POLARIZATION PHENOMENA IN ELASTIC BACKWARD P-D SCATTERING

A.P.Ierusalimov[a], G.I.Lykasov[a], M.Viviani[b]

[a] *Joint Institute for Nuclear Research, Dubna, 141980, Moscow region, Russia*

[b] *Dipartimento di Fisica "E.Fermi", Università di Pisa, and INFN, I-56100, Pisa, Italy*

O U T L O O K

I. *Motivation to study elastic P-D scattering*

II. *One-nucleon exchange model*

III. *More complicated reaction mechanism*

IV. *Relativistic effects within the light cone dynamics*

V. *Results and discussion*

VI. *Summary*

p-d scattering graphs

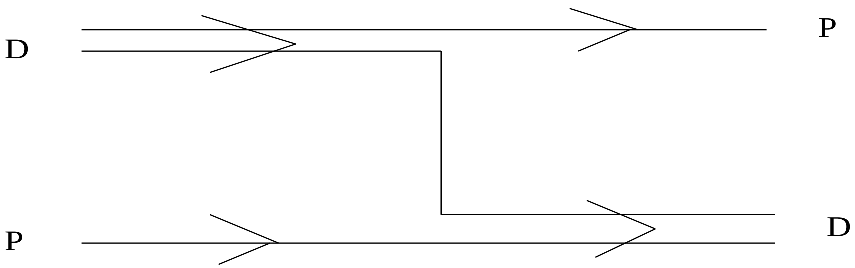

Figure 1: The ONE graph for $dp \to pd$.

Nonrelativistic ONE

(*A.K.Kerman and L.S.Kisslinger, Phys.Rev.***180***,1483 (1969)*)

$$\frac{d\sigma}{d\Omega_{c.m.s.}} = (2\pi)^4 (\frac{E_p^* E_d^*}{E_{tot}^*})^2 \frac{(k_d^2 + \Delta^2)^2}{m^2} \mid \Psi_d(\Delta) \mid^4 \ ,$$

where $\Delta = \mid \frac{1}{2}\mathbf{P}_{d'}^* - \mathbf{p}^* \mid$; E_p^*, E_d^* are the energies of initial proton and deuteron in the c.m.s., $E_{tot}^* = E_p^* + E_d^*$

Relativistic covariant ONE

(1. *F.Gross, J.W.VanOrden and Karl Holinde, Phys.Rev.C**45**,2094 (1992); C**41**,R1909(1990)*
*2. A.Yu.Illarionov,G.L., Phys.Rev.C**64**, 044004 (2001)*)

$$\frac{d\sigma}{d\Omega}|_{c.m.s.} = \frac{6\pi^2}{s} m^2 (m^2 - u)^2 \mid \Psi_d(q_s^2) \mid^4 ,$$

where u is the square of momentum transfer from initial deuteron to final proton; $q_s^2 = \frac{1}{4} s_{12} - m^2$, $s_{12} = (k_1 + k + 2)^2$, k_1, k_2 are the four-momenta of neutron and proton of deuteron.
In Ref.[1] it has been shown that the P-wave component in the deuteron wave function can be appeared in the relativistic approach. The relation of the tensor analyzing power T_{20} and the polarization transfer κ_0 to the P-wave components of the d.w.f was found in Ref.[2] within the relativistic covariant ONE model.

Light cone dynamics

(*S.Weinberg Phys.Rev.C***150***,1313 (1966); S.J.Brodsky, et.al., Phys.Rev.D***8***,4574(1973) L.L.Frankfurt, M.I.Strikman Phys.Rep.C***76***, 215 (1981); V.A.Karmanov, EPAN* **19***, 525 1988); A.P.Kobushkin, L.J.Vizireva, J.Phys.G:Nucl.Phys.* **8***, 893 (1982); M.A.Braun, M.V.Tokarev, EPAN,* **22***, 1237 (1991); L.S.Ahgirey, N.P.Yudin, Yad.Fiz.,* **63***, 2280 (2000).*)

$$P_d(P+\frac{M_d^2}{2P}, O_t, P)\ ;\ k_1(xP+\frac{m_t^2}{2xP}, k_t, xP)\ ;\ k_2((1-x)P+\frac{m_t^2}{2(1-x)P}, k_t, (1-x)P)\ ,$$

where $x = (E_N(p)+p_z)/(E_d(p_d)+p_{dz})$

$$\Psi_d(x,k_t) = (\frac{m_t^2}{4x(1-x)})^{1/4}\Phi_{n.r.}(k^2)\ ,$$

where

$$k^2 = \frac{m_t^2}{4x(1-x)} - m^2$$

Normalization of $\Psi_d(x,k_t)$:

$$\frac{1}{2}\int_0^1 \frac{dx}{x(1-x)}\int \mid \Psi_d(x,k_t) \mid^2 d^2k_t = 1$$

Triangular graphs

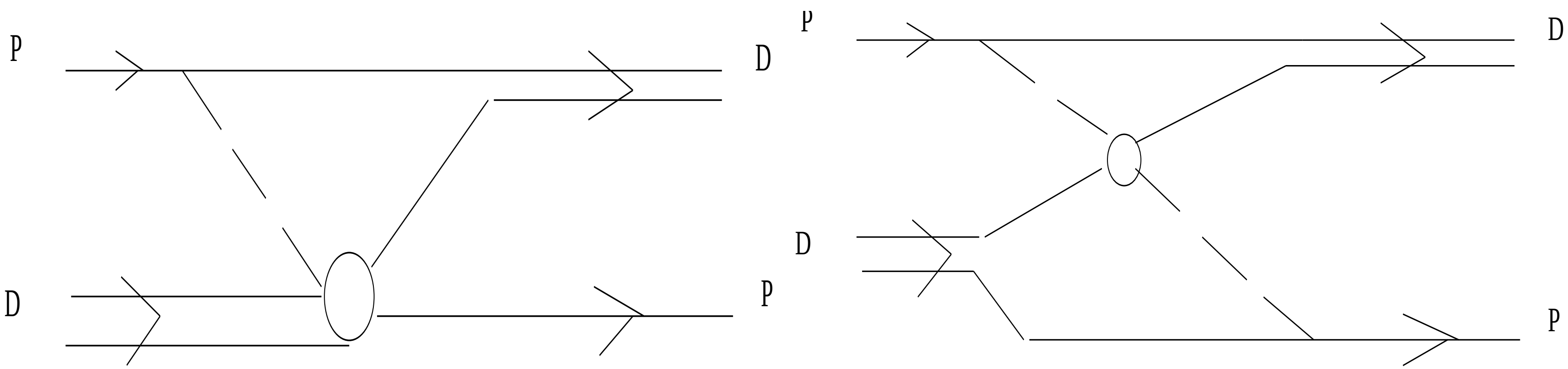

Figure 2: The triangular graph (left panel) and the more detailed graph (right panel) for $dp \to pd$.

Triangular diagrams

- **For $pd \to dp$ within the conventional relativistic invariant approach**: *G.W.Barry, Ann.Phys.,* **73***,482 (1972)*
- **For $dp \to pX$ within the relativistic invariant LCD and another approaches**: *M.G.Dolidze, G.L., Z.Phys.A***335***,95 (1990); Z.Phys.A***336***,339 (1990); G.L.EPAN,* **24***, 140 (1993); L.G. Dachno, V.A.Nikonov, Yad.Fiz.,***50***, 1757 (1989); V.B.Kopeliovich, V.V.Rodomanov, JINR, R2-671 (1978); Yu.Uzikov, et.al.*

Old fashon perturbation theory within the light cone dynamics approach

- **The Green function**

$$G = \frac{1}{E_{inc} - E_{int} + i\epsilon} = \frac{2}{\sum_{inc} s_i/P - \sum_{int} s_i/P + i\epsilon} \ ,$$

where $s_i = \frac{m_{it}}{x_i}$, P is a large initial momentum.

- **The deuteron wave function**

$$\Psi_d(x, k_t) = \frac{\Gamma_d}{(s_d - s' - s + i\epsilon)\sqrt{x(1-x)}} \ ,$$

where Γ_d is the vertex corresponding to deuteron breakup to two nucleons

- **The pion form factor**: $F_\pi = \Lambda^2/(\Lambda^2 - t)$

Differential cross section

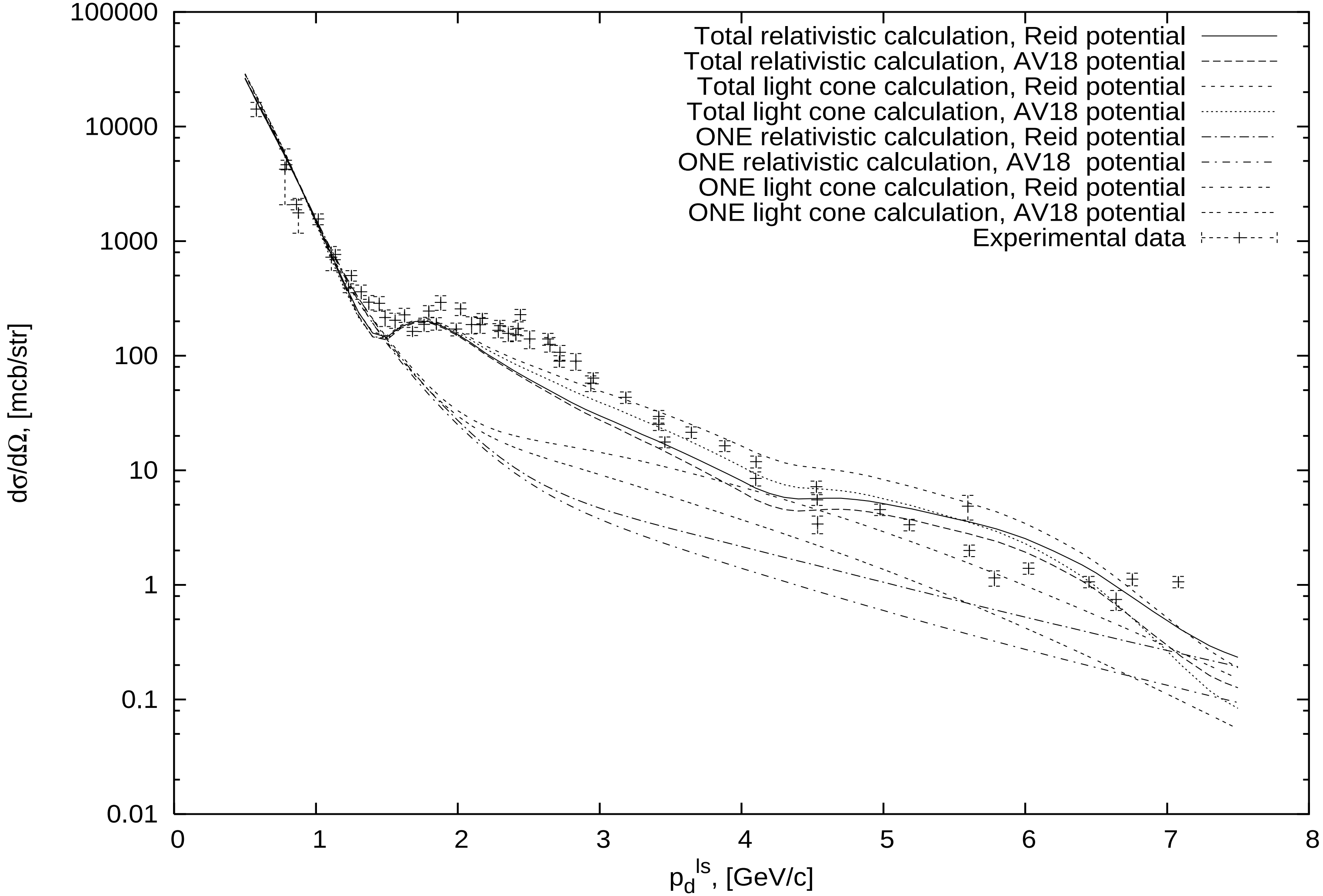

Figure 3: The differential cross sections for $dp \to pd$, $\Lambda = 1(GeV/c)^{-2}$.

Tensor polarization

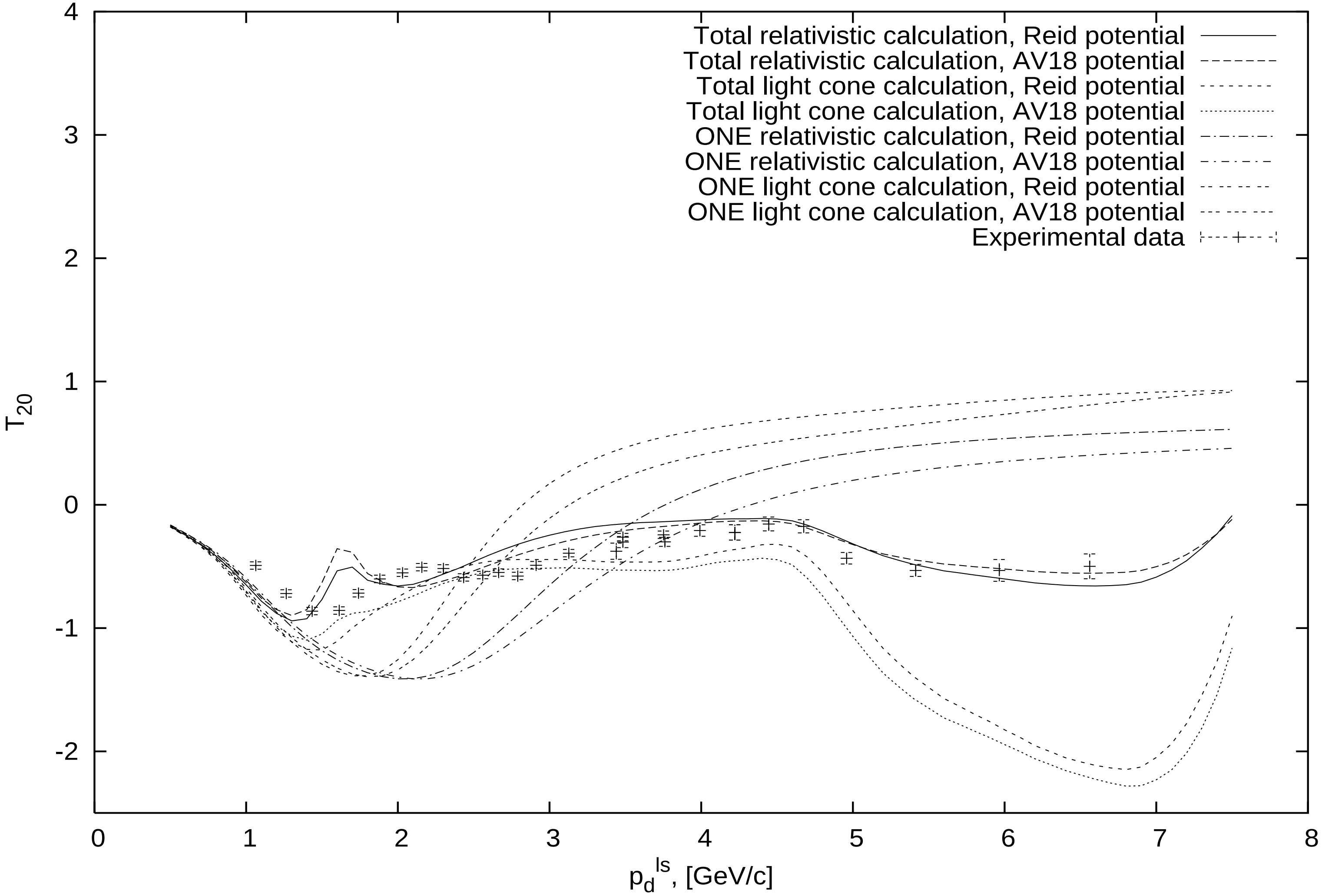

Figure 4: The tensor analyzing power for $dp \to pd$, $\Lambda = 1(GeV/c)^{-2}$.

Transfer polarization

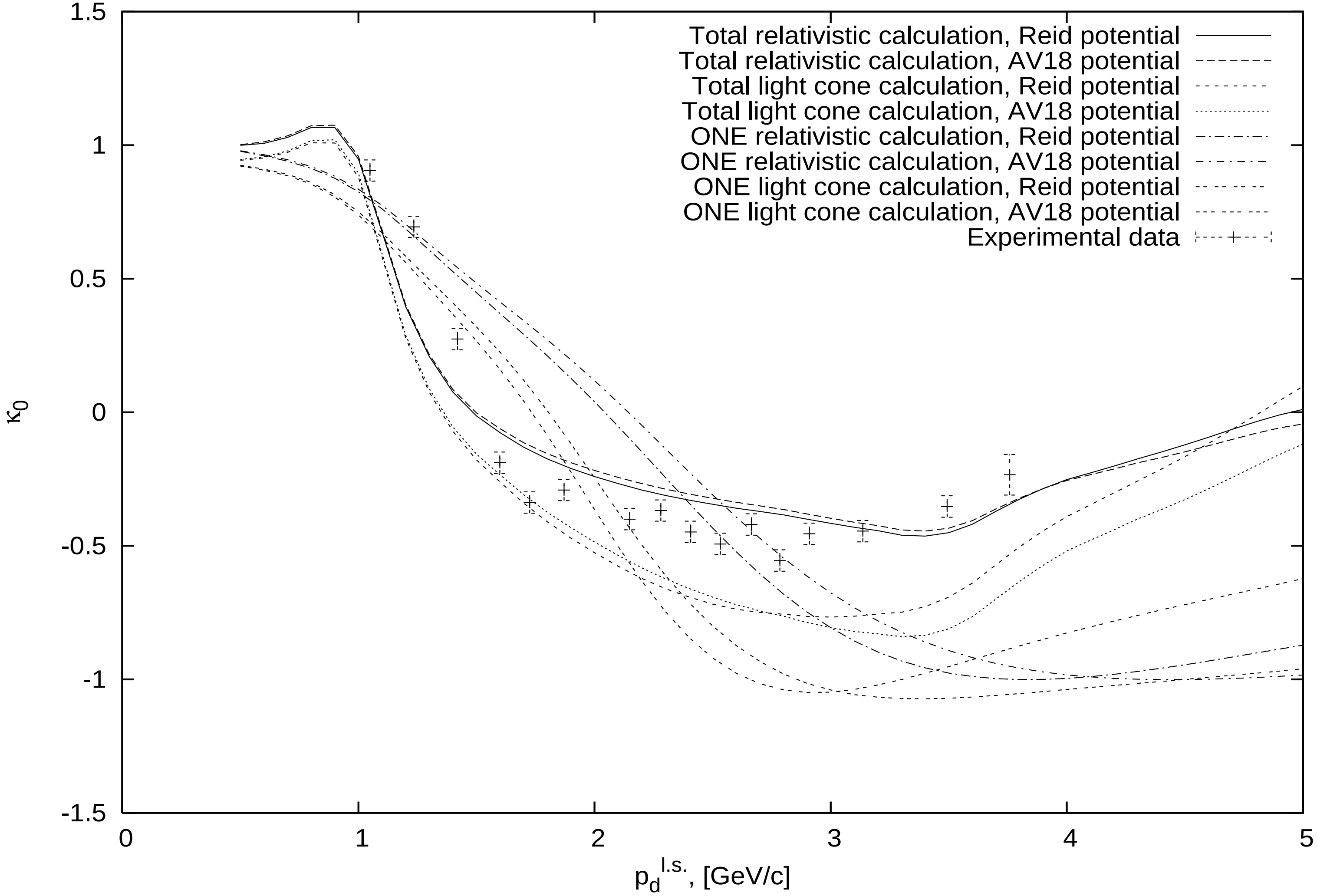

Figure 5: The transfer polarization for $dp \to pd$, $\Lambda = 1(GeV/c)^{-2}$.

SUMMARY

I. The study of the elastic backward $P-D$ scattering as well as $P\ D \to P\ X$ process at moderate and high energies can give us a new information on the deuteron structure and the reaction mechanism.

II. It is shown that the application of the ONE model does not allow us to describe both the differential cross section and polarization observables in the elastic backward $P-D$ scattering.

III. Even the relativistic covariant ONE model including a possible P-state in a deuteron is not able to describe all the experimental data especially the polarization observables.

IV. A role of the more complicated reaction mechanism due to a possible production of a meson in the primary $N-N$ collision and its rescattering on another nucleon of deuteron is discussed.

V. The suggested reaction mechanism contributes significantly at *initial energies corresponding to a creation of the Δ-isobar in the $\pi - N$ rescattering.*

VI. The calculation both the ONE graph and the more complicated suggested digrams within the relativistic approach results in the satisfactory description of all the existing experimental data on $d\sigma/d\Omega, T_{20}, \kappa_0$ as a functions of the initial energy.

VII. The same calculation within the non relativistic approach does not describe the experimental data satisfactory.

VIII. It is shown a some advantage of the relativistic covariant calculation of the Feynman graphs in comparison to the same computation within the light cone dynamics.

IX. The use of the Argon V18 $N - N$ potential allows us to describe all the data rather better than the application of another potentials.