Magnetic moments of the N(1535) resonance in the chiral unitary model

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Motivations

- Experiments

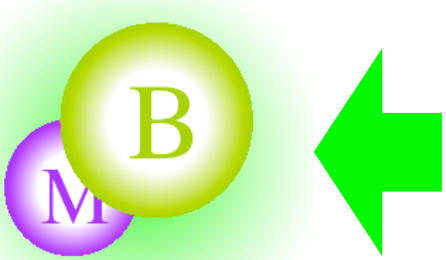
Recent developments of the experimental technique enable us to measure the **magnetic moments of the excited baryons**.

- Application of the chiral unitary model

Chiral unitary model

Flavor SU(3) meson-baryon scatterings (s-wave)

$J^P = 1/2^-$
Resonances



Chiral symmetry

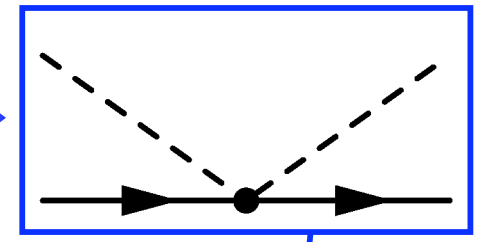
Unitarity of S-matrix

Investigation of the resonance structure

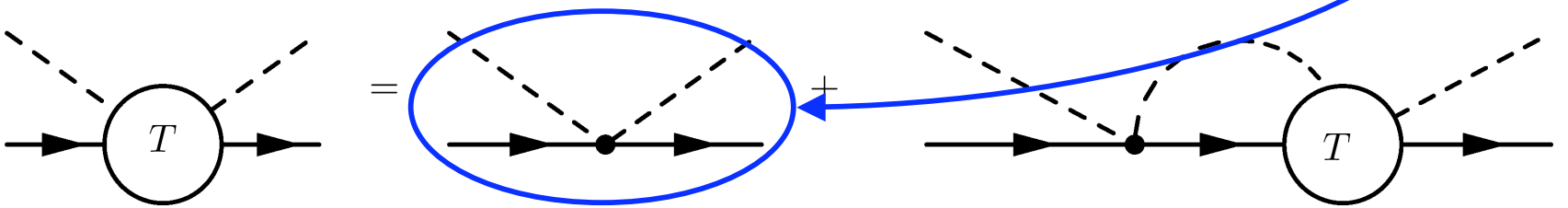
Framework of the chiral unitary model

Chiral perturbation theory

$$\mathcal{L}_{WT} = \frac{1}{4f^2}\mathrm{Tr}(\bar{B}i\gamma^\mu[(\Phi\partial_\mu\Phi - \partial_\mu\Phi\Phi), B])$$



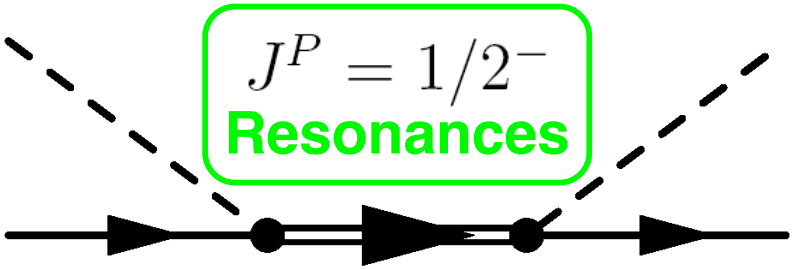
Unitarization



$$T_{ij}(\sqrt{s}) \sim \frac{g_i g_j}{\sqrt{s} - M_R + i\Gamma_R/2} + T_{ij}^{BG}$$

Generated resonances are expressed as the poles of the T-matrix.

$\sim$



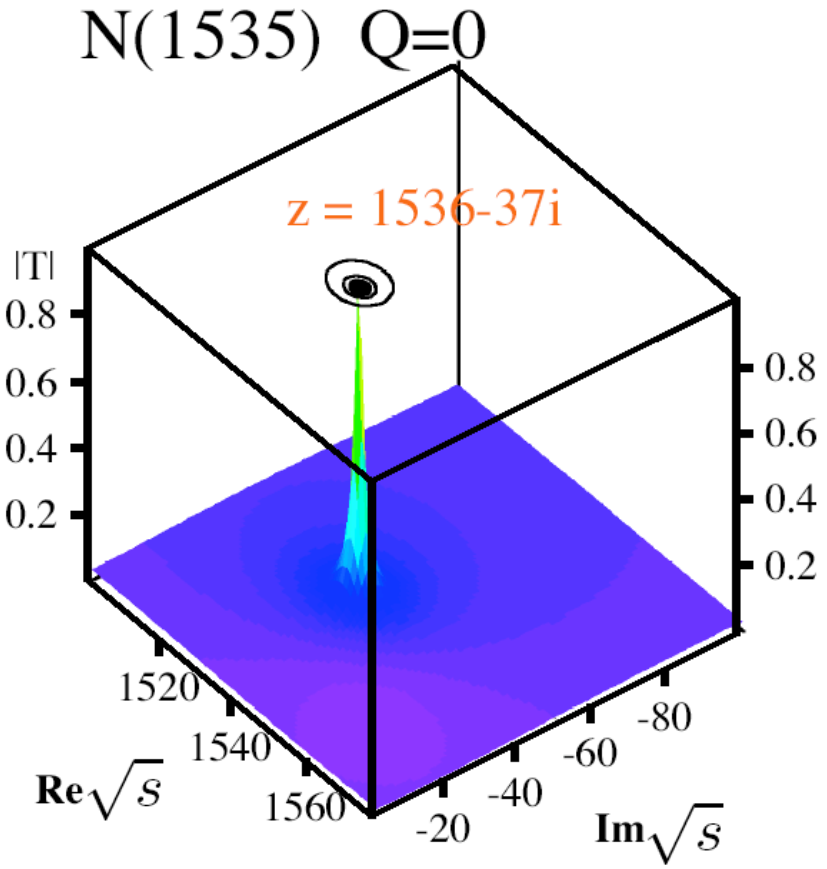
The N(1535) resonance in the chiral unitary model

$Q=0$	$\pi^0 n$	$\pi^- p$	ηn	$K^0\Lambda$	$K^0\Sigma^0$	$K^+\Sigma^-$
$Q=1$	$\pi^0 p$	$\pi^+ n$	ηp	$K^+\Lambda$	$K^+\Sigma^0$	$K^0\Sigma^+$

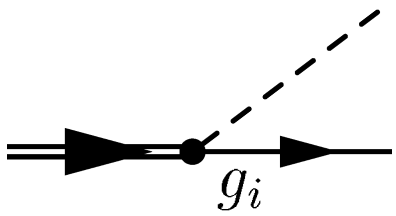
Positions of the poles

$$z_{n^*} = 1536 - 37i \ [\mathrm{MeV}]$$

$$z_{p^*} = 1531 - 36i \ [\mathrm{MeV}]$$

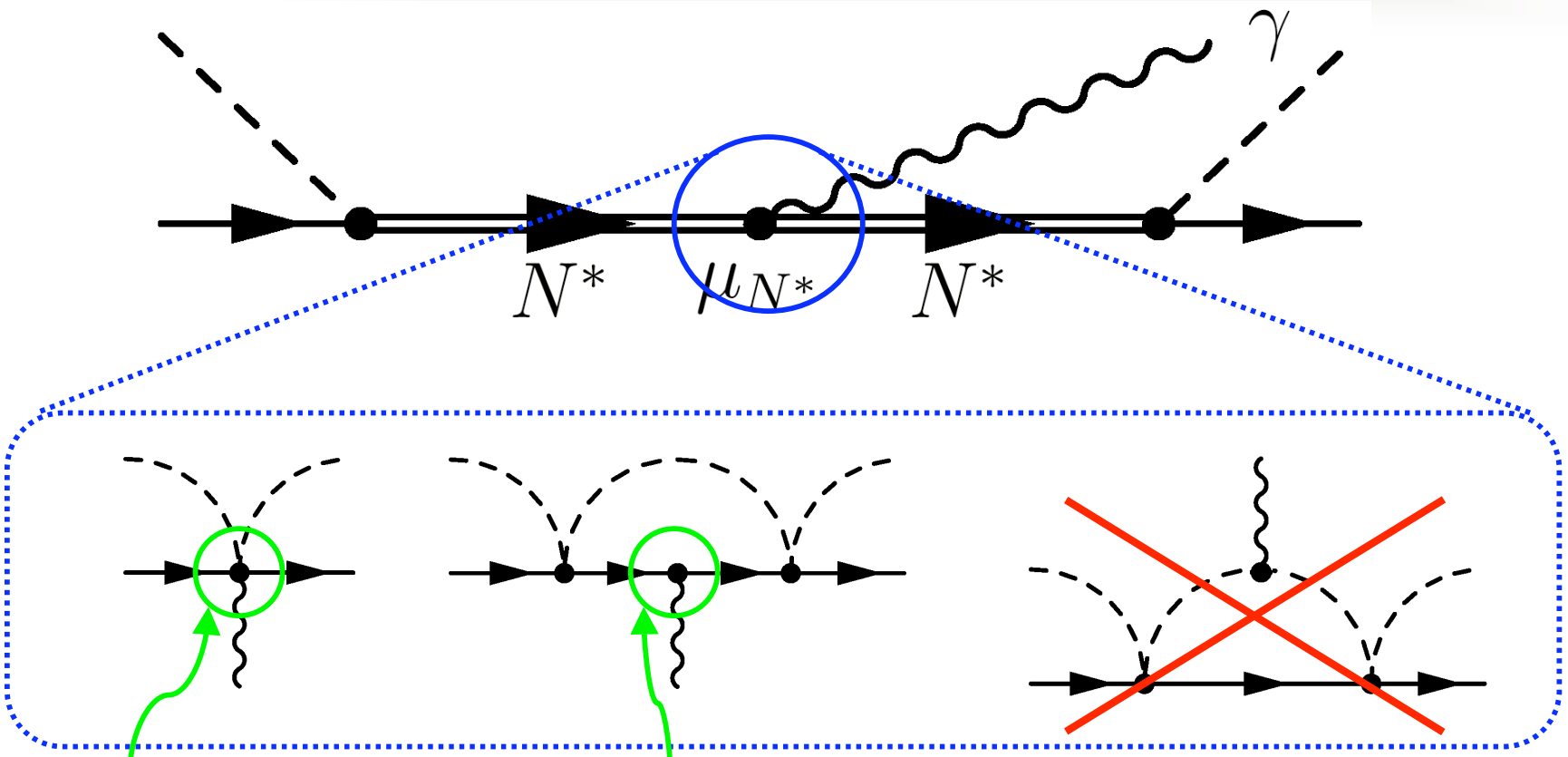


Coupling strengths



	$\lvert g_{\pi N}\rvert^2$	$\lvert g_{\eta N}\rvert^2$	$\lvert g_{K\Lambda}\rvert^2$	$\lvert g_{K\Sigma}\rvert^2$
n^*	0.623	2.30	1.93	7.29
p^*	0.619	2.35	1.88	7.37

Photon coupling diagrams



Extract μ_{N^*} ➡ T. Hyodo *et al.*, nucl-th/0305023

Flavor SU(3) symmetry

Numerical results :

$$\mu_{n^*} \sim -0.25 \mu_N \ , \quad \mu_{p^*} \sim 1.1 \mu_N \ .$$

magnetic moments of □(1670)

$$\mu_{\Lambda^*} \sim -0.29 \mu_N$$

➡ **D. Jido *et al.*, Phys. Rev. C 66, 025203 (2002)**

SU(3) octet -> Coleman-Glashow relation

$$\mu_{n^*} = 2 \mu_{\Lambda^*}$$

Qualitatively : ○

Quantitatively : ×

Flavor SU(3) symmetry

SU(3) decomposition of the coupling constant

representation	1	8	8	10	$\overline{10}$	27
$n^*(1535)$	–	5.2	6.2	0.17	–	0.58
$\Lambda^*(1670)$	4.0	2.3	7.3	–	–	0.16

- **Octet components** are dominant and 10, 27 are small.
- □(1670) contains a **singlet component**.

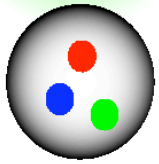
The deviation from the SU(3) relation:

➡

- **mixture of the singlet component**
- **SU(3) breaking effects**

Comparison with quark model

Compare the results with the quark model.

	$n^*[\mu_N]$	$p^*[\mu_N]$	picture
ChU model	−0.25	1.13	
Quark model	−1.28	1.89	

W.-T. Chiang *et al.*, nucl-th/0211061

The absolute values of the present results differ from those of the quark model, especially in n^*.

→ difference of pictures of the excited states

Conclusions

We calculate the magnetic moments of the N(1535) resonance using the chiral unitary model.

$$\mu_{n^*} \sim -0.25 \mu_N \ , \quad \mu_{p^*} \sim 1.1 \mu_N \ .$$

- Signs of the results are consistent with the SU(3) (Coleman-Glashow) relation.
- The results qualitatively agree with those of the quark model, but the quantitative disagreement would reflects the difference of the pictures of the excited baryons.

D. Jido *et al.*, Phys. Rev. C 66, 025203 (2002)
T. Hyodo, S.I. Nam, D. Jido and A. Hosaka nucl-th/0305023