

Separable and one-boson exchange kernel of interaction

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Abstract

We study the relation between one-boson exchange potential and rank I separable-potential. Using the separable ansatz for interaction kernel of BSE for two-nucleon systems, we can solve BSE in relativistic way more easily. The left work is to decide parameters, which are included in the separable ansatz, such that fit experimental data. For example in the case of rank I separable ansatz, which have unknown two parameters, λ and β . We determine two parameters by comparing the one-boson-exchange potential (OBEP). Using such parameters, we can reproduce the characteristic of one-boson exchange potential qualitatively.

1 Formalism

If we compare the term of σ meson in the Bonn potential [5] with separable potential. We can get the following relations.

$$\beta = m_\sigma, \quad \lambda_{sc} = -g_\sigma^2 m_\sigma^2. \quad (1)$$

Here β and λ are the parameters of separable potential and m_σ is mass of σ meson and g_σ is coupling constant of Bonn potential. We can get similar relations for ω , π , ρ . Using the relations we can decide the value of λ and β . And we can get phase shift.

2 Result

The result is the followings.

J^P	$\mu(\text{GeV})$	$g^2/4\pi(\text{Bonn})$	λ_{non}
$0^+ NN\sigma$	0.550	7.7823	-29.583
$1^- NN\rho$	0.769	0.95	-88.106
$1^- NN\omega$	0.7826	20.0	153.92
$0^- NN\pi$	0.13803	14.9	-0.01927

And we can get the four figures. All solid line is the phase shift using the meson contribution of Bonn potential. And dot lines is the phase shift using the separable potential using the parameters decided by above relations.

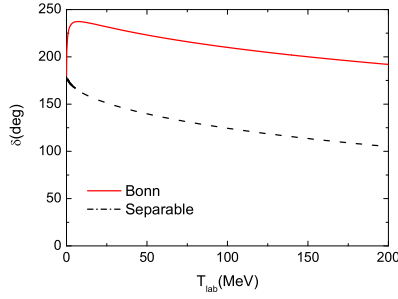


Figure 1. Comparison of the 1S_0 channels phase shifts from σ contribution and separable one is presented.

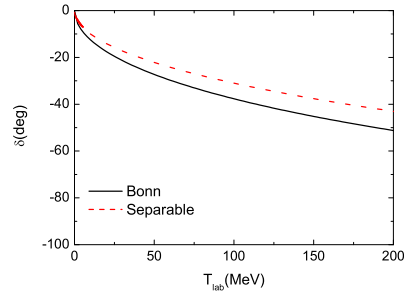


Figure 2. Comparison of the 1S_0 channels phase shifts from ω contribution and separable one is presented.

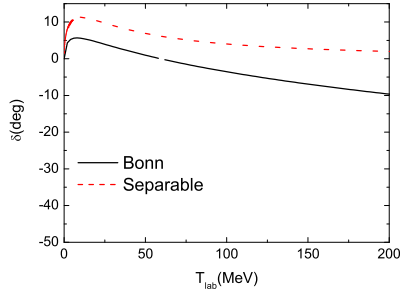


Figure 3. Comparison of the 1S_0 channels phase shifts from π contribution and separable one is presented.

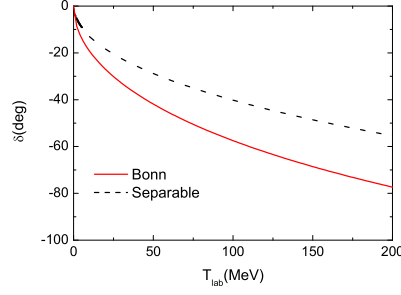


Figure 4. Comparison of the 1S_0 channels phase shifts from ρ contribution and separable one is presented.

3 Conclusion

As a result we can reproduce the characteristic of each mesons. About σ meson case, the behaviors looks different. But Both lines means that it has one bound state. It's the characteristic of attractive forces. About ω and ρ and π behaviors looks the same. It's the characteristic of repulsive forces. We can conclude the parameters of separable potential can relate one-boson exchange potential parameters. It means that the parameters of separable potential have the physical meaning, not just parameter.

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