Homework Assignment #1

(Due Date: Friday, Jan. 28, 9:10am, in class)

1.1 Empirical Features of N-N Force

(a) Briefly discuss 2 empirical evidences for the attractive nature of the force between 2 nucleons.

(b) Briefly discuss 2 empirical evidences for the short-range nature of force between 2 nucleons.

1.2 Central Nuclear Force

In this problem we develop a schematic model for nuclear saturation.

(a) Show that the Fourier transform of a static scalar meson-exchange potential,

\[ V_{\sigma}(q) = -g_{\sigma}^2 \frac{1}{q^2 + m_{\sigma}^2}, \]

yields the standard Yukawa potential in coordinate space, \( V(r) = -g_{\sigma}^2/(4\pi) e^{-m_{\sigma} r}/r. \)

(b) Graph the \( r \)-dependence (in units of [fm]) of the attractive scalar potential (in [MeV]) from \( \sigma \) exchange \( (\alpha=\sigma, m_{\sigma} = 550\text{MeV}, g_{\sigma} = 10.0) \) and of the repulsive scalar potential from \( \omega \) exchange \( (\alpha=\omega, m_{\omega} = 782\text{MeV}, g_{\omega} = 17.5) \), as well as their sum (use the conversion factor \( \hbar c = 197.33\text{MeV fm} \)).

(c) Based on your result for the central potential in part (b) estimate the nuclear saturation (ground-state) density.