Channel Dependence of the Chiral Unitary Approach for Meson Baryon Scatterings

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We study Baryon resonances using the chiral unitary approach, which uses a Lagrangian of the chiral perturbation theory and produces an unitarized S-matrix. We can reproduce not only scattering data such as phase shifts, inelasticities and cross sections but also resonance properties. The chiral unitary approach has been used for meson-meson scatterings [1] and meson-baryon scatterings [2].

In [2] strangeness $S = -1$ scatterings were studied. Using only one cutoff parameter, experimental results such as cross sections and threshold branching ratios were well reproduced, and $\Lambda(1405)$ resonance was found in $\pi\Sigma$ mass distribution.

This work was extended to $S = 0$ scatterings [3], where $N^*(1535)$ resonance appears. However, for this channels, previous study introduced four parameters called subtruction constants (a_i, i : channel) which were added to loop integrals. Although a_i should be determined from regularization scheme, a_i were treated as parameters to provide a good agreement with data.

In recent study for $S = -1$ channel [4], a_i were introduced. However it was found that differences between a_i were small. This means the effect of a_i was also rather small. The values were from -2.52 to -1.83. On the other hand, in [3], they were from -2.8 to $+2.0$.

Here we investigate how large the effect of a_i is. In Fig.1 and Fig.2, numerical results of $S = 0$ scatterings with and without a_i are shown. The important point is kink structure of T-matrix elements and phase shifts, which can be seen around $\sqrt{s} \simeq 1535$MeV. This structure indicates an existence of resonance state. $\pi^- p \to \eta n$ cross section is also important beccause $N^*(1535)$ strongly couples to ηn state. Absolute values of this cross section should reach $\sim$ 3 mb.

It is obvious that resonance can not be generated without a_i parameters. Then we change the value of regularization scale (μ) in order to produce better result without a_i. At $\mu =$ 600MeV, result become rather good, however an evidence of resonance can not be seen and $\pi^- p \to \eta n$ cross section does not agree with data. Therefore the introduction of a_i is essential, especially for $S = 0$ scatterings and $N^*(1535)$ resonance. From this fact, we conclude that the important physics is hidden in the parameters a_i. In previous calculation, lowest order Chiral Lagrangian has been used. It can be improved by introducing explicit SU(3) breaking terms.

References

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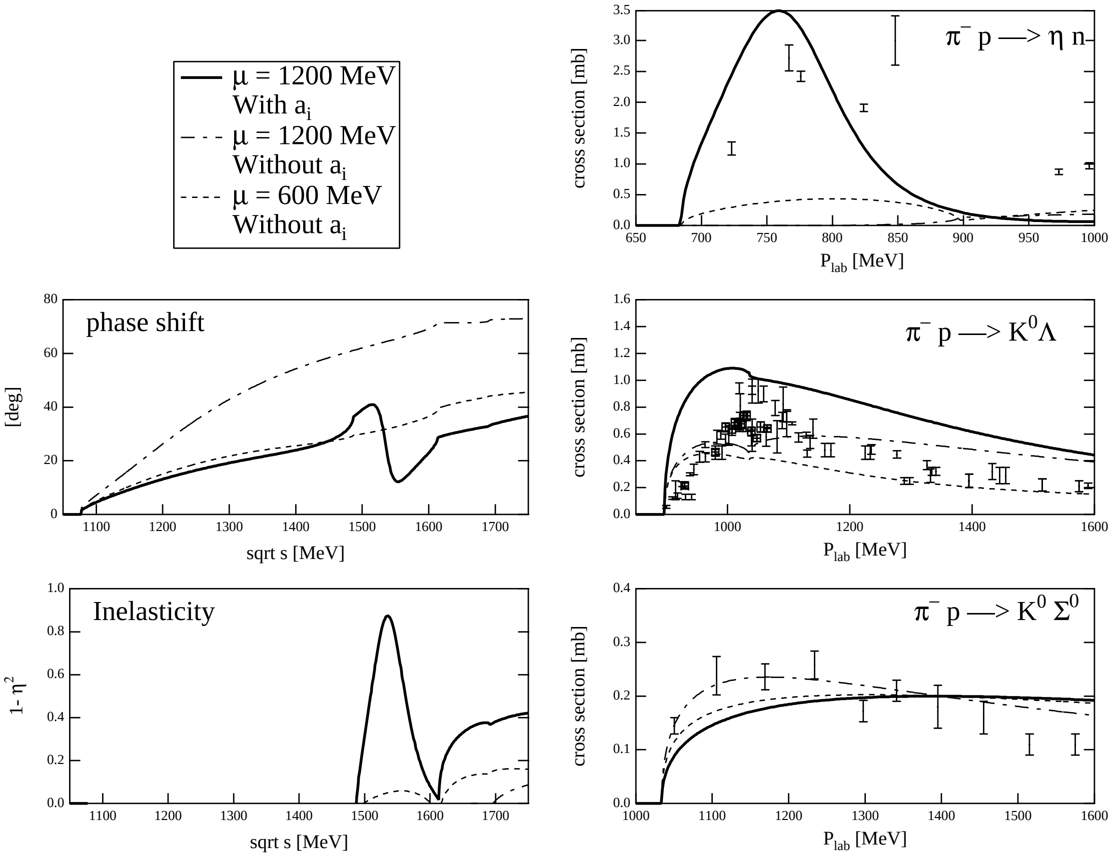

Figure 1: Comparison.

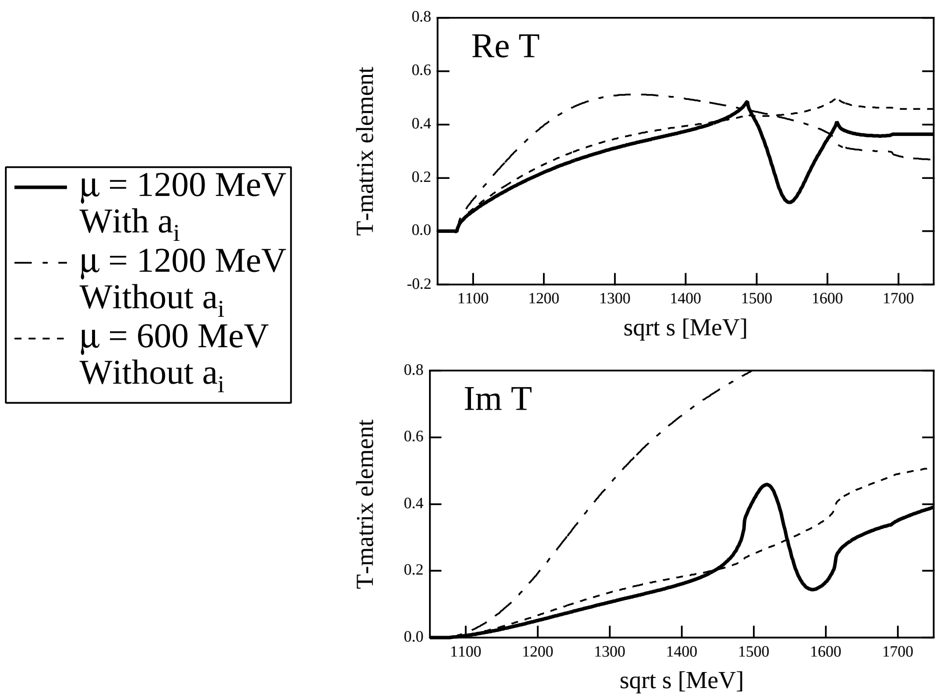

Figure 2: T-matrix element Comparison.