The NN interaction above the pion threshold in a constituent quark cluster model

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A model is presented to describe NN scattering above the pion production threshold, laboratory energies up to 1 GeV. We use as a basic tool a quark-quark interaction which has been successfully employed to describe NN scattering bellow pion production, the deuteron properties and the triton binding energy [1]. The model has also been applied to study the spectrum of low lying baryons obtaining reasonable results [2].
This quark model is based on the idea of a different scale for confinement and spontaneous chiral symmetry breaking. In the region between the two scales QCD may be formulated as an effective theory of constituent quarks ($m_q \sim 313$ MeV) interacting through the exchange of gluons and Goldstone bosons.
The NN scattering is studied in a Lippmann-Schwinger coupled channel formulation. We include explicitly $N\Delta(1232)$ and $NN^*(1440)$ channels. The main point of our calculation is that all the transition and direct potentials are obtained consistently from the same underlying quark model using both the resonating group method (RGM) and the Born-Oppenheimer (BO) approximation. We use two different approaches for the $\pi N\Delta$ and πNN^* vertexes. One of them is obtained from the elementary emission model at the quark level while the other one refers to the dynamical meson-exchange model of Lee [3]. In each case we use slightly different couple channel formulations. The main difference between both cases comes from the two approaches followed to calculate the Delta and Roper self energies.
Both T=1 and T=0 channels are studied and compared to the model of Lee where the Paris potential is employed for the NN interaction with a suitable subtraction scheme to remove the delta and Roper components. A reasonable description of the energy dependence of the phase-shifts is obtained. Possible dybarion structures are discussed.

References

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