Two-meson cloud contribution to the baryon antidecuplet binding

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We study the two-meson virtual cloud contribution to the self-energy of the $SU(3)$ antidecuplet, to which the Θ^+ pentaquark is assumed to belong [1, 2, 3]. This is motivated by the large branching ratio of the $N(1710)$ decay into two pions and one nucleon. We derive effective Lagrangians that describe the $N(1710)$ decay into $N\pi\pi$ with two pions in s- or p-wave,

$$\mathcal{L}^{8s} = \frac{g^{8s}}{2f}\bar{P}_{ijk}\epsilon^{lmk}\phi_l{}^a\phi_a{}^i B_m{}^j + h.c.\ , \tag{1}$$

$$\mathcal{L}^{8a} = i\frac{g^{8a}}{4f^2}\bar{P}_{ijk}\epsilon^{lmk}\gamma^\mu(\partial_\mu\phi_l{}^a\phi_a{}^i - \phi_l{}^a\partial_\mu\phi_a{}^i)B_m{}^j + h.c.\ , \tag{2}$$

and calculate the self-energy diagrams of the baryon antidecuplet as shown in Fig. 1 We obtain increased binding for all members of the antidecuplet as shown in Fig. 2. It is found that two-meson cloud contribution to the mass splitting between states with different strangeness is at least 20 % of the empirical one. We also provide predictions for three body decays of the pentaquark antidecuplet and investigate other possible contributions to the present results.

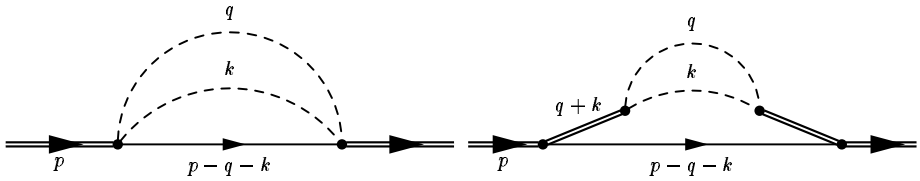

Figure 1: Self-energy of baryon antidecuplet due to two-meson cloud. Right : with vector meson propagators

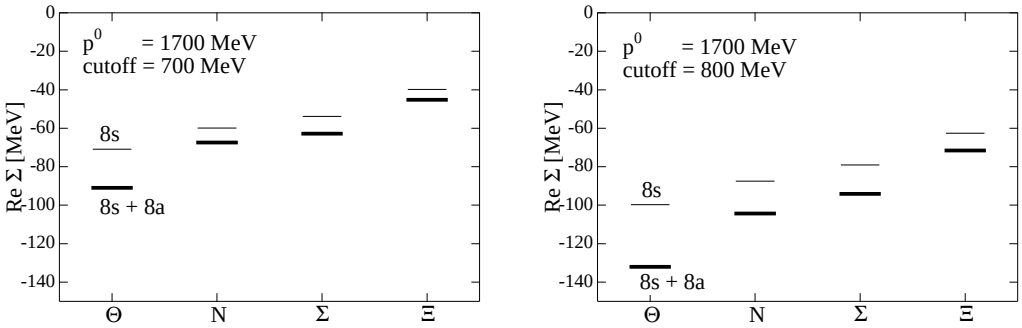

Figure 2: Mass shifts of baryon antidecuplet ($\mathrm{Re}\Sigma_P$) due to two-meson cloud with $p^0 = 1700$ MeV. Thin lines represent the results from contributions from $\mathcal{L}^{8s}$, and thick lines denote the total contribution with $\mathcal{L}^{8s}$ and $\mathcal{L}^{8a}$. Left : cutoff 700 MeV, right : cutoff 800 MeV.

References

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[2] T. Hyodo, A. Hosaka, F. J. Llanes-Estrada, E. Oset, J. R. Peláez, and M. J. Vicente Vacas, hep-ph/0501116.
[3] E. Oset, S. Sarkar, M. J. Vicente Vacas, V. Mateu, T. Hyodo, A. Hosaka and F. J. Llanes-Estrada, nucl-th/0410071.