Nucleon-nucleon Scattering

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1) Neutron- neutron scattering

Since free neutrons are not stable particle and they decay with a life time (mean) of just under 15 minutes (881 sec), so it is not possible to have a fixed neutron target. The only way to simulate a fixed neutron is to take loosely bound deuterium.
One can extract n-n scattering cross section, by knowedge of n-p scattering cross section.

2) Proton - proton scattering.

1. The long range coulomb potential should be added to the short-range nuclear potential.
2. Due to the identity of the scattered and target particles, the low energy p-p scattering can take place only in spin singlet state.

Perhaps both p-p and n-n system exist only in T=1 i.e. isospin 1 state.

3. The scattered particles and scatterers are identical, the detector can not distinguish the small angle scattering (θ) and large angle scattering ($\pi-\theta$) in the COM system of p-p scattering.

The nucleon-nucleon scattering lengths and effective ranges obtained from low energy nucleon-nucleon scattering is given in the following table.

		$S=0,\ T=1$	$S=1,\ T=0$
p-p	a	-17.1 ± 0.2 fm	
	r_0	2.794 ± 0.015 fm	
n-n	a	-16.6 ± 0.6 fm	
	r_0	2.84 ± 0.03 fm	
n-p	a	-23.715 ± 0.015 fm	5.423 ± 0.005 fm
	r_0	2.73 ± 0.03 fm	1.73 ± 0.02 fm

We note that for $T=1$ scattering lengths differ slightly in n-n, p-p and n-p scattering. The discrepancy in the scattering lengths may be due to the mass difference in the exchange particles.

$$m_{\pi^\pm} - m_{\pi^0} = 4.6\,\text{MeV}$$

p-p and n-n forces arise only from the exchange of neutral pions, whereas n-p force arise due to the exchange of neutral as well as charge pions.