Proc. Sixth Int. Symp. Polar. Phenom. in Nucl. Phys., Osaka, 1985
J. Phys. Soc. Jpn. 55 (1986) Suppl. p. 846-847

3.22 400-1000 MeV NN Scattering in OBE-πNN Dynamics and Dibaryons —— Observables ——

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The cross-section difference $\Delta\sigma_L$ of pp scattering with a beam and a target, both longitudinally polarized, revealed the strong structure in the 400-1000 MeV energy region[1]. This finding triggered to raise controversy about the existence of dibaryon states and stimulated to measure various observables. Now data are considerably rich to test theoretical models. In this paper we would like to show that pp observables at 400-1000 MeV, including the $\Delta\sigma_L$, can be described by the OBE-πNN dynamics, the model where only the OBE-NN and πN interactions are input.

The formalism which describes the coupled systems of NN, πNN, ρNN and πNΔ states with input of OBE, πN-πN and πN-ρN interactions has been proposed by us[2]. The same formalism is used here, but with much improvement of the input interactions and our result is directly compared with the observables.

The basic equation is as follows

$$X_{A,B} = Z_{A,B} + \sum_C Z_{A,C}\, \tau_C\, X_{C,B}, \quad (1)$$

where A,B and C indicate eigenstates of the two and three body systems and the variables of momentum q and energy E in Z and X be understood. The driving term Z and the propagator τ are constructed with the following inputs: (i) The heavy meson exchange for NN-NN. ρ, ω,σ,S*δ and η contributions are taken into account with some modification of the coupling constants of Ueda-Green model. (ii) πN-P11 interactions. The pole part only is involved. (iii) πN-P33 interaction. (iv) The backward going pion contributions in the three body processes of NN-NN, NN-NΔ and NΔ-ΔΔ. (fig.1)

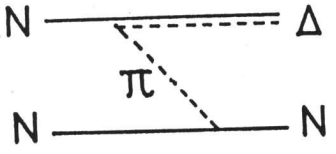

fig.1 Backward going pion contribution.

In ignoring the non-pole part in (ii), the πN-ρN channel in (iii) and all the NN interactions in the πNN system, the present version is more simplified than the one in ref. 2. However we supplement it for momentum transfers $q_\pi > 1$ GeV with the following phenomenology.

As usual, $Z_{A,B}$ is defined by the expectation value of a three-body Green function G with weight of the initial and final two-body form factors. This G is now defined by, for example, for NN-NΔ ,

$$G = [\, E - E_\pi(q_\pi) - E_N(q_1) - E_N(q_2)]^{-1} + [\, E - E_\pi(q_\pi) - E_N(q_1) - E_\Delta(q_2)]^{-1}$$
$$-\xi \{[\, E - E_X(q_\pi) - E_N(q_1) - E_N(q_2)]^{-1} + [\, E - E_X(q_\pi) - E_N(q_1) - E_\Delta(q_2)]^{-1}\} . \quad (2)$$

The first term represents the ordinary three-body rearrangement process and the second does the pion contribution going backward in time to the Δ. (fig. 1)
The third and forth terms are phenomenological with $m_X = 1$ GeV fixed in

$$E_X(q) = \sqrt{q^2 + m_X^2} - m_X .$$

Namely those terms cutoff partially the part with momentum tranfer $q_\pi > 1$ GeV of the first and second terms. The cutoff parameter ξ in eq. (2) is chosen state-dependently.

With this scheme the NN scattering amplitudes with $J \leqq 4$ are calculated and the ones with $J > 4$ are given by the OBE contribution. Resulting observables are displayed in figs. 2 and 3. One sees there that observables are reproduced. In particular the remarkable structure in $\Delta\sigma_L$ appears in our theoretical result, rather more sharply than the data. This indicates that the 1D2 and 3F3 anomalies suggesting dibaryons can be explained in terms of the OBE-πNN dynamics.

The theoretical phase parameters with $J \leqq 4$, both I = 1 and 0, are consistent with

the recent phase shift analysis result by Arndt.

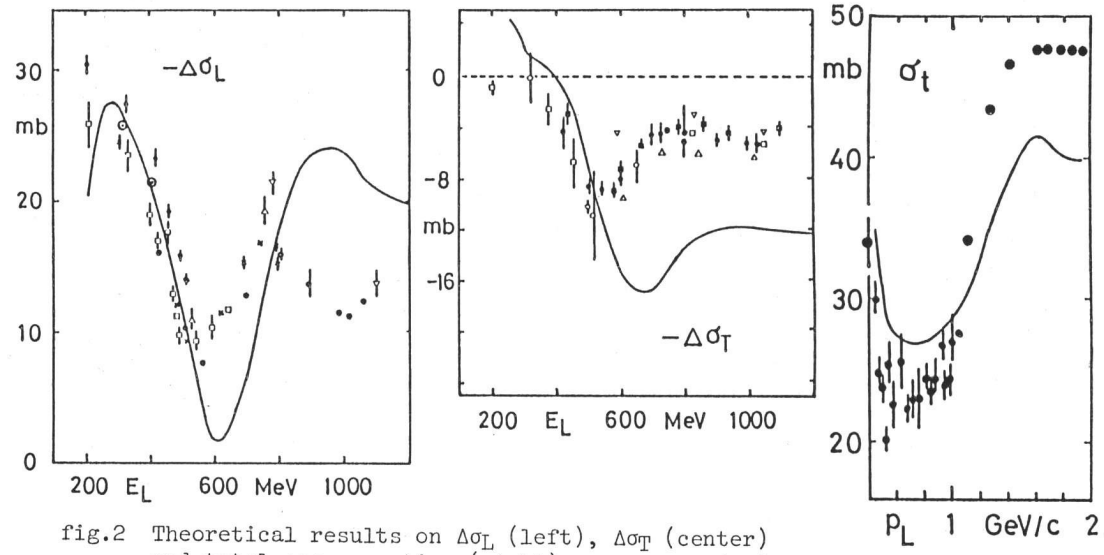

fig.2 Theoretical results on $\Delta\sigma_L$ (left), $\Delta\sigma_T$ (center) and total cross-section (right) are compared with data from Argonne, TRIUMF, LAMPF, Rice, Saclay and SIN.

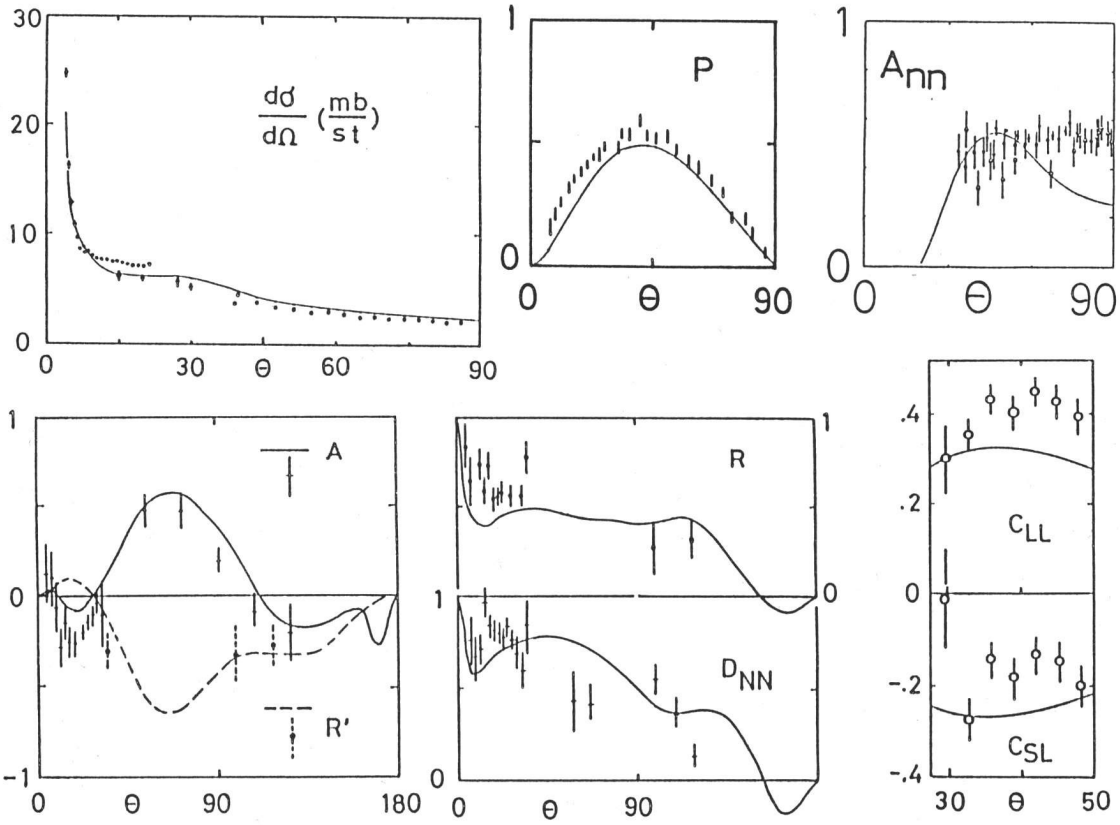

fig.3 Angular distributions of theoretical calculation at E_L= 600 MeV are compared with data around this energy.

References

1) A. Yokosawa, Phys. Rep. 64 (1980) 47.
2) T. Ueda, Phys. Lett. 141B (1984) 157.