Phi photoproduction
in
a coupled-channel approach

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in collaboration with

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Introduction

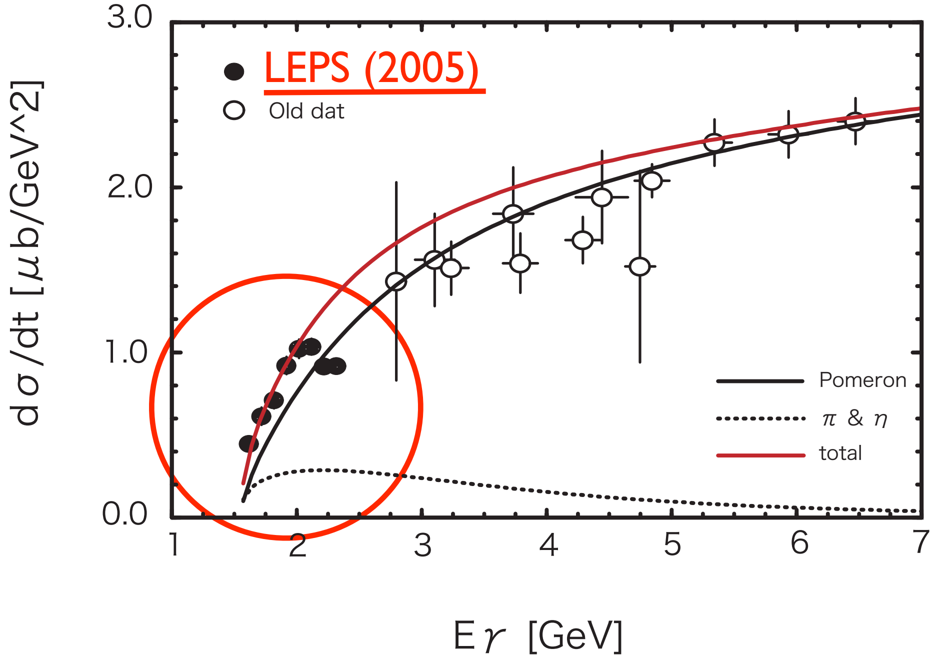
Recently, several photon facilities have reported very accurate data of strangeness photoproduction.

However there are many phenomena which are difficult to be explained in terms of conventional models near threshold (~2GeV).

- √ Λ(1405) photoproduction — M. Niiyama et al. PRC.78:035202, 2008
- √ Λ(1520) photoproduction — H. Kohri et al. arXiv: 0906.01967
- √ Θ photoproduction — T. Nakano et al. PRL.91:012002, 2003; T. Nakano et al. PRC.79:025210, 2009
- √ Φ photoproduction — T. Mibe et al. PRL.95:182001, 2005

Is there some specific production mechanism near threshold (~ 2 GeV)?

Differential cross section of phi photoproduction at θ~0



pomeron
+meson exchange

Titov et al, PRC76, 035202, (2007)

T. Mibe et al. PRL.95:182001, (2005)

It is difficult to reproduce such a dip structure
by using Pomeron and meson exchange model.

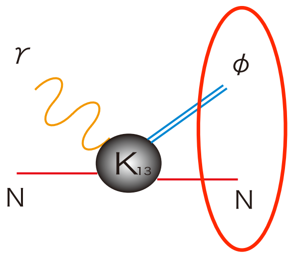
Coupled channel effects in Φ-photoproduction

→ We study coupled channel effects in phi photo production

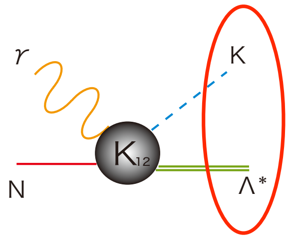
- ✓ On-shell Kaon exchange
- ✓ ΦN, KΛ* Resonance

KΛ(1520) channel

KΛ(1520) threshold is very close to ΦN threshold.
We expect KΛ(1520) channel strongly contribute to Φ-photoproduction near threshold energy region.

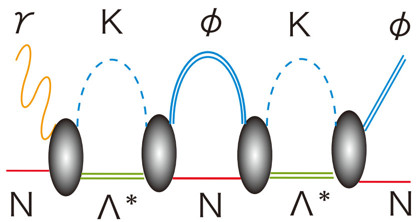


$$m_\phi + m_N \sim 2[GeV]$$

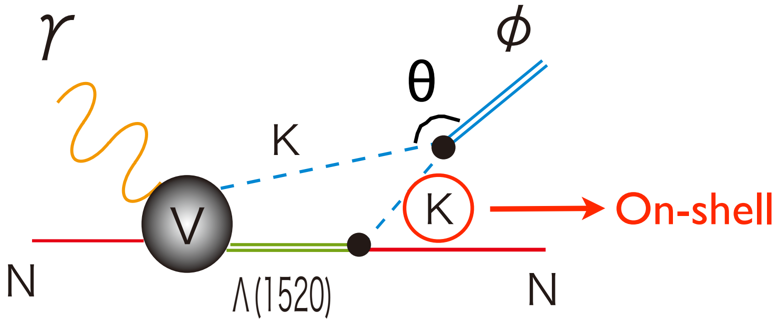


$$m_K + m_{\Lambda(1520)} \sim 2[GeV]$$

$$\sqrt{s} \sim 2[GeV] \longrightarrow$$



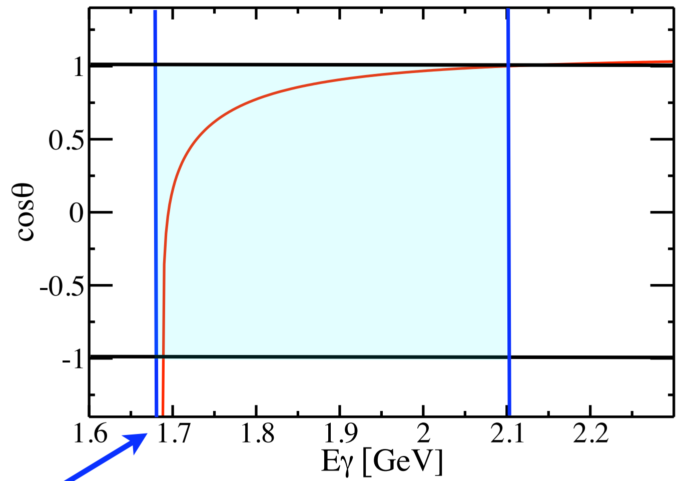
1. Kaon on-sell effect

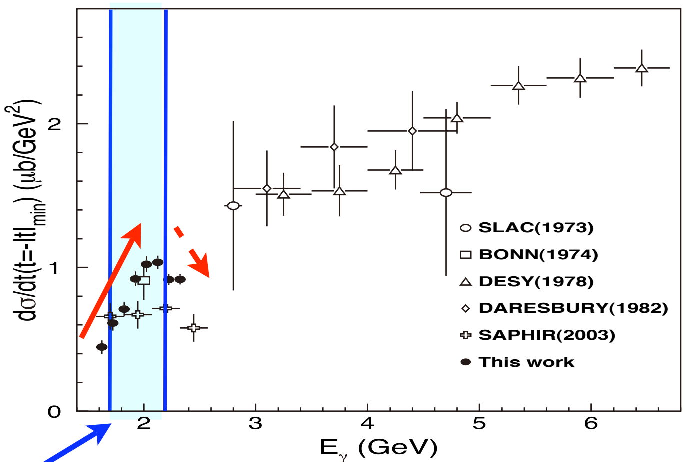


On shell condition

$$t(E_\gamma, cos\theta) - m_K^2 = 0$$

solution of on-shell condition





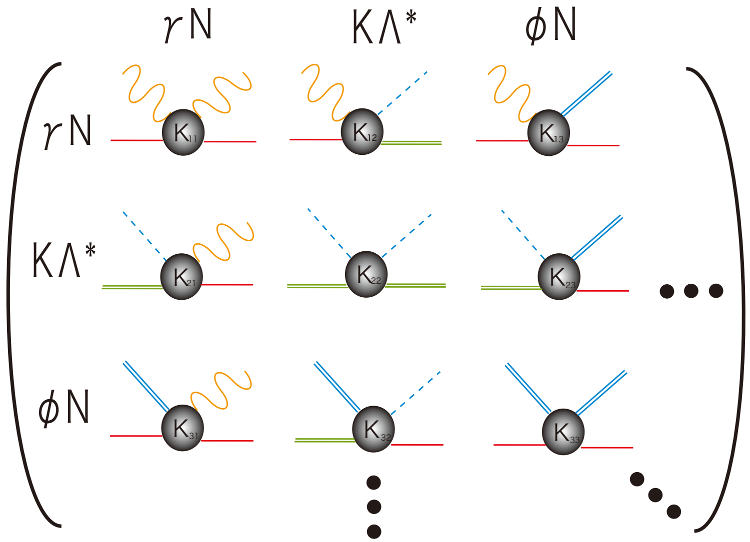
KΛ(1520) threshold

KΛ(1520) threshold

Formalism

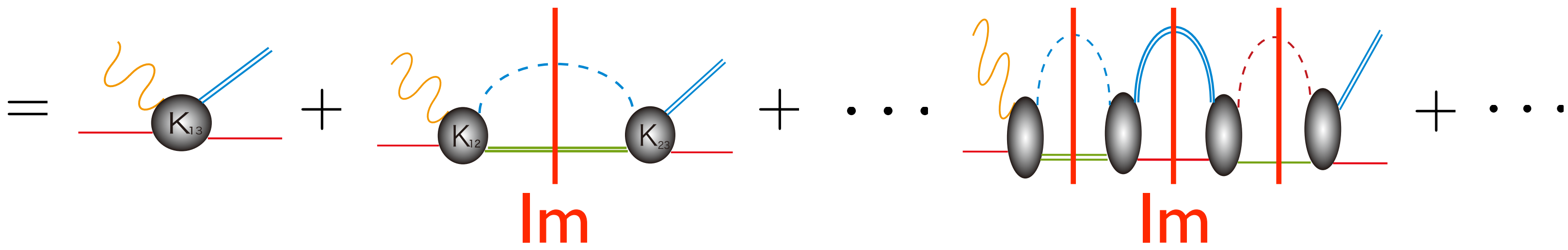
Coupled channel K-matrix

K_{ij} =



Phi-photoproduction amplitude

$$T_{\gamma N\to\phi N} = (\frac{K}{1-iK})_{\gamma N\to\phi N} = K + iK^2 - K^3 \cdots$$

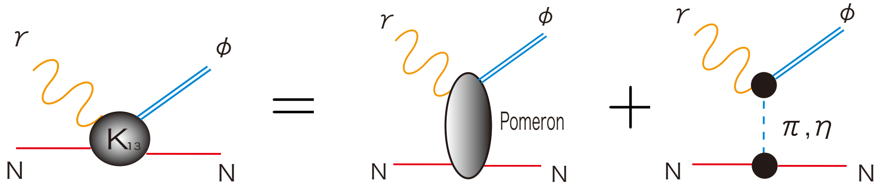


K-matrix elements

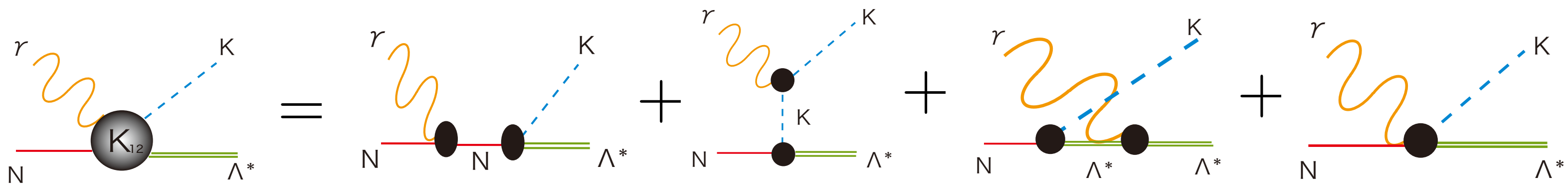
We use the effective Lagrangian method for each K-matrix elements.

→ chiral symmetry, gauge symmetry, vector meson dominance, OZI

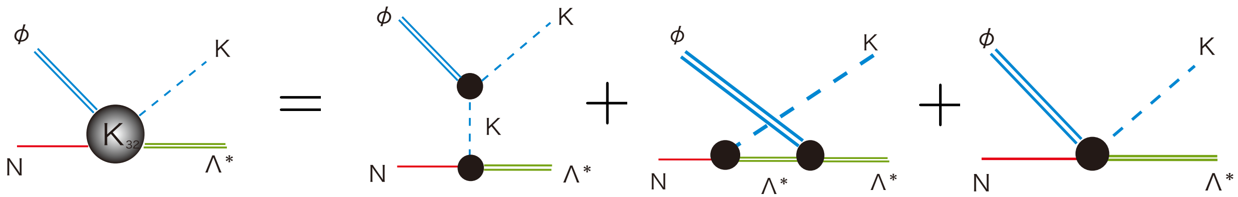
1. $\gamma N \longrightarrow \phi N$ Titov et al, PRC76, 035202, (2007)



2. $\gamma N \longrightarrow K\Lambda(1520)$ Nam et al, PRD75, 014027 (2007)



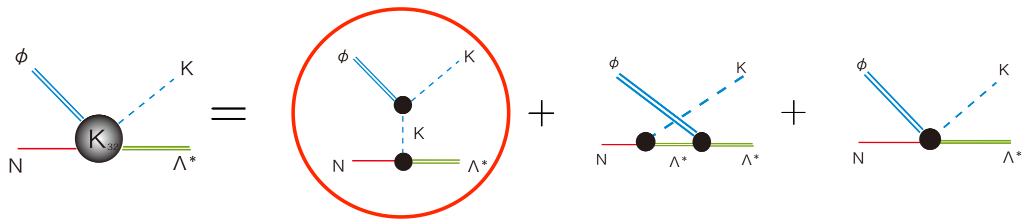
3. $\phi N \longrightarrow K\Lambda(1520)$



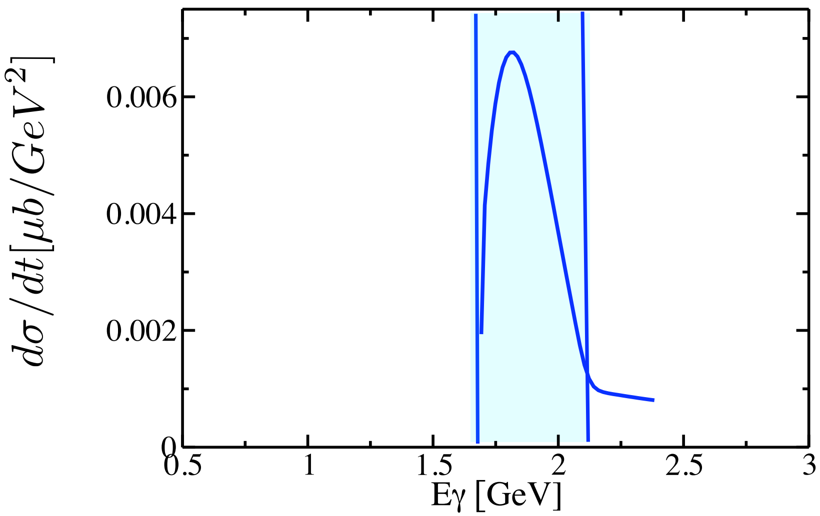
4. Other channels

$$\pi N,\ \rho N,\ \eta N,\ K\Lambda \text{ and } K\Sigma$$

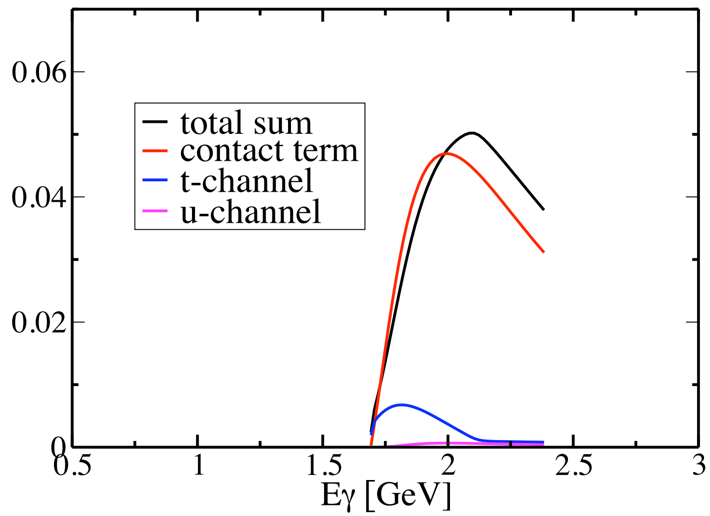
Results I (on-shell)



Only t-channel effect of ΦN → KΛ(1520)



All ΦN → KΛ(1520) channel effects



On-shell effect makes peak structure in the cross section in the desired energy region.

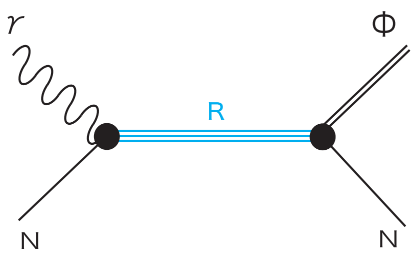
However in ΦN → KΛ(1520) channel dominant contribution is contact term like γN → KΛ(1520) channel.

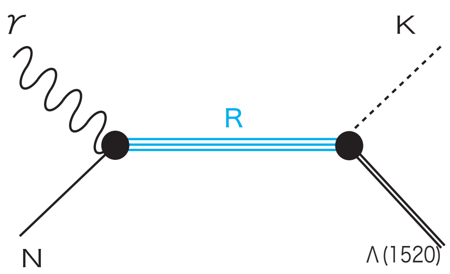
Therefore the t-channel effect (on-shell effect) is buried under the contact term.

2. Possibility of KΛ(1520), ΦN resonance

There is a peak structure in Λ(1520) photoproduction at the same energy region.

→ A resonance strongly correlating KΛ(1520) and ΦN may exists and makes peak structures in Λ(1520) and Φ photoproduciton.

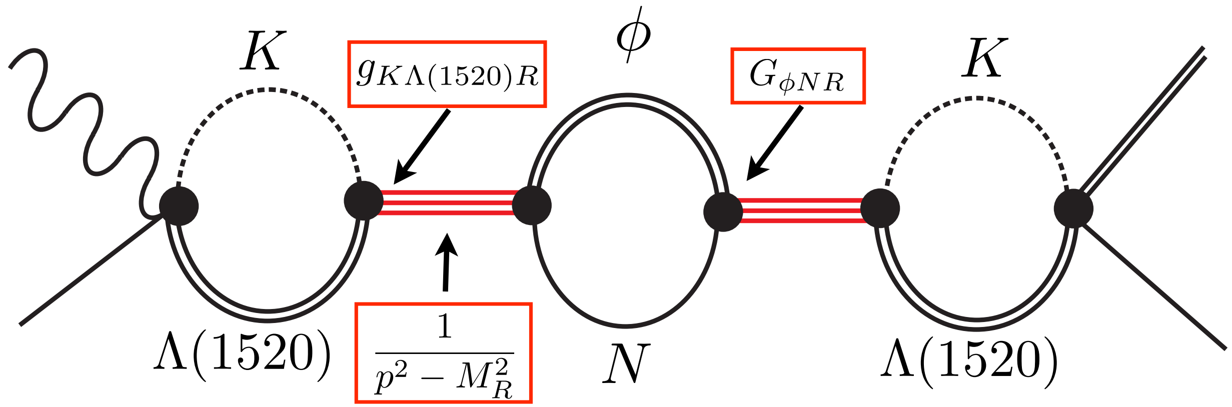




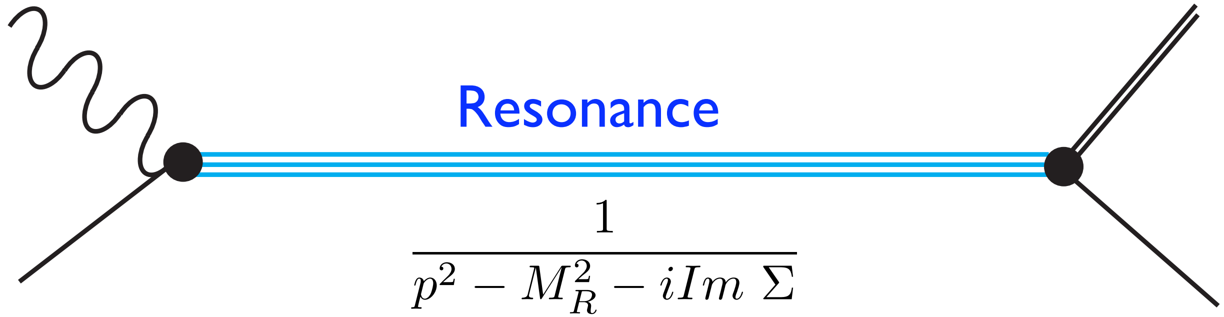
$M_R \sim 2200\ \mathrm{MeV}$

Since a resonance, consisting of KΛ(1520) and ΦN, contains large s-sbar component, this contribution may not be suppressed by OZI rule.

Resonance in the coupled channel K-matrix approach



all order sum



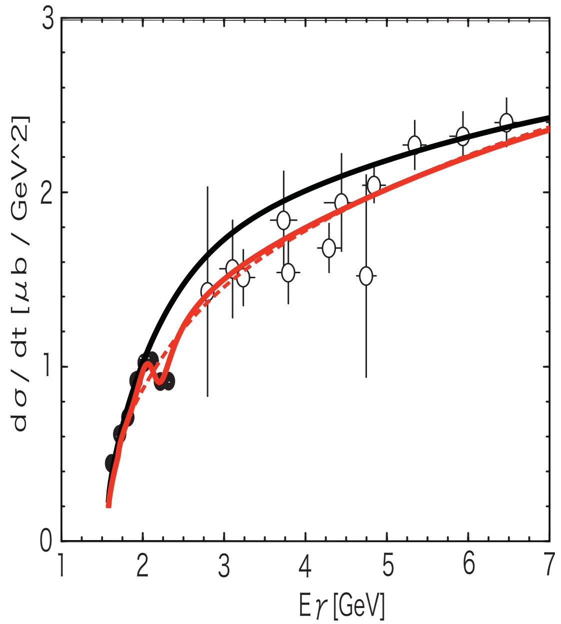
- ✓ Parameters characterizing the resonance

$$g_{K\Lambda(1520)R}\ ,\ G_{\phi NR}\ ,\ M_R$$

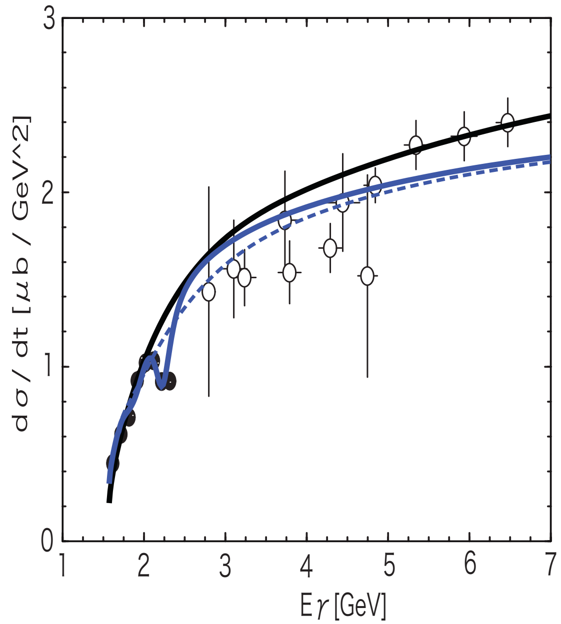
- ✓ We take into account only spin 1/2 case for simplicity

Results with resonance $(\frac{1}{2}^-)$

model A



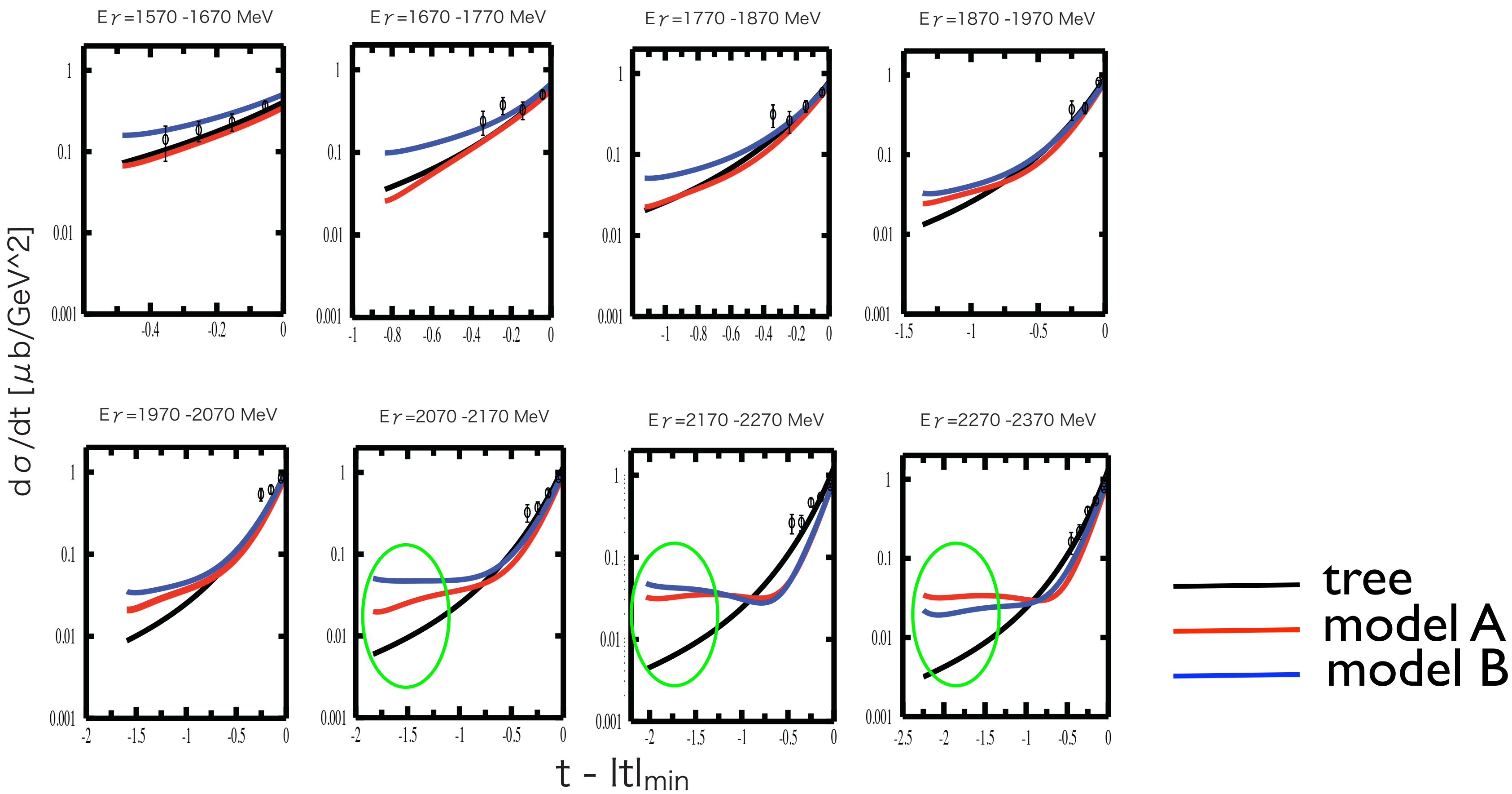
model B



Resonance parameters

models	$g_{\phi KK}$	$g_{K\Lambda(1520)R}$	$G_{\phi NR}$	M_R
model A	+4.7	-4.24	0.33	2250 MeV
model B	-4.7	-4.90	-0.28	2260 MeV

t-dependence



Theoretically a resonance effect makes angular distribution flat.

If the flat behavior is observed experimentally,
it could be the possibility of the resonance.

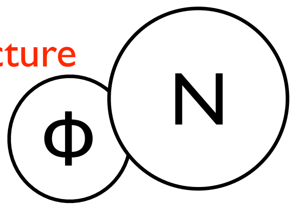
Summary

- We study coupled-channel effects in Φ photoproduction by using coupled-channel K-matrix.
- On-shell Kaon indeed makes a peak structure at desired energy region, but this structure is buried under broad contact term contribution.
- We discuss the possibility of the resonance which contains large s-sbar components.

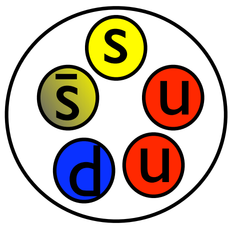
Future work

- Taking into account not only spin1/2 case but also higher spin case
- Effects of the resonance in Λ(1520) photoproduction
- Structure of the resonance

Molecular picture



or



CDD(quark origin) pole

around ~ 2 GeV