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

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Motivations

- Experiments

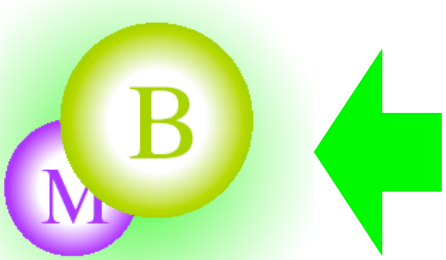
Recent developments of the experimental technique enable us to measure the **magnetic moments of the excited baryons**.

- Application of the chiral unitary model

Chiral unitary model

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

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



Chiral symmetry

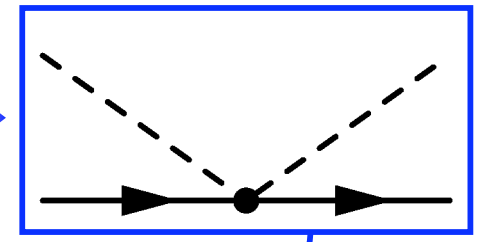
Unitarity of S-matrix

Investigation of the resonance structure

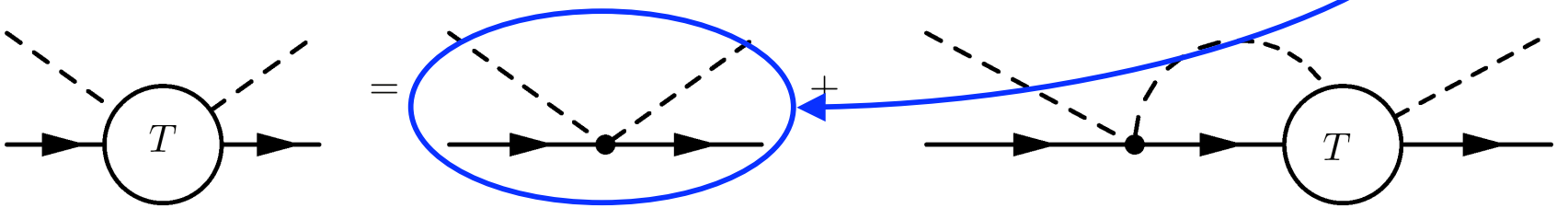
Framework of the chiral unitary model

Chiral perturbation theory

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



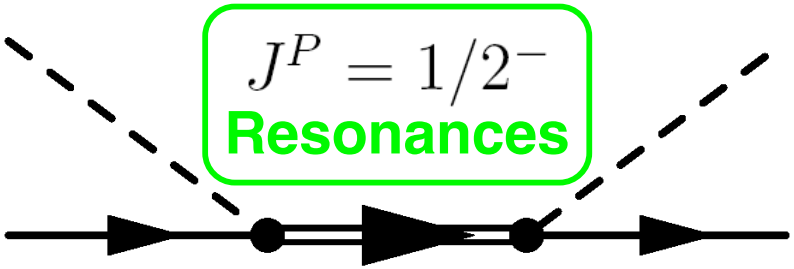
Unitarization



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

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

$\sim$



The N(1535) resonance in the chiral unitary model

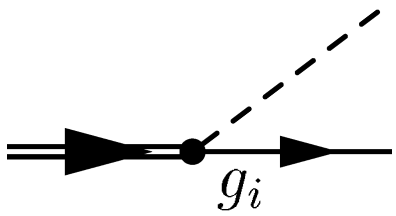
$Q=0$	$\pi^0 n$	$\pi\ p$	ηn	$K^0\Lambda$	$K^0\Sigma^0$	$K^+\Sigma$
$Q=1$	$\pi^0 p$	$\pi^+ n$	ηp	$K^+\Lambda$	$K^+\Sigma^0$	$K^0\Sigma^+$

Position of the pole

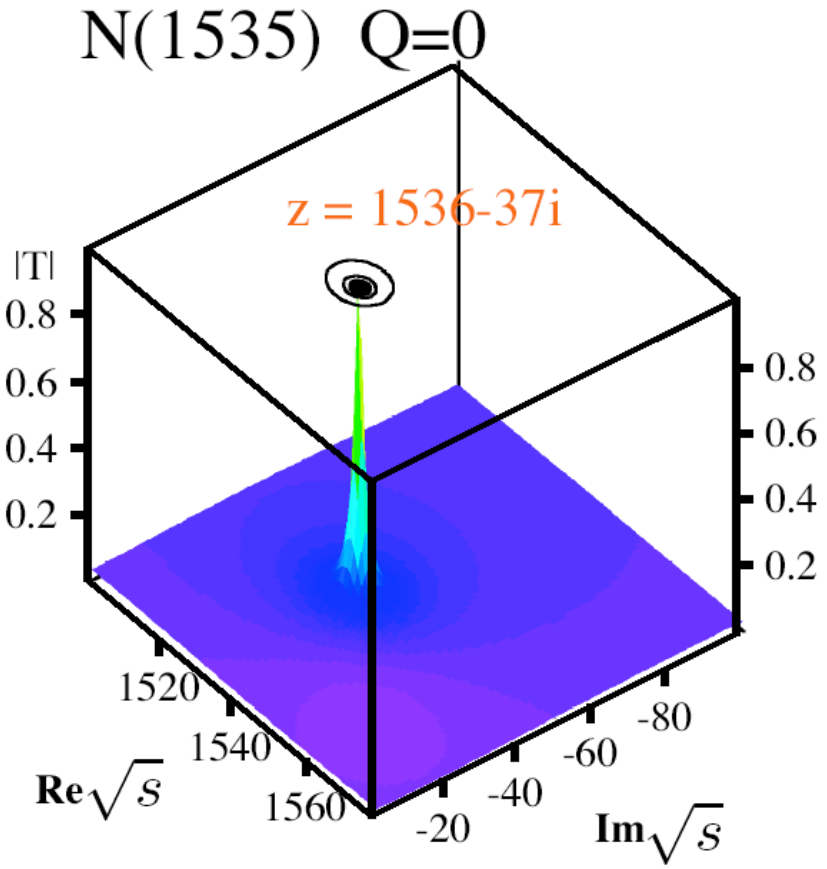
$$z_{n^*} = 1536 - 37i \ [\mathrm{MeV}]$$

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

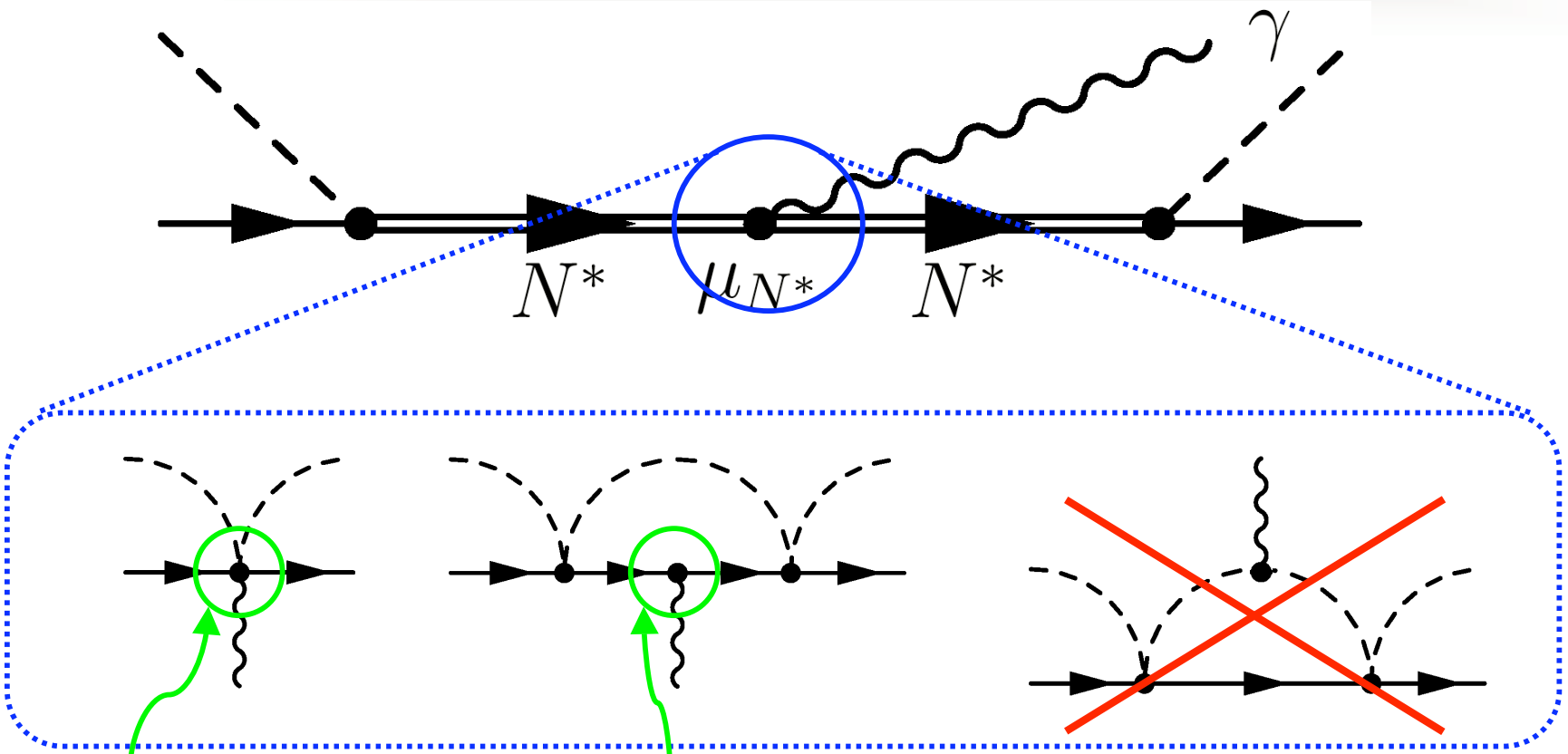
Coupling strengths



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



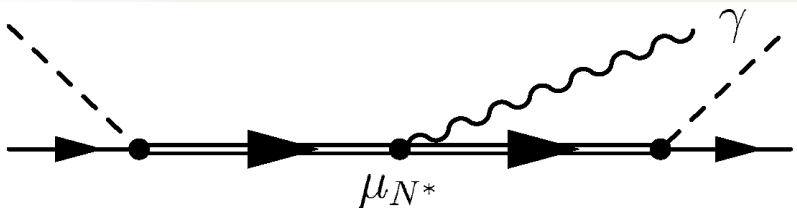
Photon coupling diagrams



Two ways to extract μ_{N^*}

Evaluation of the magnetic moments

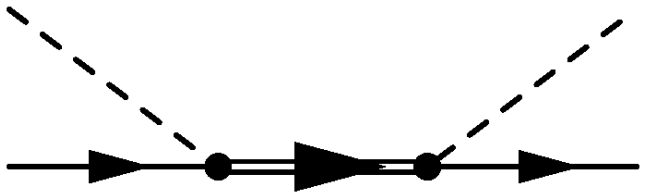
$$-i\tilde{t}_{ij}(\sqrt{s}) =$$



$$\times \left(\frac{e}{2M_p}(\boldsymbol{\sigma}\times\mathbf{q})\cdot\boldsymbol{\epsilon}\right)^{-1}$$

$$\sim g_i \left(\frac{1}{\sqrt{s}-M_{N^*}+i\Gamma_{N^*}/2}\right)\mu_{N^*}\left(\frac{1}{\sqrt{s}-M_{N^*}+i\Gamma_{N^*}/2}\right)g_j$$

$$T_{ij}(\sqrt{s}) =$$



$$\sim \frac{g_i g_j}{\sqrt{s}-M_{N^*}+i\Gamma_{N^*}/2}$$

Real axis

$$\mu_R(\sqrt{s}) = \frac{-i\tilde{t}_{ij}(\sqrt{s})}{\frac{\partial}{\partial\sqrt{s}}T_{ij}(\sqrt{s})},$$

Complex plane

$$\mu_C(z_R) = \lim_{z\to z_R}(z-z_R)\frac{-i\tilde{t}_{ij}(z)}{T_{ij}(z)}$$

Real axis and complex plane

Real axis

- **Sign : O.K.**
  - Channel dependence
    → strong coupling
  - $\sqrt{s}$ dependence
    → around resonance
- **Ambiguities**

Complex plane

- **No background**

Complex value

↓

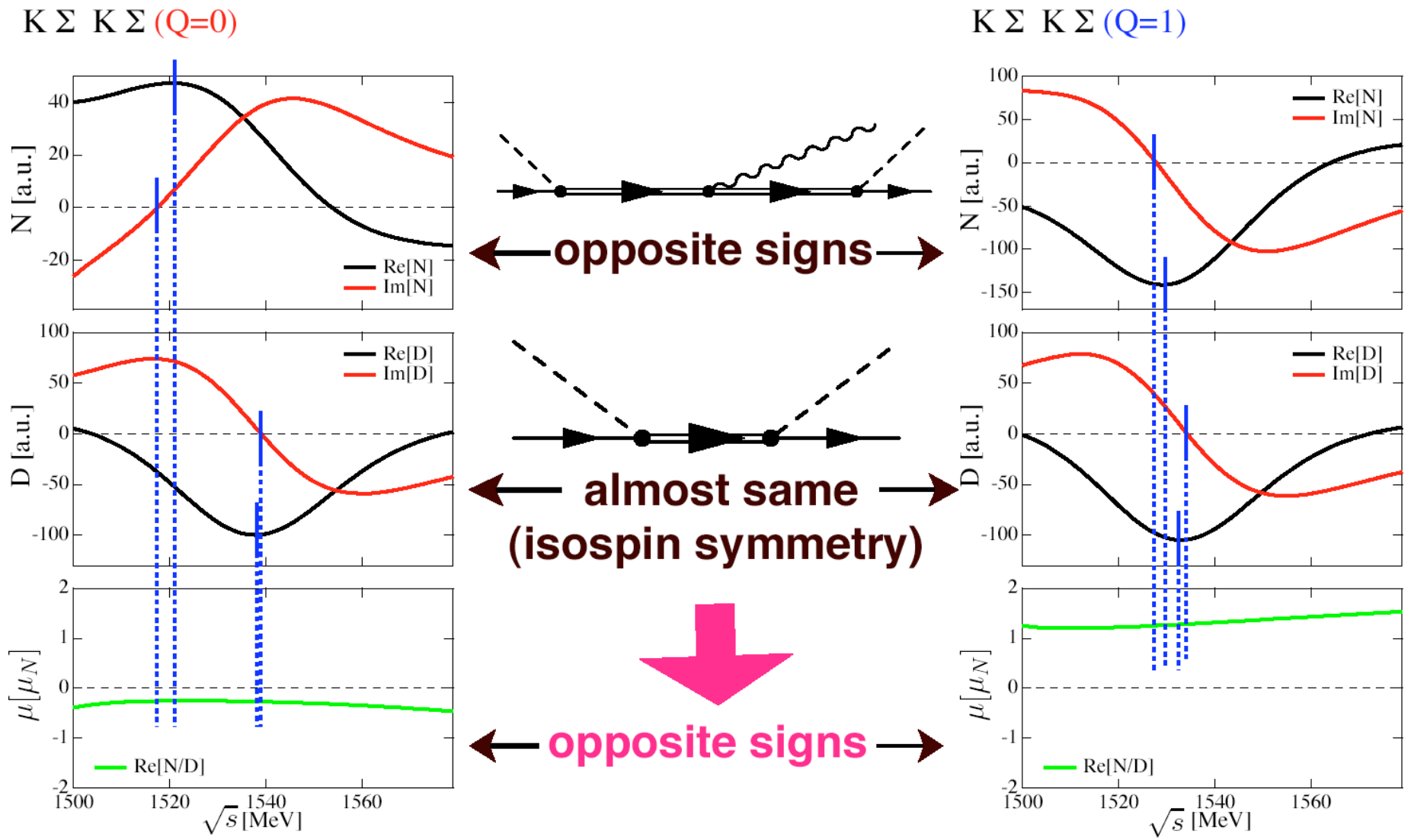
Complex phase

↓

- **Sign : ×**

Strategy : combine both the results

Results on the real axis.

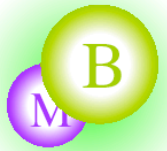
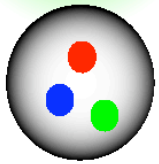


Results in the complex plane (channel independent).

$$|\mu_{n^*}| \sim 0.248 \mu_N \ , \quad |\mu_{p^*}| \sim 1.13 \mu_N \ .$$

Conclusion

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

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

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

➡ pictures of the excited states?

This point will be checked when experimental data are available.