Effects of Hidden-strange Hadronic Molecular States $N(2080)3/2^-$ *and* $N(2270)3/2^-$ *on* $K^*\Sigma$ *Photoproduction*

隐奇异夸克强子分子态 N(2080)$3/2^-$和N(2270)$3/2^-$ 在$K^*\Sigma$光生反应中效应的研究

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Formalism

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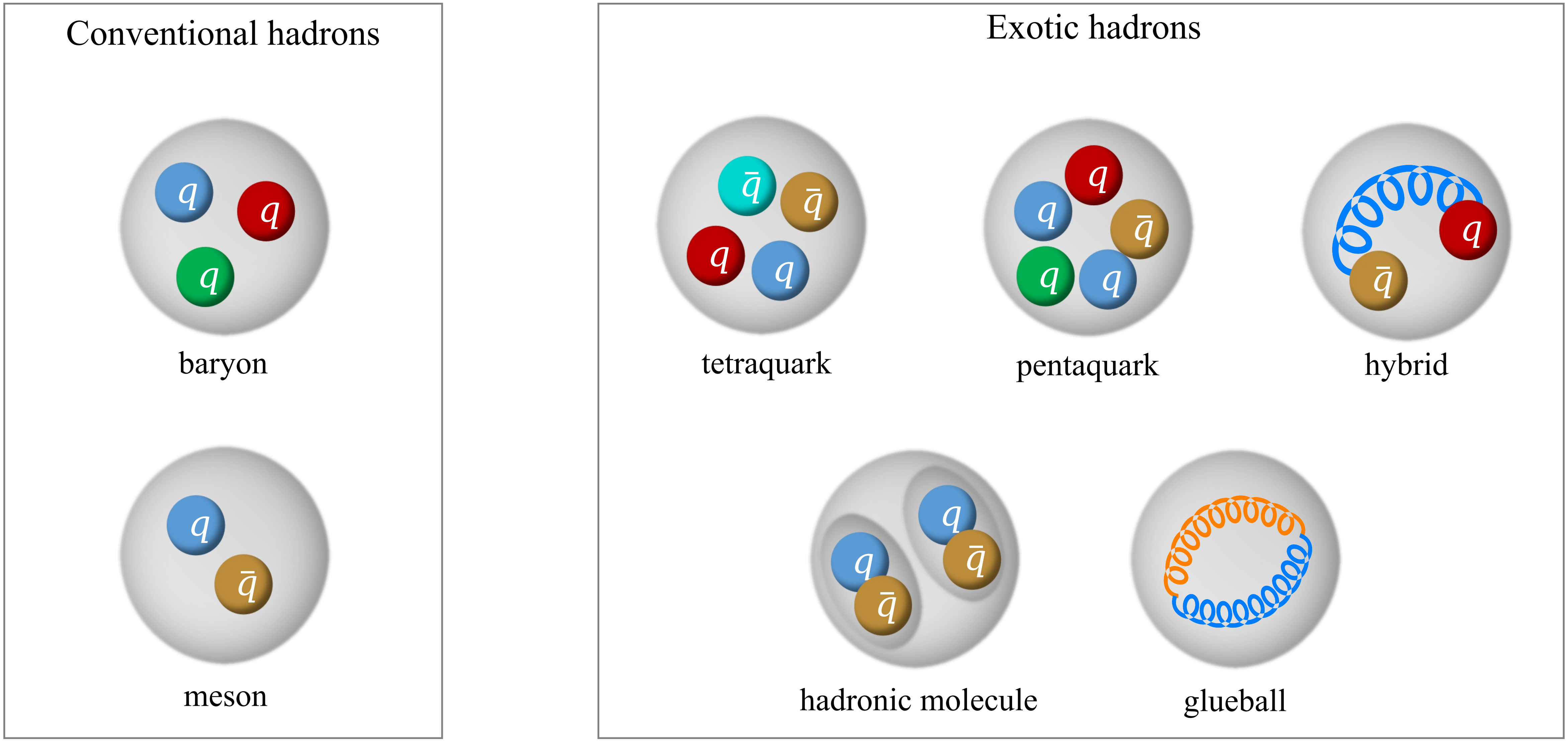
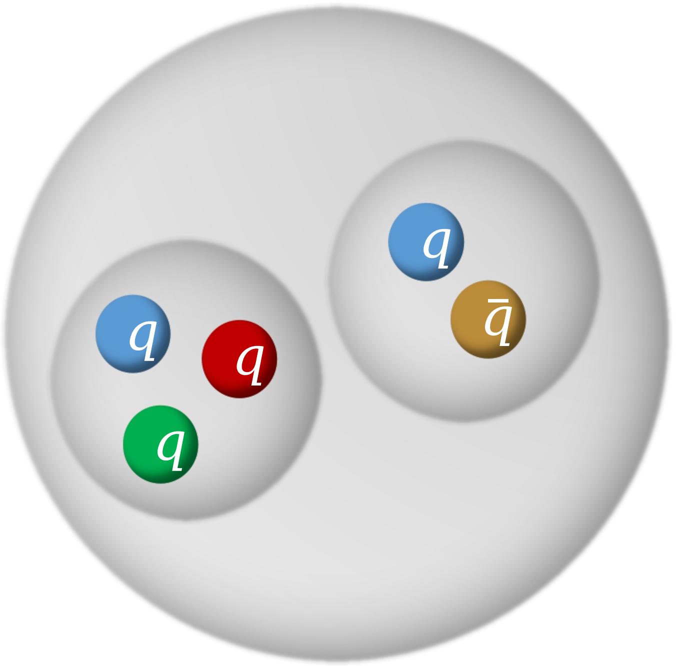
Introduction



Made by F.K. Guo

Introduction

In literature, there are many theoretical investigations on the nature of the P_c states [9, 10]. The fact that the reported masses of $P_c^+(4380)$ and $P_c^+(4457)$ locate just below the thresholds of $\bar{D}\Sigma_c^*$ and $\bar{D}^*\Sigma_c$ at 4382 MeV and 4459 MeV seems strongly support the interpretation of $P_c^+(4380)$ and $P_c^+(4457)$ as hadronic molecules composed of $\bar{D}\Sigma_c^*$ and $\bar{D}^*\Sigma_c$, respectively. Analogously, in the light quark sector, as the masses of $N(1875)3/2^-$ and $N(2080)3/2^-$ are just below the thresholds of $K\Sigma^*$ and $K^*\Sigma$ at 1880 MeV and 2086 MeV, respectively, the $N(1875)3/2^-$ and $N(2080)3/2^-$ are proposed to be the strange partners of the $P_c^+(4380)$ and $P_c^+(4457)$ molecular states [11, 12]. In Ref.[12], the decay patterns of $N(1875)3/2^-$ and $N(2080)3/2^-$ as S-wave $K\Sigma^*$ and $K^*\Sigma$ molecular states were calculated within an effective Lagrangian approach, and it was found that the measured decay properties of $N(1875)3/2^-$ and $N(2080)3/2^-$ can be reproduced well, supporting the molecule interpretation of the $N(1875)3/2^-$ and $N(2080)3/2^-$ states.



Replace $c\bar{c}$ with $s\bar{s}$

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Introduction

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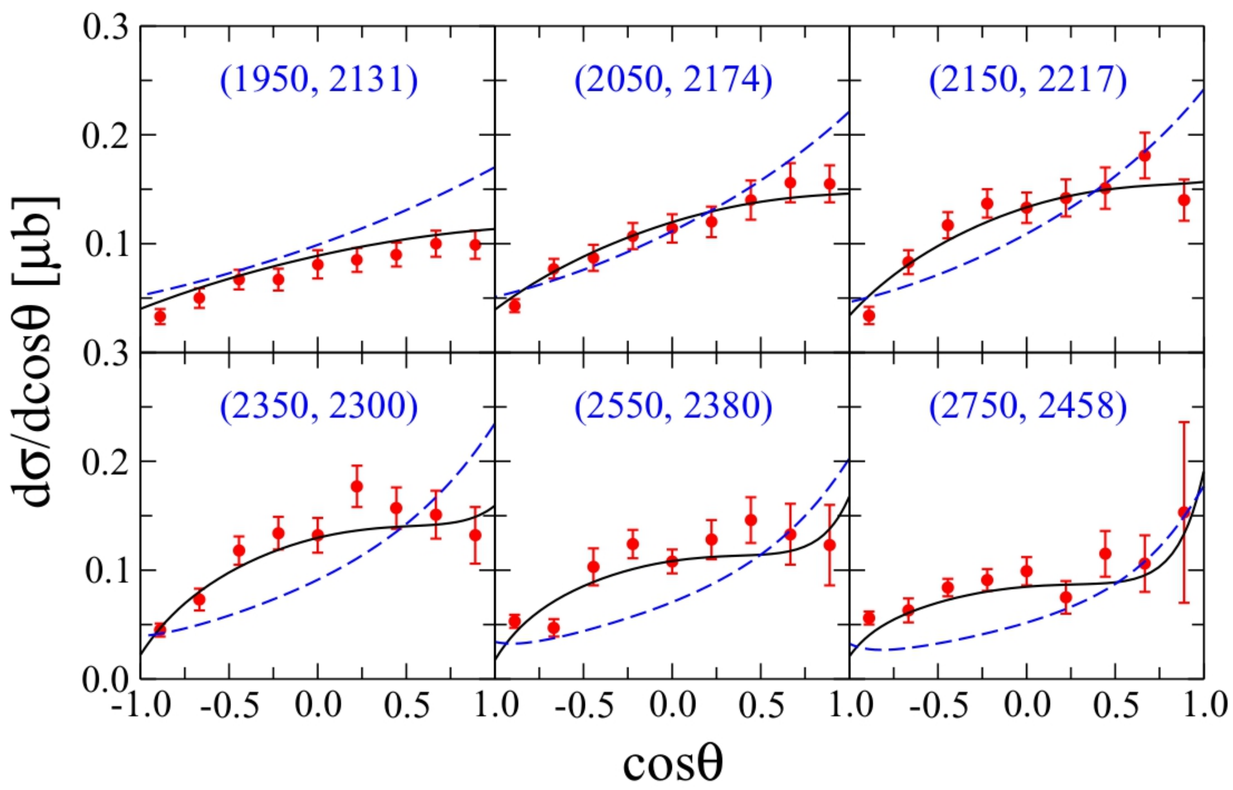

FIG. 1. Status of theoretical description of the differential cross sections for $\gamma p \to K^{*+}\Sigma^0$ at selected energies. The numbers in parentheses denote the photon laboratory incident energy (left number) and the total center-of-mass energy of the system (right number). The blue dashed lines represent the results from Ref. [9], and the black solid lines denote our theoretical results. The scattered symbols are the most recent data from CLAS Collaboration [5].

This Work: Δ(1905) V.S. N(2080)+N(2270)

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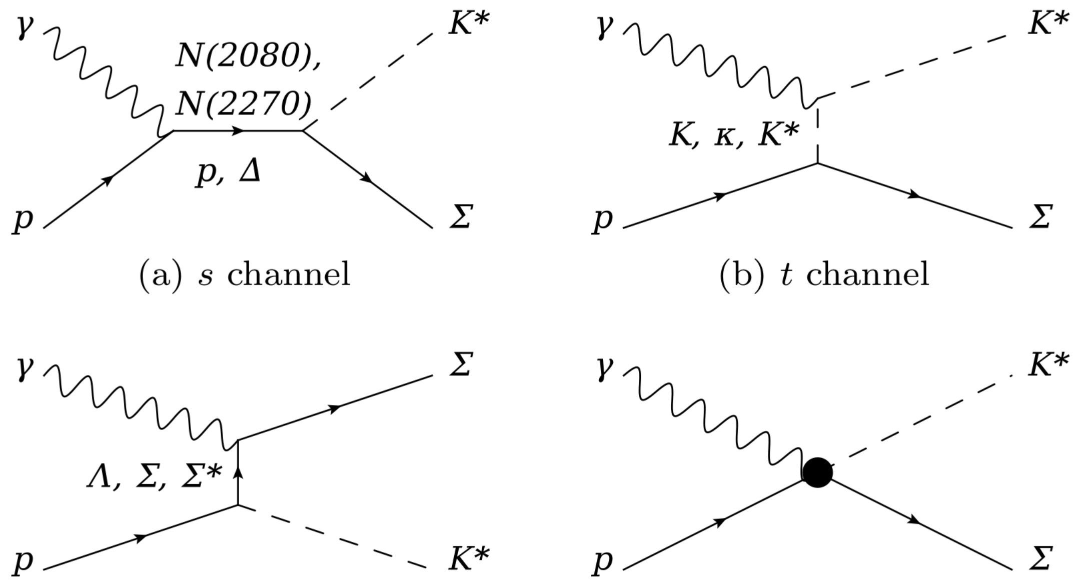
Formalism: Total Amplitude

The Effective Lagrangian Approach



(a) s channel (b) t channel (c) u channel (d) Interaction current

FIG. 1. Generic structure of the K^* photoproduction amplitude for $\gamma p \to K^*\Sigma$. Time proceeds from left to right.

$$\boxed{M^{\nu\mu} = M_s^{\nu\mu} + M_t^{\nu\mu} + M_u^{\nu\mu} + M_{\text{int}}^{\nu\mu}}$$

$$M_{\text{int}}^{\nu\mu} = \Gamma_{\Sigma N K^*}^{\nu}(q) C^\mu + M_{\text{KR}}^{\nu\mu} f_t.$$

$$\Gamma_{\Sigma N K^*}^{\nu}(q) = -i g_{\Sigma N K^*} \left[\gamma^\nu - i \frac{\kappa_{\Sigma N K^*}}{2M_N} \sigma^{\nu\alpha} q_\alpha \right]$$

$$M_{\text{KR}}^{\nu\mu} = g_{\Sigma N K^*} \frac{\kappa_{\Sigma N K^*}}{2M_N} \sigma^{\nu\mu} Q_{K^*}$$

Following Refs. [14,15], we choose C^μ for $\gamma p \to K^{*+}\Sigma^0$ as

$$C^\mu = -Q_{K^*} \frac{f_t - \hat{F}}{t - q^2} (2q - k)^\mu - Q_N \frac{f_s - \hat{F}}{s - p^2} (2p + k)^\mu, \tag{5}$$

with

$$\hat{F} = 1 - \hat{h}(1 - f_s)(1 - f_t), \tag{6}$$

and for $\gamma p \to K^{*0}\Sigma^+$ as

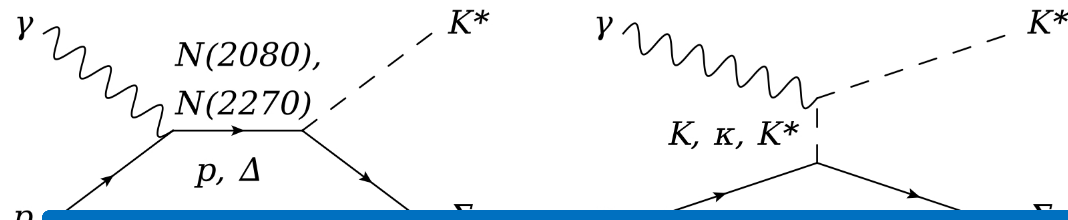
$$C^\mu = -Q_\Sigma \frac{f_u - \hat{F}}{u - p'^2} (2p' - k)^\mu - Q_N \frac{f_s - \hat{F}}{s - p^2} (2p + k)^\mu, \tag{7}$$

with

$$\hat{F} = 1 - \hat{h}(1 - f_u)(1 - f_s). \tag{8}$$

Formalism: Total Amplitude

The Effective Lagrangian Approach



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$$M^{\nu\mu} = M_s^{\nu\mu} + M_t^{\nu\mu} + M_u^{\nu\mu} + M_{\rm int}^{\nu\mu}$$

$$M_{\rm int}^{\nu\mu} = \Gamma^{\nu}_{\Sigma N K^*}(q) C^{\mu} + M_{\rm KR}^{\nu\mu} f_t.$$

$$\Gamma^{\nu}_{\Sigma N K^*}(q) = -i g_{\Sigma N K^*}\left[\gamma^{\nu} - i\frac{\kappa_{\Sigma N K^*}}{2M_N}\sigma^{\nu\alpha} q_{\alpha}\right]$$

$$M_{\rm KR}^{\nu\mu} = g_{\Sigma N K^*}\frac{\kappa_{\Sigma N K^*}}{2M_N}\sigma^{\nu\mu} Q_{K^*}$$

Following Refs. [14,15], we choose C^{μ} for $\gamma p \to K^{*+}\Sigma^0$ as

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(5)

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(6)

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(7)

with

$$\hat{F} = 1 - \hat{h}(1 - f_u)(1 - f_s). \quad (8)$$

[14] H. Haberzettl, K. Nakayama, and S. Krewald, Phys. Rev. C **74**, 045202 (2006).

[15] F. Huang, M. Döring, H. Haberzettl, J. Haidenbauer, C. Hanhart, S. Krewald, U.-G. Meißner, and K. Nakayama, Phys. Rev. C **85**, 054003 (2012).

Formalism: Background Terms

$$\mathcal{L}_{NN\gamma} = -e\bar{N}\left[\left(\hat{e}\gamma^{\mu} - \frac{\hat{\kappa}_N}{2M_N}\sigma^{\mu\nu}\partial_{\nu}\right)A_{\mu}\right]N, \quad (12)$$

$$\mathcal{L}_{\gamma K^* K^*} = -e(K^{*\nu} \times K^{*}_{\mu\nu})_3 A^{\mu}, \quad (13)$$

$$\mathcal{L}_{\gamma\kappa K^*} = e\frac{g_{\gamma\kappa K^*}}{2M_{K^*}}F^{\mu\nu}K^{*}_{\mu\nu}\kappa, \quad (14)$$

$$\mathcal{L}_{\gamma K K^*} = e\frac{g_{\gamma K K^*}}{M_K}\varepsilon^{\alpha\mu\lambda\nu}(\partial_{\alpha}A_{\mu})(\partial_{\lambda}K)K^{*}_{\nu}, \quad (15)$$

$$\mathcal{L}_{\Sigma\Sigma\gamma} = -e\bar{\Sigma}\left[\left(\hat{e}\gamma^{\mu} - \frac{\hat{\kappa}_{\Sigma}}{2M_N}\sigma^{\mu\nu}\partial_{\nu}\right)A_{\mu}\right]\Sigma, \quad (16)$$

$$\mathcal{L}_{\Sigma\Lambda\gamma} = e\frac{\kappa_{\Sigma\Lambda}}{2M_N}\bar{\Lambda}\sigma^{\mu\nu}(\partial_{\nu}A_{\mu})\Sigma^0 + \mathrm{H.\,c.}, \quad (17)$$

$$\begin{aligned}\mathcal{L}_{\Sigma^*\Sigma\gamma} &= ie\frac{g^{(1)}_{\Sigma^*\Sigma\gamma}}{2M_N}\bar{\Sigma}\gamma_{\nu}\gamma_5 F^{\mu\nu}\Sigma^{*}_{\mu} \\ &\quad - e\frac{g^{(2)}_{\Sigma^*\Sigma\gamma}}{(2M_N)^2}(\partial_{\nu}\bar{\Sigma})\gamma_5 F^{\mu\nu}\Sigma^{*}_{\mu} + \mathrm{H.\,c.}, \quad (18)\end{aligned}$$

$$\begin{aligned}\mathcal{L}_{\Delta N\gamma} &= -ie\frac{g^{(1)}_{\Delta N\gamma}}{2M_N}\bar{\Delta}_{\mu}\gamma_{\nu}\gamma_5 F^{\mu\nu}N \\ &\quad + e\frac{g^{(2)}_{\Delta N\gamma}}{(2M_N)^2}(\bar{\Delta}_{\mu})\gamma_5 F^{\mu\nu}\partial_{\nu}N + \mathrm{H.\,c.}, \quad (19)\end{aligned}$$

$$\mathcal{L}_{\Sigma N K^*} = -g_{\Sigma N K^*}\bar{\Sigma}\left[\left(\gamma^{\mu} - \frac{\kappa_{\Sigma N K^*}}{2M_N}\sigma^{\mu\nu}\partial_{\nu}\right)K^{*}_{\mu}\right]N + \mathrm{H.\,c.}, \quad (20)$$

$$\mathcal{L}_{\Lambda N K^*} = -g_{\Lambda N K^*}\bar{\Lambda}\left[\left(\gamma^{\mu} - \frac{\kappa_{\Lambda N K^*}}{2M_N}\sigma^{\mu\nu}\partial_{\nu}\right)K^{*}_{\mu}\right]N + \mathrm{H.\,c.}, \quad (21)$$

$$\mathcal{L}_{\Sigma N\kappa} = -g_{\Sigma N\kappa}\bar{\Sigma}\kappa N + \mathrm{H.\,c.}, \quad (22)$$

$$\mathcal{L}_{\Sigma N K} = -g_{\Sigma N K}\bar{\Sigma}\Gamma^{(+)}\left[\left(i\lambda + \frac{1-\lambda}{2M_N}\not{\partial}\right)K\right]N + \mathrm{H.\,c.}, \quad (23)$$

$$\begin{aligned}\mathcal{L}_{\Sigma^* N K^*} &= -i\frac{g^{(1)}_{\Sigma^* N K^*}}{2M_N}\bar{\Sigma}^{*}_{\mu}\gamma_{\nu}\gamma_5 K^{*\mu\nu}N \\ &\quad + \frac{g^{(2)}_{\Sigma^* N K^*}}{(2M_N)^2}\bar{\Sigma}^{*}_{\mu}\gamma_5 K^{*\mu\nu}\partial_{\nu}N \\ &\quad - \frac{g^{(3)}_{\Sigma^* N K^*}}{(2M_N)^2}\bar{\Sigma}^{*}_{\mu}\gamma_5(\partial_{\nu}K^{*\mu\nu})N + \mathrm{H.\,c.}. \quad (24)\end{aligned}$$

$$\begin{aligned}\mathcal{L}_{\Delta\Sigma K^*} &= +i\frac{g^{(1)}_{\Delta\Sigma K^*}}{2M_N}\bar{\Sigma}\gamma_{\nu}\gamma_5 K^{*\mu\nu}\Delta_{\mu} \\ &\quad - \frac{g^{(2)}_{\Delta\Sigma K^*}}{(2M_N)^2}\partial_{\nu}\bar{\Sigma}\gamma_5 K^{*\mu\nu}\Delta_{\mu} \\ &\quad + \frac{g^{(3)}_{\Delta\Sigma K^*}}{(2M_N)^2}\bar{\Sigma}\gamma_5(\partial_{\nu}K^{*\mu\nu})\Delta_{\mu} + \mathrm{H.\,c.}, \quad (25)\end{aligned}$$

Formalism: Parameter Setting

$$\mathcal{L}_{NN\gamma} = -e\bar{N}\left[\left(\hat{e}\gamma^{\mu} - \frac{\hat{\kappa}_N}{2M_N}\sigma^{\mu\nu}\partial_{\nu}\right)A_{\mu}\right]N, \quad (12)$$

$$\mathcal{L}_{\gamma K^* K^*} = -e(K^{*\nu} \times K^{*}_{\mu\nu})_3 A^{\mu}, \quad (13)$$

$$\mathcal{L}_{\gamma\kappa K^*} = e\frac{g_{\gamma\kappa K^*}}{2M_{K^*}}F^{\mu\nu}K^{*}_{\mu\nu}\kappa, \quad (14)$$

$$\mathcal{L}_{\gamma K K^*} = e\frac{g_{\gamma K K^*}}{M_K}\varepsilon^{\alpha\mu\lambda\nu}(\partial_{\alpha}A_{\mu})(\partial_{\lambda}K)K^{*}_{\nu}, \quad (15)$$

$$\mathcal{L}_{\Sigma\Sigma\gamma} = -e\bar{\Sigma}\left[\left(\hat{e}\gamma^{\mu} - \frac{\hat{\kappa}_{\Sigma}}{2M_N}\sigma^{\mu\nu}\partial_{\nu}\right)A_{\mu}\right]\Sigma, \quad (16)$$

$$\mathcal{L}_{\Sigma\Lambda\gamma} = e\frac{\kappa_{\Sigma\Lambda}}{2M_N}\bar{\Lambda}\sigma^{\mu\nu}(\partial_{\nu}A_{\mu})\Sigma^0 + \mathrm{H.c.}, \quad (17)$$

$$\boxed{\mathcal{L}_{\Sigma^*\Sigma\gamma} =} e\frac{g^{(1)}_{\Sigma^*\Sigma\gamma}}{2M_N}\bar{\Sigma}\gamma_{\nu}\gamma_5 F^{\mu\nu}\Sigma^{*}_{\mu} - e\frac{g^{(2)}_{\Sigma^*\Sigma\gamma}}{(2M_N)^2}(\partial_{\nu}\bar{\Sigma})\gamma_5 F^{\mu\nu}\Sigma^{*}_{\mu} + \mathrm{H.c.}, \quad (18)$$

$$\mathcal{L}_{\Delta N\gamma} = -ie\frac{g^{(1)}_{\Delta N\gamma}}{2M_N}\bar{\Delta}_{\mu}\gamma_{\nu}\gamma_5 F^{\mu\nu}N + e\frac{g^{(2)}_{\Delta N\gamma}}{(2M_N)^2}(\bar{\Delta}_{\mu})\gamma_5 F^{\mu\nu}\partial_{\nu}N + \mathrm{H.c.}, \quad (19)$$

$$\mathcal{L}_{\Sigma N K^*} = -g_{\Sigma N K^*}\bar{\Sigma}\left[\left(\gamma^{\mu} - \frac{\kappa_{\Sigma N K^*}}{2M_N}\sigma^{\mu\nu}\partial_{\nu}\right)K^{*}_{\mu}\right]N + \mathrm{H.c.}, \quad (20)$$

$$\mathcal{L}_{\Lambda N K^*} = -g_{\Lambda N K^*}\bar{\Lambda}\left[\left(\gamma^{\mu} - \frac{\kappa_{\Lambda N K^*}}{2M_N}\sigma^{\mu\nu}\partial_{\nu}\right)K^{*}_{\mu}\right]N + \mathrm{H.c.}, \quad (21)$$

$$\mathcal{L}_{\Sigma N\kappa} = -g_{\Sigma N\kappa}\bar{\Sigma}\kappa N + \mathrm{H.c.}, \quad (22)$$

$$\mathcal{L}_{\Sigma N K} = -g_{\Sigma N K}\bar{\Sigma}\Gamma^{(+)}\left[\left(i\lambda + \frac{1-\lambda}{2M_N}\not{\partial}\right)K\right]N + \mathrm{H.c.}, \quad (23)$$

$$\mathcal{L}_{\Sigma^* N K^*} = -i\frac{g^{(1)}_{\Sigma^* N K^*}}{2M_N}\bar{\Sigma}^{*}_{\mu}\gamma_{\nu}\gamma_5 K^{*\mu\nu}N + \frac{g^{(2)}_{\Sigma^* N K^*}}{(2M_N)^2}\bar{\Sigma}^{*}_{\mu}\gamma_5 K^{*\mu\nu}\partial_{\nu}N - \frac{g^{(3)}_{\Sigma^* N K^*}}{(2M_N)^2}\bar{\Sigma}^{*}_{\mu}\gamma_5(\partial_{\nu}K^{*\mu\nu})N + \mathrm{H.c.}. \quad (24)$$

$$\boxed{\mathcal{L}_{\Delta\Sigma K^*} =} i\frac{g^{(1)}_{\Delta\Sigma K^*}}{2M_N}\bar{\Sigma}\gamma_{\nu}\gamma_5 K^{*\mu\nu}\Delta_{\mu} - \frac{g^{(2)}_{\Delta\Sigma K^*}}{(2M_N)^2}\partial_{\nu}\bar{\Sigma}\gamma_5 K^{*\mu\nu}\Delta_{\mu} + \frac{g^{(3)}_{\Delta\Sigma K^*}}{(2M_N)^2}\bar{\Sigma}\gamma_5(\partial_{\nu}K^{*\mu\nu})\Delta_{\mu} + \mathrm{H.c.}, \quad (25)$$

And also cutoffs

Formalism: Hadronic Molecular States

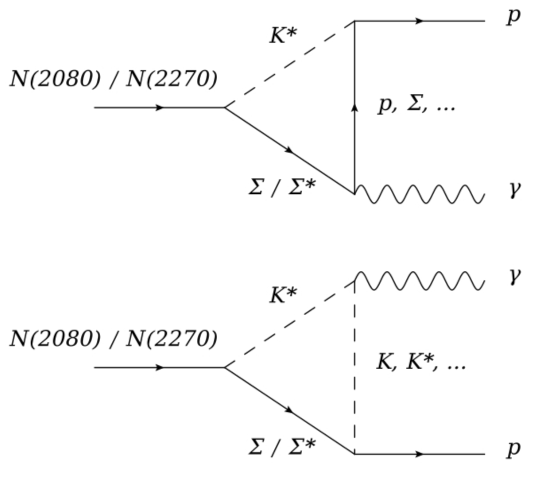

FIG. 3. Electromagnetic coupling of $N(2080)3/2^-$ as $K^*\Sigma$ molecule.

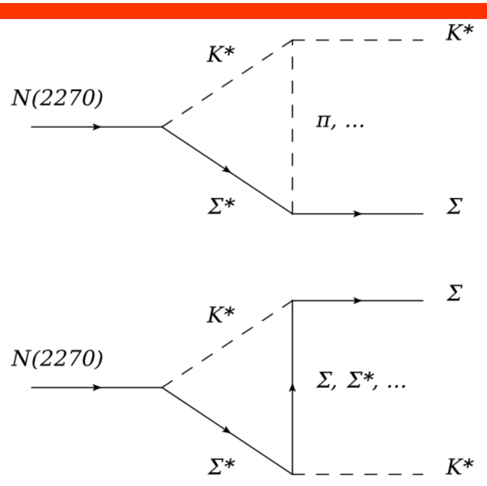

FIG. 2. Hadronic coupling of $N(2270)3/2^-$ as $K^*\Sigma^*$ molecule to $K^*\Sigma$.

The Weinberg Compositeness Criterion

$$\mathcal{L}^{3/2^-}_{K^*\Sigma R} = g_{K^*\Sigma R}\bar{R}_\mu \Sigma K^{*\mu} + \mathrm{H.\,c.},$$

where $R \equiv N(2080)3/2^-$ or $N(2270)3/2^-$.

$$\boxed{g^2_{K^*\Sigma R} = \frac{4\pi}{4M_R M_\Sigma}\frac{(M_{K^*}+M_\Sigma)^{5/2}}{(M_{K^*}M_\Sigma)^{1/2}}\sqrt{32\,\epsilon},}$$

$$\epsilon \equiv M_{K^*} + M_\Sigma - M_R. \quad \boxed{g_{K^*\Sigma R} = 1.72.}$$

$$\mathcal{L}_{\gamma NR} = -ie\frac{g^{(1)}_{RN\gamma}}{2M_N}\bar{R}_\mu \gamma_\nu F^{\mu\nu} N + e\frac{g^{(2)}_{RN\gamma}}{(2M_N)^2}\bar{R}_\mu F^{\mu\nu}\partial_\nu N + \mathrm{H.\,c.}.$$

Formalism: Hadronic Molecular States

PHYSICAL REVIEW VOLUME 137, NUMBER 3B 8 FEBRUARY 1965

Evidence That the Deuteron Is Not an Elementary Particle*

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(Received 30 September 1964)

If the deuteron were an elementary particle then the triplet *n-p* effective range would be approximately $-ZR/(I-Z)$, where $R=4.31\mathrm{F}$ is the usual deuteron radius and Z is the probability of finding the deuteron in a bare elementary-particle state. This formula is model-independent, but has an error of the order of the range $m_\pi^{-1}=1.41\mathrm{F}$ of the *n-p* force, so it becomes exact only in the limit of small deuteron binding energy, i.e., $R \gg m_\pi^{-1}$. The experimental value of the effective range is not of order R and negative, but rather of order m_π^{-1} and positive, so Z is small or zero and the deuteron is mostly or wholly composite.

Formalism: Hadronic Molecular States

PHYSICAL REVIEW 8 FEBRUARY 1965

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Department of ley, California

If the deutero e approximately
$-ZR/(I-Z)$, w ing the deuteron
in a bare elemen the order of the
range $m_\pi^{-1}=1.4$ binding energy,
i.e., $R\gg m_\pi^{-1}$. T e, but rather of
order m_π^{-1} and p

REVIEWS OF MODERN PHYSICS, VOLUME 90, JANUARY–MARCH 2018

Hadronic molecules

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Intermediate Result: Fit 1 (~2.3 GeV) V.S. Fit 2 (~2.8 GeV)

TABLE I. Fitted values of model parameters.

$g^{(1)}_{\Lambda\Sigma K^*}$	1.79 ± 0.31
$g^{(1)}_{RN\gamma}$	-0.10 ± 0.02
ϕ_R	2.67 ± 0.34
Γ_R [MeV]	83.8 ± 17.6
$\Lambda_{N,\Delta,N(2080)}$ [MeV]	2059 ± 41
Λ_K [MeV]	1116 ± 112
$\Lambda_{K^*,\kappa}$ [MeV]	894 ± 113
$\Lambda_{\Sigma,\Lambda}$ [MeV]	856 ± 24
Λ_{Σ^*} [MeV]	851 ± 26

Fit 1: N(2080)3/2- only

Near threshold $\chi^2 = 1.28$

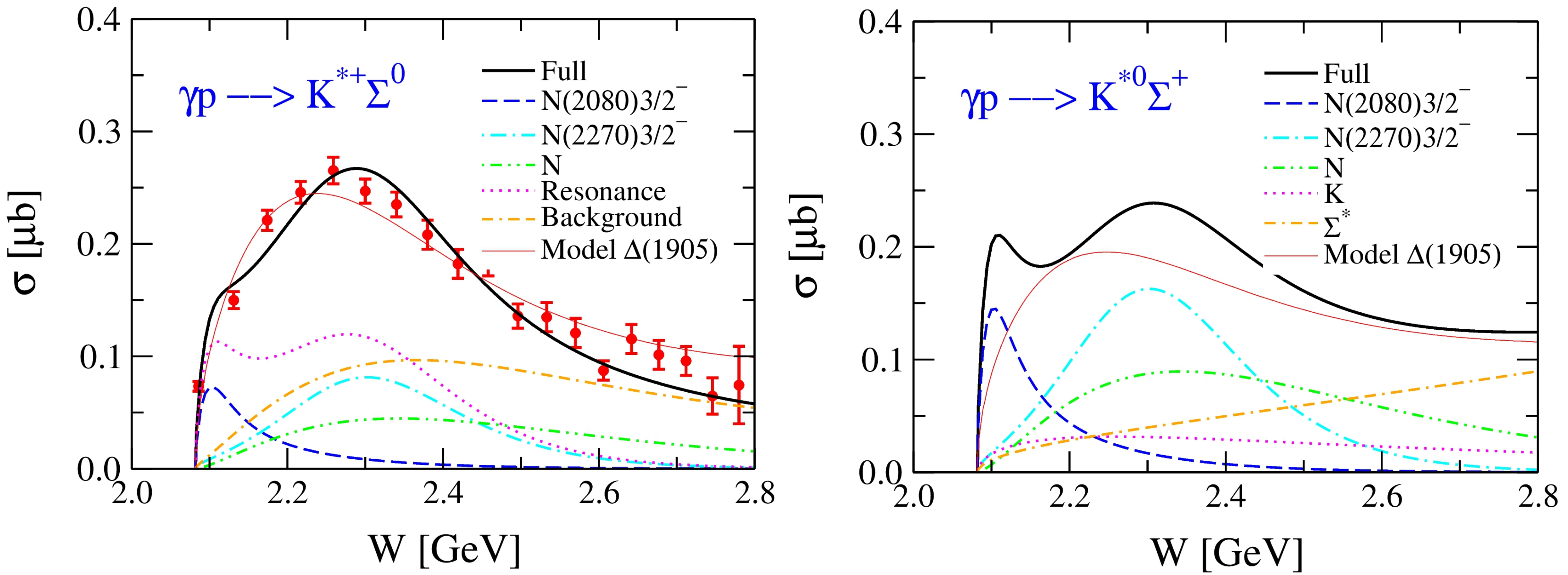
Fit 2: N(2080) & N(2270)

All energy region $\chi^2 = 1.65$

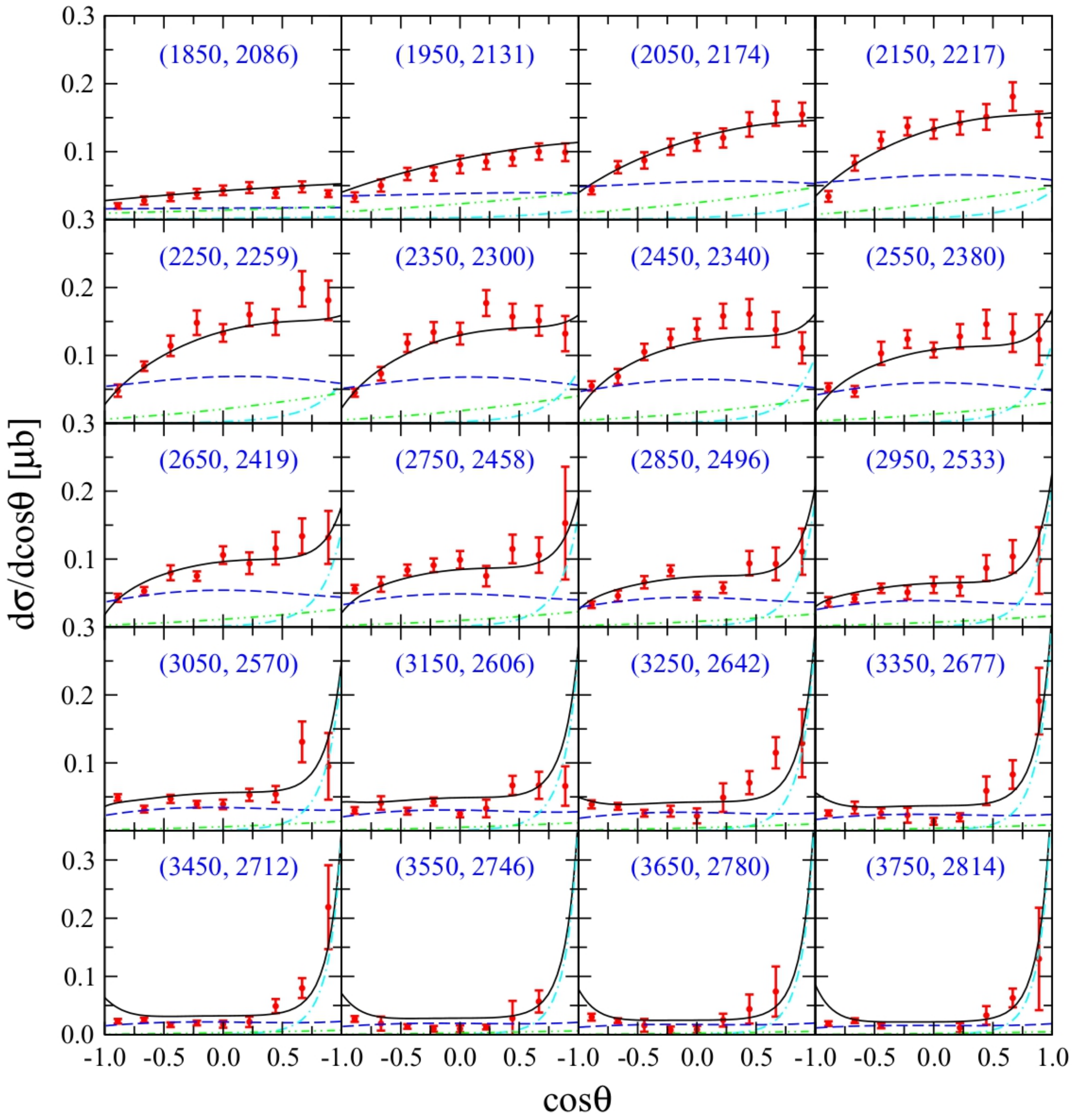
TABLE I. Fitted values of model parameters.

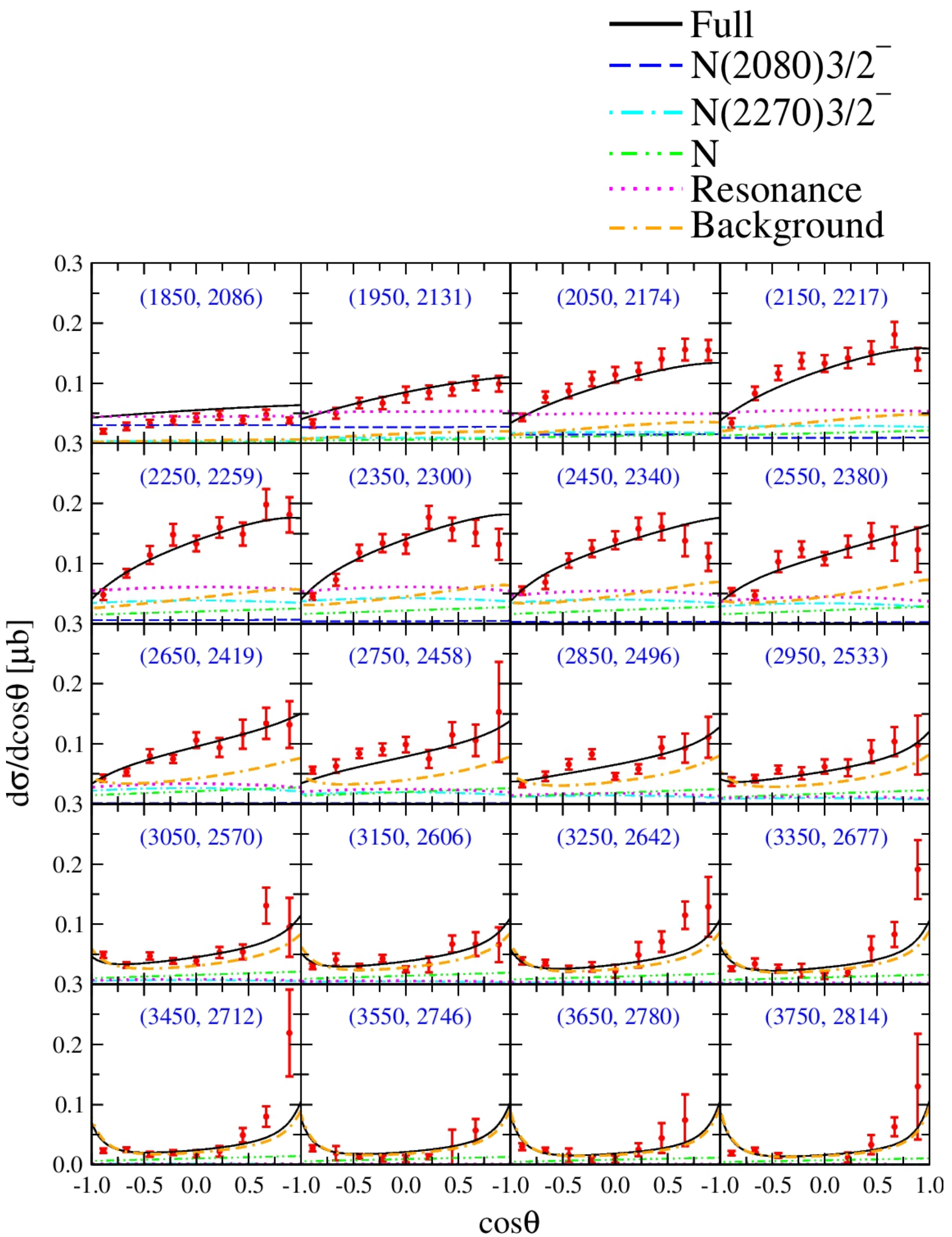
$g^{(1)}_{\Sigma^{*0}\Sigma^0\gamma}$	7.06 ± 2.55
$g^{(2)}_{\Sigma^{*0}\Sigma^0\gamma}$	-38.83 ± 11.15
$g^{(1)}_{\Lambda\Sigma K^*}$	-0.42 ± 0.14
$g^{(1)}_{N(2080)N\gamma}$	-0.12 ± 0.04
$g^{(2)}_{N(2080)N\gamma}/g^{(1)}_{N(2080)N\gamma}$	-1.60 ± 0.19
$g^{(1)}_{N(2270)N\gamma}$	0.28 ± 0.06
$g^{(2)}_{N(2270)N\gamma}/g^{(1)}_{N(2270)N\gamma}$	-0.51 ± 0.12
$\phi_{N(2080)}$	2.83 ± 0.26
$\phi_{N(2270)}$	1.55 ± 0.13
$\Gamma_{N(2080)}$ [MeV]	70.1 ± 9.7
Λ_R [MeV]	1607 ± 118
Λ_s [MeV]	1862 ± 31
Λ_t [MeV]	1064 ± 26
Λ_u [MeV]	715 ± 35

Final Results: Total Cross Sections



Final Results: Differential Cross Sections





Final Results: Differential Cross Sections

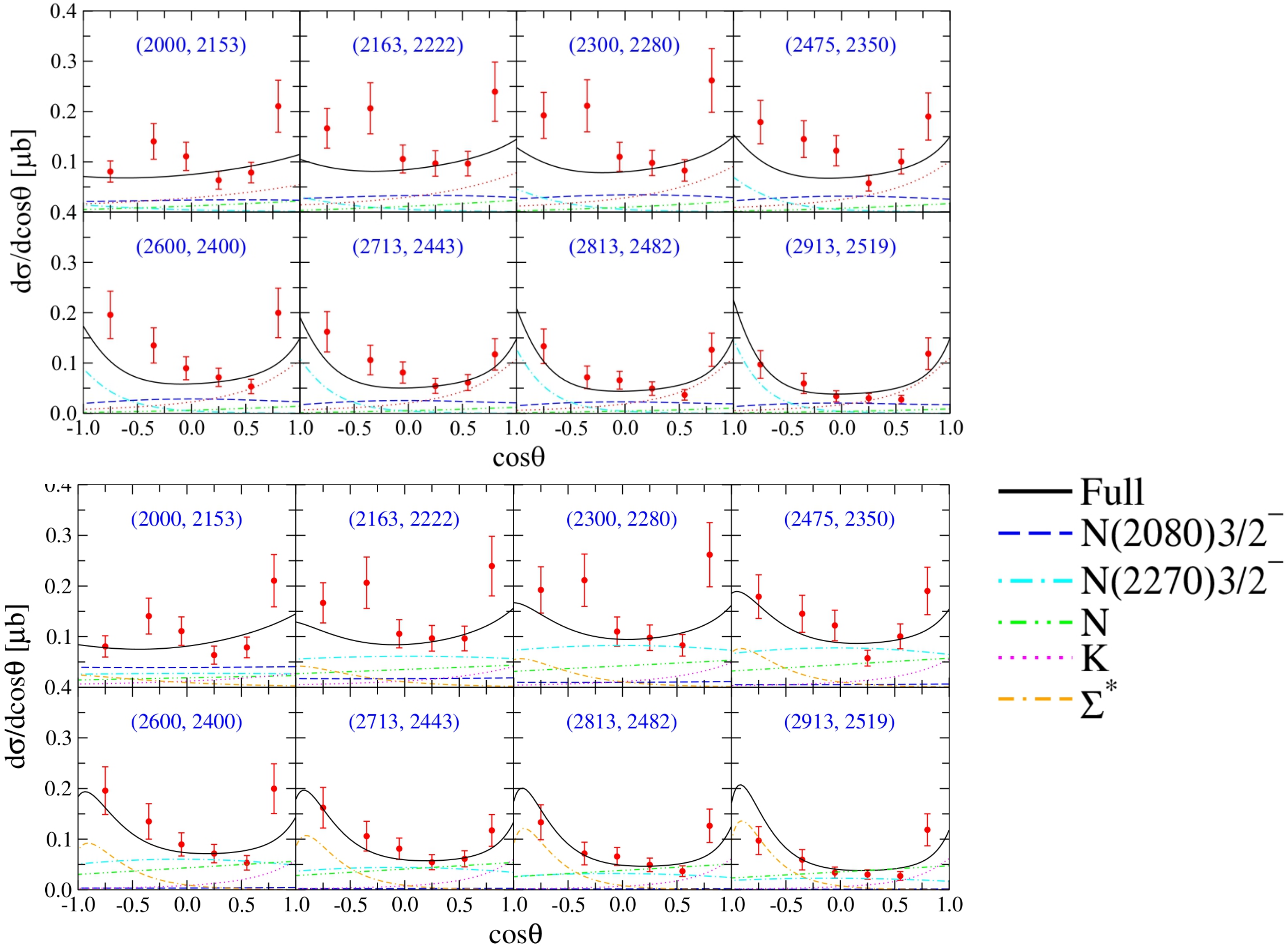


FIG. 5. Differential cross sections for $\gamma p \to K^{*0}\Sigma^+$ as a function of $\cos\theta$. Notations are the same as in Fig. 4 except that now the magenta dotted lines and orange double-dashed lines represent the individual contributions from the t-channel K exchange and u-channel Σ^* exchange, respectively, and the scattered symbols denote the CLAS data in Ref. [14].

Predictions: Single Spin Observables

Beam Asymmetry

$$\Sigma = \frac{\frac{\mathrm{d}\sigma}{\mathrm{d}\Omega}(\perp,0,0) - \frac{\mathrm{d}\sigma}{\mathrm{d}\Omega}(\parallel,0,0)}{\frac{\mathrm{d}\sigma}{\mathrm{d}\Omega}(\perp,0,0) + \frac{\mathrm{d}\sigma}{\mathrm{d}\Omega}(\parallel,0,0)},$$

Target Asymmetry

$$T = \frac{\frac{\mathrm{d}\sigma}{\mathrm{d}\Omega}(0,+y,0) - \frac{\mathrm{d}\sigma}{\mathrm{d}\Omega}(0,-y,0)}{\frac{\mathrm{d}\sigma}{\mathrm{d}\Omega}(0,+y,0) + \frac{\mathrm{d}\sigma}{\mathrm{d}\Omega}(0,-y,0)},$$

Recoil Asymmetry

$$P = \frac{\frac{\mathrm{d}\sigma}{\mathrm{d}\Omega}(0,0,+y) - \frac{\mathrm{d}\sigma}{\mathrm{d}\Omega}(0,0,-y)}{\frac{\mathrm{d}\sigma}{\mathrm{d}\Omega}(0,0,+y) + \frac{\mathrm{d}\sigma}{\mathrm{d}\Omega}(0,0,-y)}.$$

Predictions: Single Spin Observables

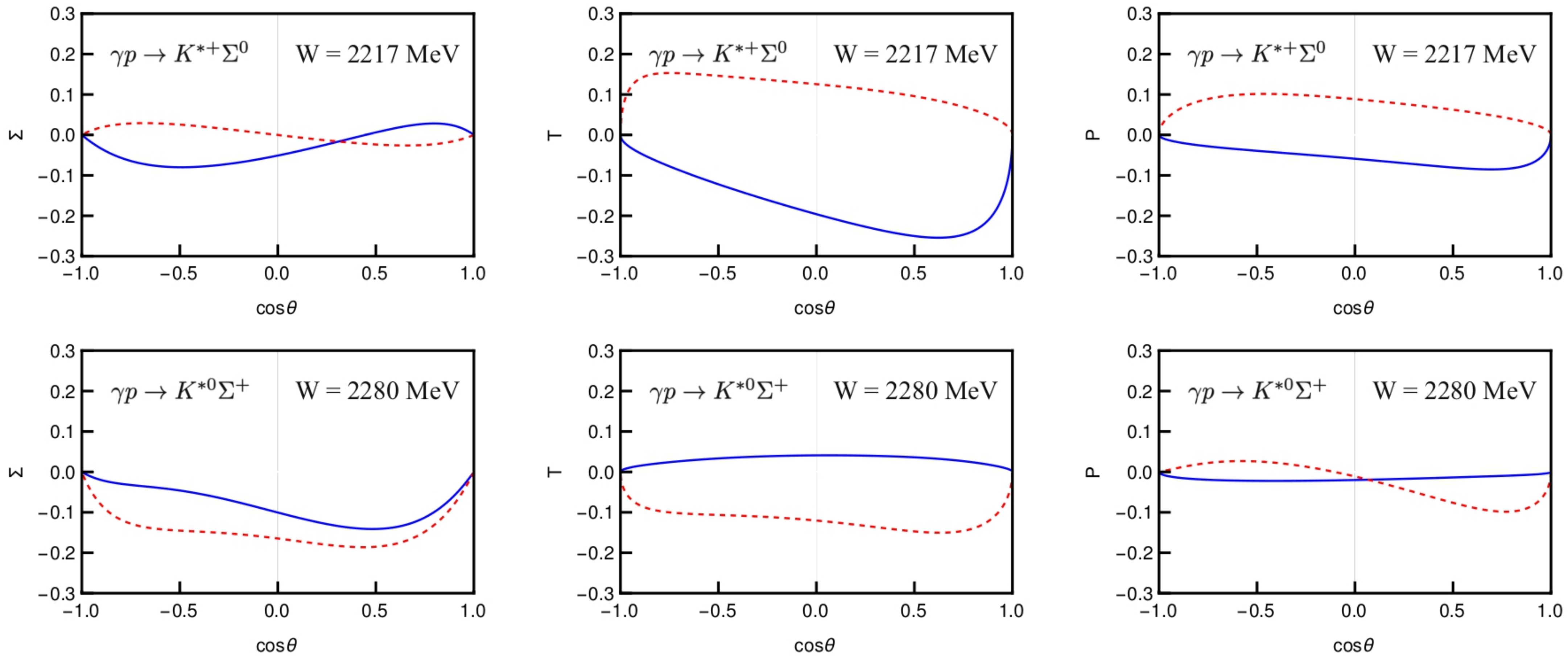


FIG. 7. Single spin asymmetries Σ (left), T (middle), and P (right) predicted at $W = 2217$ MeV for $\gamma p \to K^{*+}\Sigma^0$ (the upper row) and $W = 2280$ MeV for $\gamma p \to K^{*0}\Sigma^+$ (the lower row). The blue solid lines represent the results from the present work, and the red dashed lines denote the results from Ref. [23].

Another Work in Parallel

ArXiv: 2306.15385

Strange molecular partners of P_c states in $\gamma p \to \phi p$ reaction

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Based on the high statistical data of the CLAS Collaboration on $\gamma p \to \phi p$ reaction in the center-of-mass energy range of 2.2 GeV to 2.8 GeV, we investigate the possible existence of strange molecular partners of P_c states, i.e., $N^*(2080)$ and $N^*(2270)$ as $K^*\Sigma$ and $K^*\Sigma^*$ molecular states. In addition to the t-channel Pomeron exchange, t-channel meson exchange including pseudo-scalar meson (π, η), scalar meson $(\sigma, a_0(980), f_0(980))$, axial-vector meson $f_1(1285)$, tensor meson $f_2(1270)$, as well as s- and u-channel proton exchange, including s-channel $N^*(2080)$ and $N^*(2270)$ states can fit the data very well. The fitted coupling constants of these N^* molecular states to $p\phi$ and γp are consistent with the results directly calculated from the relevant hadronic triangle diagrams of the molecular picture.

Outline

Introduction

Formalism

Results

Conclusion

Conclusion

1. N(2080) contribute at near threshold region and N(2270) contribute at higher energy region

2. Both Δ(1905) and N(2080)+N(2270) exchange can well reproduce the exsiting experimental data. The predictions of single spin observables are totally different.

3. We are looking forward to the further experiments to verify.

And some outlooks...

Thanks