However this effect is \( O\left( \frac{1}{V} \right) \) and we will ignore this effect for now.

Solution of the equation in simple cases to understand the effects of various parts of \( \psi \) in interaction on nuclear matter energy.

First consider a nonsingular attractive square-well with parameters chosen so that the \( N-N \) system has a bound state at zero energy (hits the 'softening')

\[
U(N \Lambda) = A \sin\left( \sqrt{2V_0} r \right) \Rightarrow \sqrt{2V_0} \alpha = \frac{\pi}{2} \quad (\text{bound state} @ E=0)
\]

\[
\Rightarrow V_0 = \frac{\pi^2}{4M\alpha^2}
\]

Setting the effective range \( V_0 - a \) \( (a = 2 + \text{ff from pp data})\)

\[
\Rightarrow V_0 = 14 \text{ MeV}, \quad \leq E_F = \frac{k_F^2}{2M} \approx 40 \text{ MeV}. \quad (\text{at nuclear matter density})
\]

So the potential is relatively weak.

\[
k_F = 1.41 \text{ fm}^{-1} \quad \Rightarrow \quad E = \frac{A}{V} = 0.195 \left( \frac{k_F}{\text{fm}^{-1}} \right)^2
\]

\[
E = \frac{7}{3} \alpha^2 k_F^2
\]
While the 2-G equation for $P = 0$ and concentration on the
S-wave ($k = 0$) solution was $\psi_{k = 0}(x) = \frac{u(x)}{x}$
$\nu = \frac{\nu_0}{x}$

$\frac{u(x)}{x} = j_0(k x) + \int \frac{2 d t}{k_F^2} \frac{j_0(t x)}{k_F^2 + t^2} \int_0^\infty (-\nu_0) j_0(t y) \frac{u(y)}{y} 4\pi y^2 d y$

$\text{in contrast to previous work}$

$\text{explore by } j_0(k y)$

$\text{it assumes} c_{x y z} \text{is small}$

$\Rightarrow$ the s-quark potential is weak and nonsingular.

Let $k \to 0$ $j_0(k y) \to 1$ and for $r < a$ (inside the potential).

$\Delta N = \frac{u(x)}{x} - j_0(k x) \approx \frac{2 \nu_0}{\pi} \int \frac{2 d t}{k_F^2} j_0(t x) \int j_0(t y) y^2 d y$

$= \frac{a^2 j_0(t x)}{t a} \approx \frac{a^2}{t^2} \cos a$

(\text{since } k_F a \lesssim 3.8)

$\Rightarrow \Delta N \approx -2a \int_0^{50} \int \sin t x \cos a \frac{d t}{t^3}$

$= -\frac{2a}{t x} \left( \frac{\nu_0}{k_F^2} \right) \int_1^{50} \sin (t x) \cos (t k_F a) \frac{d t}{t^2}$

Now \ $\frac{\nu_0}{k_F^2} = \frac{\nu_0}{k_F^2} \frac{2}{\mu^*} = \frac{M^* \frac{2}{\mu}}{M^* 4/(k_F a)^2} = \frac{M^*}{M} (10.17) \approx 0.1$

$\approx 0.58$
This means $\Delta \chi > 1$ is attractive, nonsingular potential has little effect on the wave function.

\[ \Delta \chi > 1 \] (small perturbation)

\[ \rightarrow \frac{V_0}{k_F^2} \ll 1 \]

2) in BSE equation we use $\mu \rightarrow \mu > e_F \rightarrow e_F$

and (1) is even smaller.

Numerically, the result for $\Delta \chi$ looks like this:

\[ \Delta \chi \]

\[ 0.02 \]

\[ 0.04 \]

\[ 0 \]

\[ 1 \]

\[ 2 \]

\[ 3 \]

\[ 4 \]

\[ 5 \]

\[ k_F x \]