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Comment on "Evidence Against Broad Dibaryons"

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Comment on "Evidence against Broad Dibaryons"

Shypit et al.[1] have performed the PWA of $pp \to np\pi^+$ from 492 to 796MeV. They conclude that dibaryons are excluded in $^1D_2$, $^3F_3$ and $^3P_2$. However, we find that the conclusion is far from conclusive. Their conclusion is based on an <u>unfounded assumption</u> that branching ratio of the dibaryon(B^2) to $N\Delta$ should be very large ($B_{N\Delta} \gtrsim 0.7$).

For $B^2(^1D_2)$, $B_{NN} \sim 0.1$, $B_{\pi d} \sim 0.15$ and hence $B_{N\Delta} + B_{\text{"}NN\pi\text{"}} \sim 0.75$. "$NN\pi$" refers a completely free state. Compared with $B_{\text{"}NN\pi\text{"}}$, $B_{N\Delta}$ should be fairly small due to very strong phase-space suppression: Allowing width effect of $\pm\Gamma/2$, $m_{B^2} - (m_N + m_\Delta) \simeq -17 + 110$MeV while $m_{B^2} - (2m_N + m_\pi) \simeq 135 \pm 50$MeV, where $m_{B^2} \simeq 2155$MeV and $\Gamma_{B^2} \simeq 100$MeV. Hence we expect at least that $B_{N\Delta} \not\gg B_{\text{"}NN\pi\text{"}}$ allowing a possibility of $B_{N\Delta} < 0.5$. Clearly for $B_{N\Delta}$ of this size identification of the resonance is not necessarily a large rapid increase of the phase $\delta_{N\Delta}(^1D_2 \to {}^5S_2)$, but it could even be a rapid <u>decrease</u> of the phase! Indeed one can reproduce the phase decrease very similar to that of Fig.2 of ref.1 assuming a proper background for the resonance as illustrated in Fig.1a. Note that $\delta_{N\Delta}(^1D_2 \to {}^5S_2) \simeq \delta_{N\Delta}(^5S_2)$ in the weak scattering limit. The observed rapid phase decrease strongly suggests the resonance! The work[1] has another problem: They <u>fixed</u> the magnitude of the $^1D_2 \to {}^5S_2$ amplitude to fit the inelasticity in NN elastic PSA assuming $N\Delta$ dominance in σ(NN->inel). This assumption is probably wrong: As argued above $N\Delta$ channel is strongly phase-space suppressed compared with "$NN\pi$" in 500-700MeV range, which strongly suggests the important 3rd channel "$NN\pi$" in σ_{inel}. Indeed they[1] obtained very large NN->NS amplitudes implying a sizable σ(NN->"$NN\pi$") in the range. Here S is S wave $N\pi$ free

state. As pointed out in ref.2, clearly in face of the important 3rd channel where the 2x2 S-matrix for NN and NΔ is <u>not unitary</u> the size of the $^1D_2 \to {}^5S_2$ amplitude can't be determined from the NN elastic PSA, and hence it should be taken as a free parameter.

For $B^2(^3F_3)$, $B_{NN}\sim 0.2$, $B_{\pi d}\sim 0.15$ and hence $B_{N\Delta}+B_{\text{"}NN\pi\text{"}}\sim 0.65$. As $\sigma(NN\to B^2\to inel)\simeq 7.4$mb is much smaller than $\sigma_{inel}\equiv\sigma(NN\to inel)=$ 24.3 ± 3.0mb(data) at $E=m_{B^2}\simeq 2240$MeV, the NΔ dominance in σ_{inel} (if it dominates) at this energy doesn't necessarily imply its dominance in B_{inel} (B^2 branching ratio to inelastic channels) allowing a possibility of $B_{N\Delta}<0.5$. Again for $B_{N\Delta}$ of this size identification of the resonance is not necessarily a large rapid increase of $\delta_{N\Delta}(^3F_3\to {}^5P_3)$, but it could even be a decrease of the phase around the resonance energy $T_{lab}\simeq 789$MeV. Indeed we see a hint of the phase decrease in 729-796MeV range in ref.1. Note that the <u>P wave</u> amplitude $N\Delta(^5P_3)\to N\Delta(^5P_3)$ should have very small phase-shift $\delta_{N\Delta}(^5P_3)(\simeq\delta_{N\Delta}(^3F_3\to {}^5P_3)$ in the weak scattering limit) and magnitude near the threshold $E^o_{th}\equiv m_N+m_\Delta$ ($T_{lab}\simeq 632$MeV) which is close to $E=m_{B^2}-\Gamma_{B^2}/2$ ($T_{lab}\simeq 616$MeV with $\Gamma_{B^2}\simeq 150$MeV), resulting in a strong suppression of the phase activity below the resonance energy as illustrated in Fig.1.b. Hence the inactivity of the $\delta_{N\Delta}$ doesn't necessarily exclude the resonance. We expect a rapid decrease of the $\delta_{N\Delta}$ to negative values <u>above E_R</u>. The work[1] has another problem: The badly large χ^2/d.f. at 729 and 796MeV strongly suggest their omission of other important amplitudes, e.g. $NN(^3F_3)\to NS$ and $NP(\not\neq P_{33})$. Inclusion of them might change the $\delta_{N\Delta}$ significantly.

The most crucial point is that they[1] did not use cross section data on $d\sigma$, σ_{tot} and $\Delta\sigma_L$ for $NN\to NN\pi$ which have dramatic struc-

tures strongly suggestive of the resonances at the corresponding energies[3]. Inclusion of these data may well cause drastic change of the PWA results just as in the NN elastic PWA!

References

1 R. L. Shypit et al., Phys.Rev.Lett.60,901 (1988).

2 N. Hoshizaki, Proc. of Workshop on the Experiments by KEK Polarized Proton and Electron Beams, KEK, Oct.27-28,1988, ed. N. Horikawa.

3 I. P. Auer et al., Phys.Rev.Lett.51,1411(1983); N. Tanaka et al., Phys.Rev.C37,2071(1988).

Figure Caption

Fig.1 (a): Argand diagram of $T(N\Delta(^5S_2)\to N\Delta(^5S_2))$ with the resonance loop of radius $B_{N\Delta}(<0.5)$ and a background, where $E_{th}\equiv m_N+m_\Delta-\Gamma_\Delta/2(T_{lab}=492\text{MeV})$, $E_R\equiv m_{B^2}(T_{lab}\simeq 590\text{MeV})$ and $\Gamma_{B^2}\simeq 100\text{MeV}$. (b):That of $T(N\Delta(^5P_3)\to N\Delta(^5P_3))$ with the resonance loop of radius $B_{N\Delta}(<0.5)$ distorted by the strong threshold suppression, where $E_R\equiv m_{B^2}$ $(T_{lab}\simeq 789\text{MeV})$.

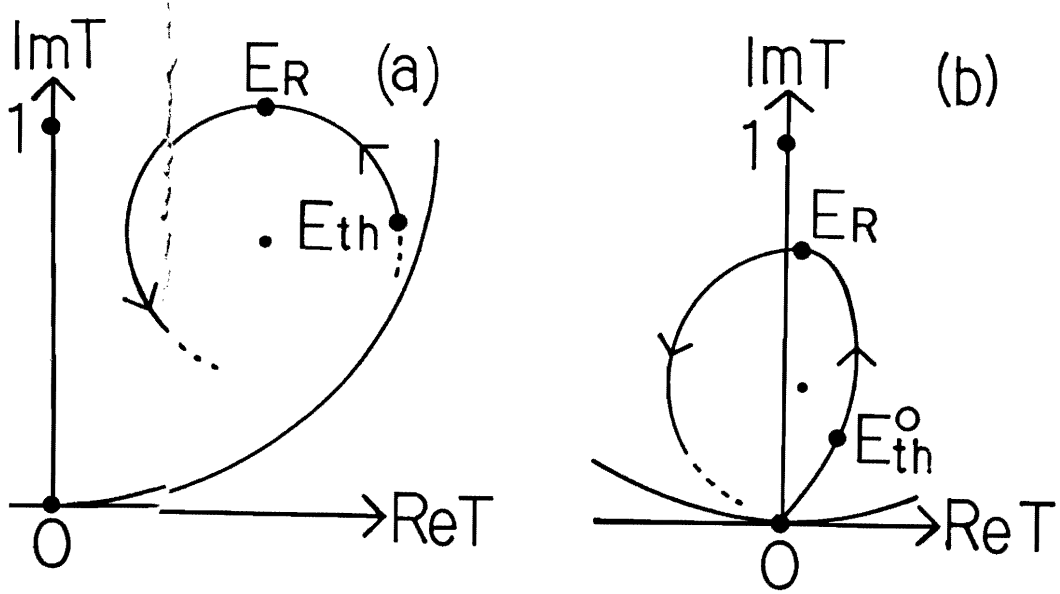

Fig.1