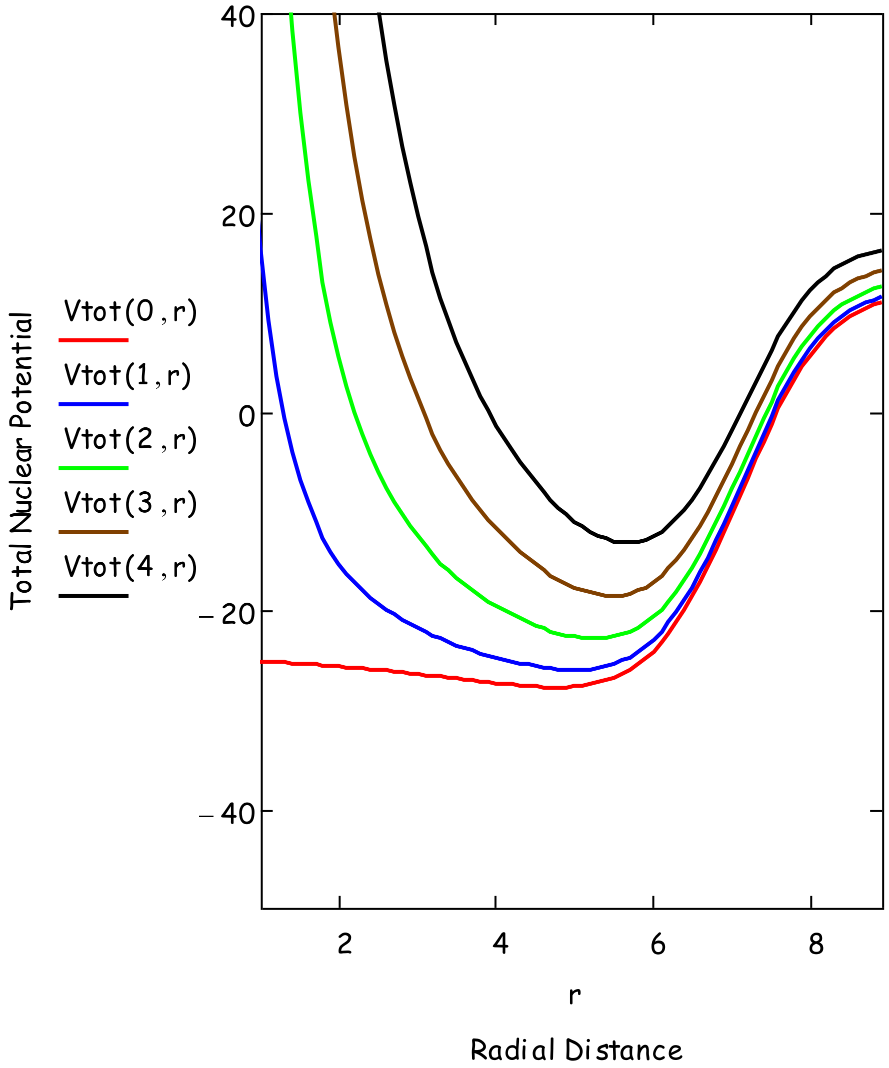
$$Vtot(l, r) := Vn(r) + Vc(r) + Vl(l, r)$$

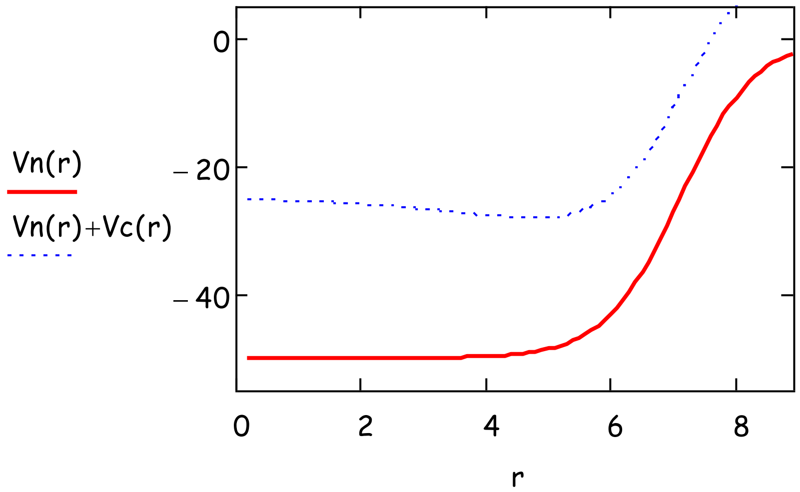
$$VVtot(l, j, r) := Vn(r) + Vc(r) + Vl(l, r) + VLS(l, j, r)$$

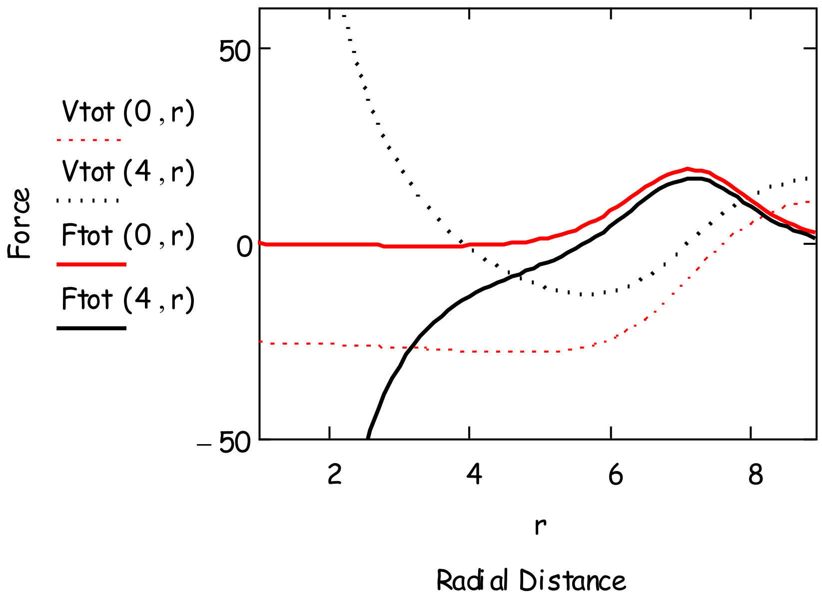
$$Ftot(l, r) := \frac{d}{dr} Vtot(l, r)$$

$$r := 0.20, 0.30 .. R + 3a$$

Nuclear Potentials







Schroedinger Equation
Solutions through Runge-Kutta Integration

The radial Schroedinger equation has the form:

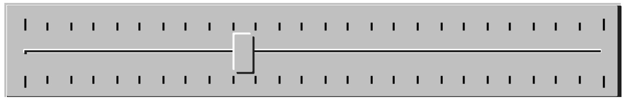
$$\frac{d^2u}{dr^2} = (V(r) - E)\cdot u$$

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

$dX_0/dr = X_1$

$dX_1/dr = (V(r)\text{-}E)X_0$

$E :=$



Using a fixed step Runge-Kutta method:

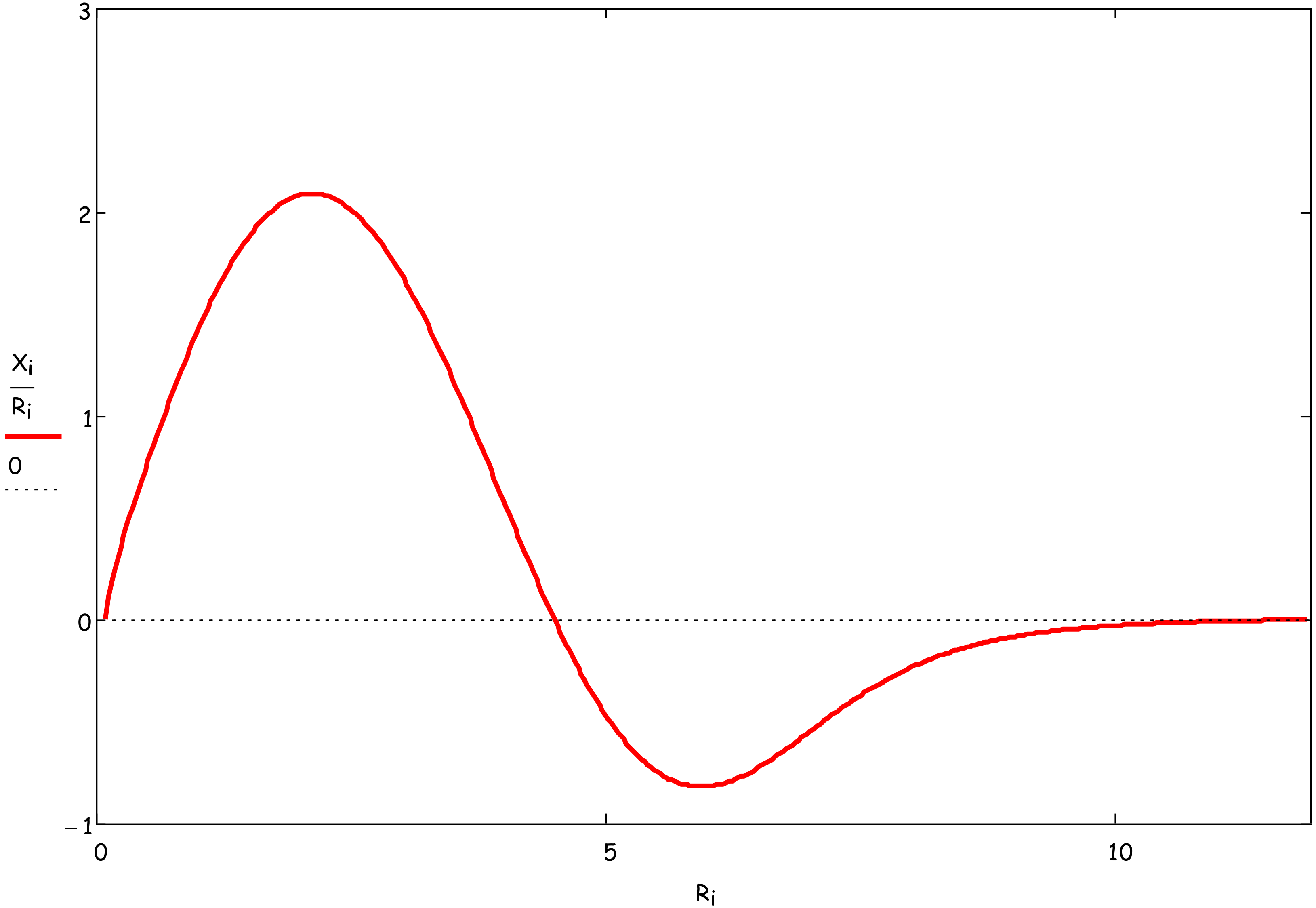
$r0 := R + 8a$ $\quad r1 := 0.1$ $\quad N := 400$ $\quad n := 2$ $\quad L := 1$ $\quad E := En(n, L)$ $\quad E = -5.5860$

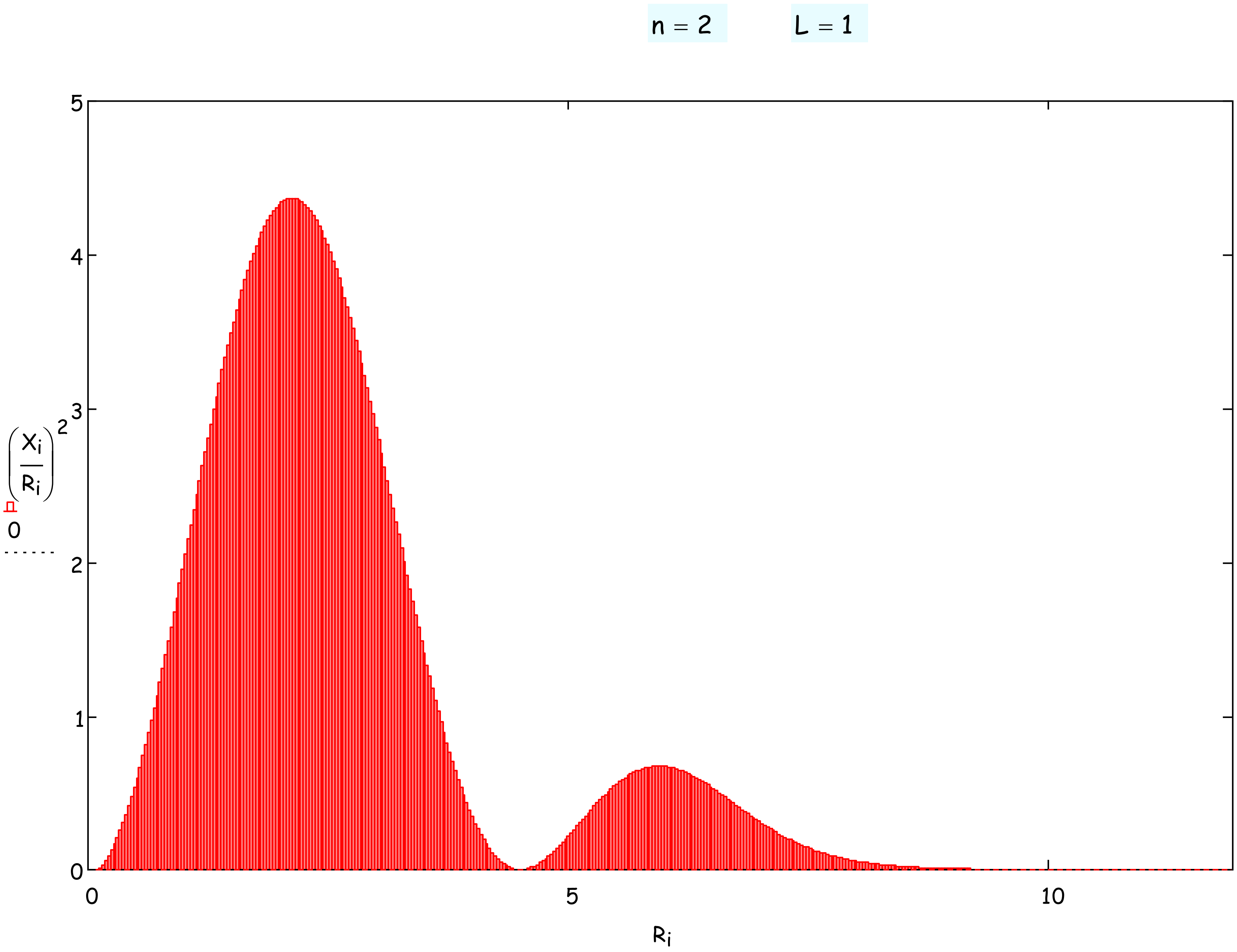
$$D(r, X) := \begin{bmatrix} X_1 \\ 0.048193\,(Vtot(L, r) - E)\cdot X_0 \end{bmatrix} \qquad ic := \begin{pmatrix} 0 \\ 0.1 \end{pmatrix} \qquad S := rkfixed(ic, r0, r1, N, D)$$

$Y := S^{\langle 2\rangle}$ $\quad X := S^{\langle 1\rangle}$ $\quad R := S^{\langle 0\rangle}$

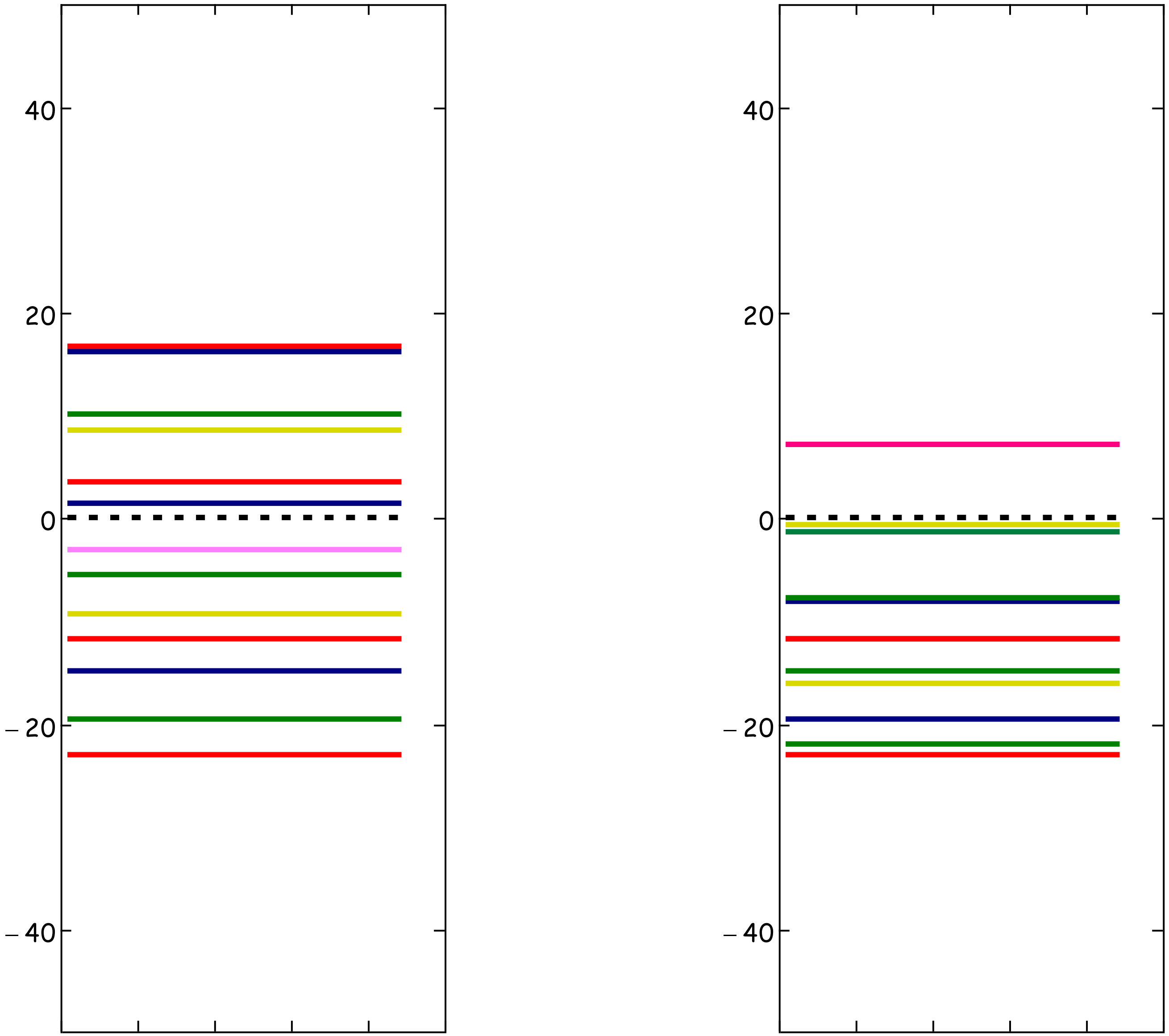
$X_N = -1.431 \times 10^{-4}$ $\quad i := 1 .. N$

$n = 2$ $L = 1$





n = 2
L = 1
5
4
3
2
1
0
0
5
10
R_i
(X_i / R_i)^2
0


40
20
0
– 20
– 40
40
20
0
– 20
– 40