REACTION (K^-,K^+) AND PROPERTIES OF DOUBLE-STRANGENESS HYPERNUCLEI

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Phenomenological model for the elementary process $K^-N \to K\Xi$

*Consistent description of all the experimental cross sections from the threshold to 3.2 GeV at various charge channels

*Role of high-mass and high-spin resonances

*Polarization and spin-flip amplitude. Implications for Ξ hypernuclear production

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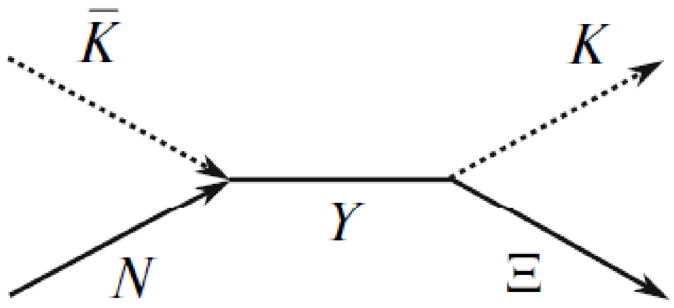
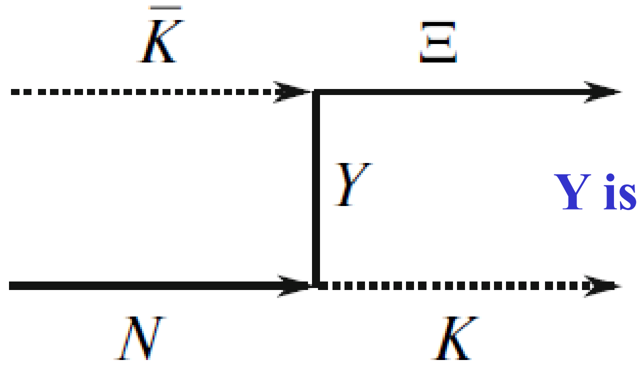
$K^{-}N \to K\Xi$ reaction

- Much less theoretical attention than other binary processes of hyperon production
- Rather scarce data from old bubble-chamber experiments
- No one-boson *t* channel exchange





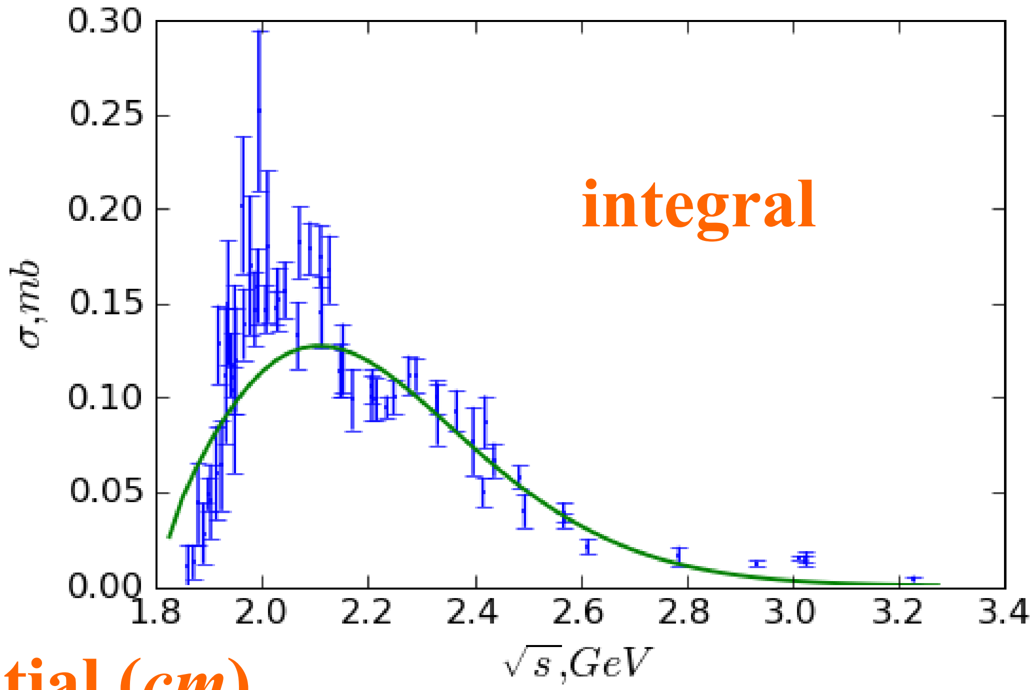
Y is an S=-*1* hyperon

1. Y=Λ, Σ, Σ(1385), Λ(1520)

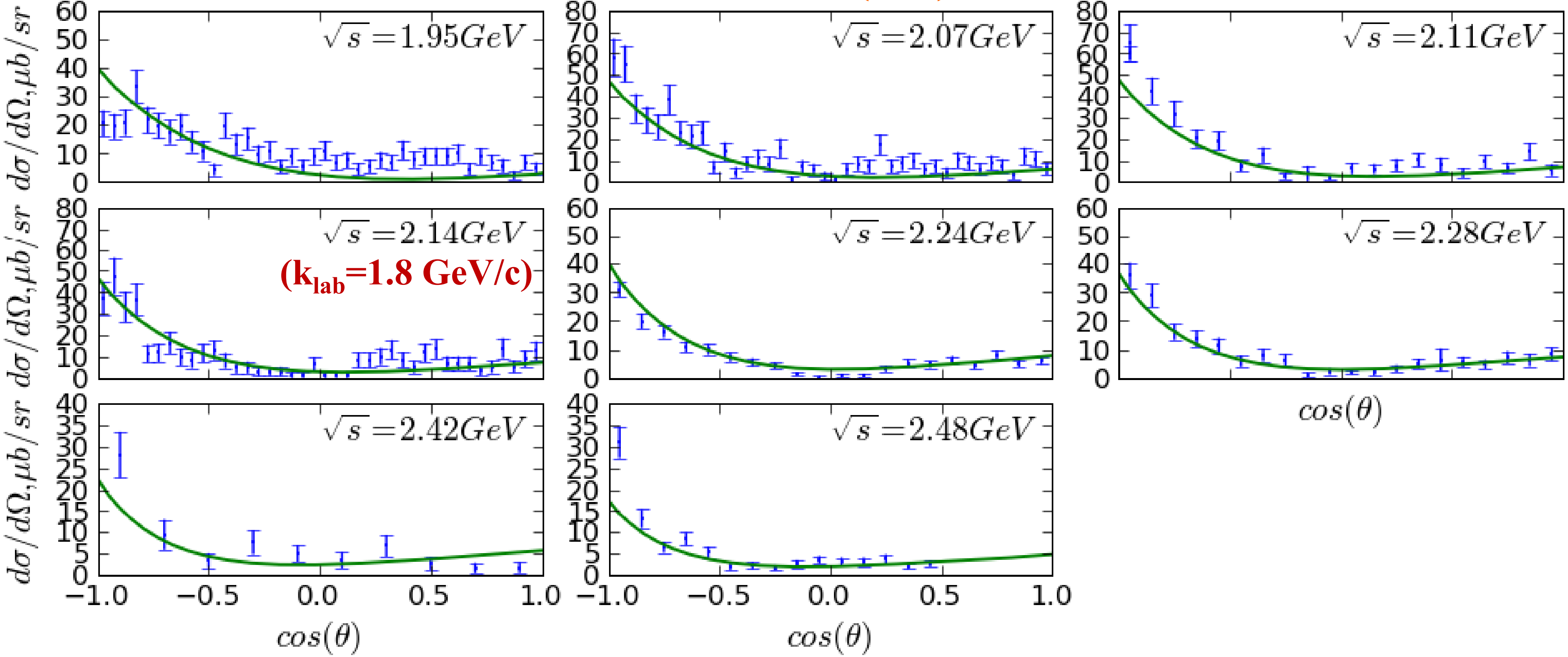
Direct fit to differential and integral cross sections of the reactions $K^{-}p \to K^{+}\Xi^{-}$ and $K^{-}p \to K^{0}\Xi^{0}$ from the threshold to *cm* energy 3.2 GeV

374 points, 5 free parameters

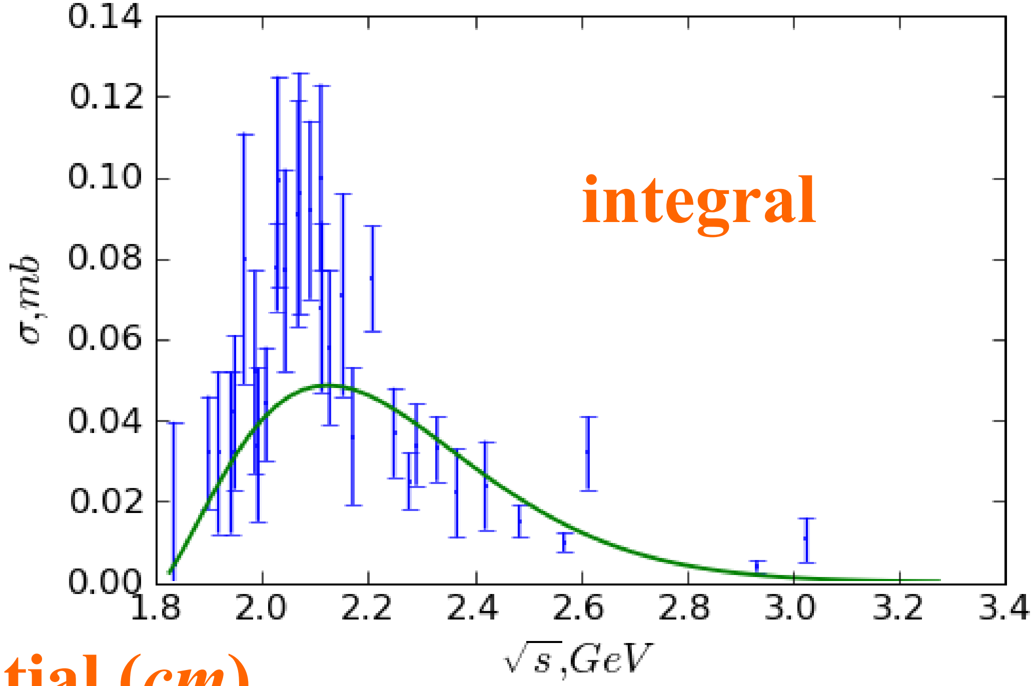
$K^-p \rightarrow K^+\Xi^-$
cross sections



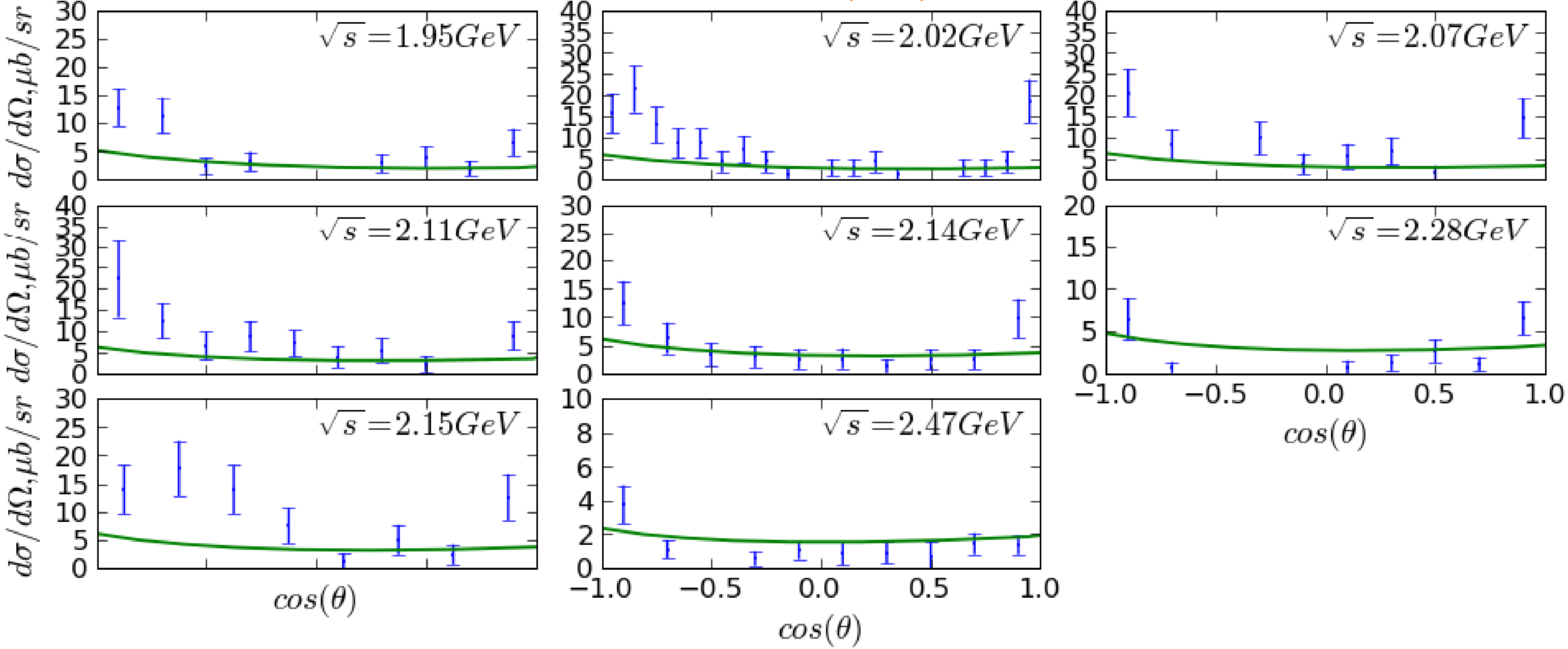
Differential (*cm*)



$K^-p \rightarrow K^0\Xi^0$ cross sections



Differential (*cm*)



Description with subthreshold exchange particles

Experimental data are reproduced fairly well.

But some defects are seen:

***Integral cross sections are underestimated in the bump region**

***The forward peak for the $K^-p \to K^0\Xi^0$ is not reproduced**

***The calculated polarization is almost zero**

2. Y=Λ, Σ, Σ(1385), Λ(1520) + some on-shell resonances

Many *S=-1* resonances are known in this energy range, but for none of them the PDG compilation establishes branching ratios $Y \to K\Xi$.

Four-star and three-star resonances (from PDG)

	J^{π}	M (MeV)	Γ (MeV)	Status	KΞ branching
Λ(1890)	3/2+	1850-1910	60-200	****	?
Σ(1915)	5/2+	1900-1935	80-160	****	?
Σ(1940)	3/2-	1900-1950	150-300	***	?
Σ(2030)	7/2+	2025-2040	150-200	****	<2%
Λ(2100)	7/2-	2090-2110	100-250	****	<3%
Λ(2110)	5/2+	2090-2140	150-250	***	?
Σ(2250)	5/2-(?)	2210-2280	100-250	***	?
Λ(2350)	9/2+	2340-2370	100-250	***	?

We checked different versions and choose the following one:

Y=Λ, Σ, Σ(1385), Λ(1520) + Σ(2030) + Σ(2250)

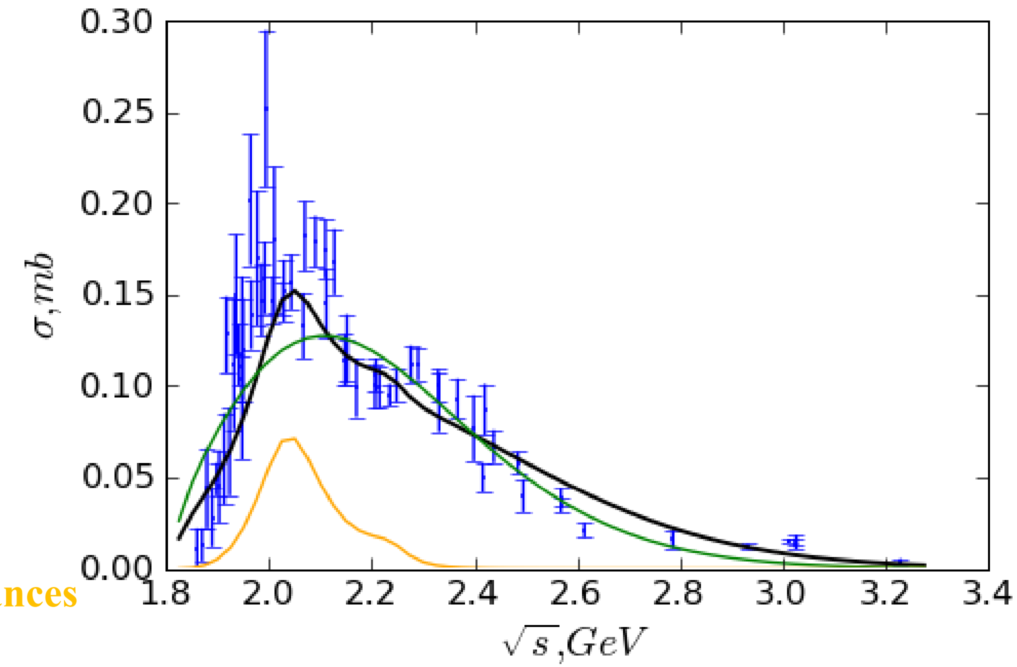
8 free parameters

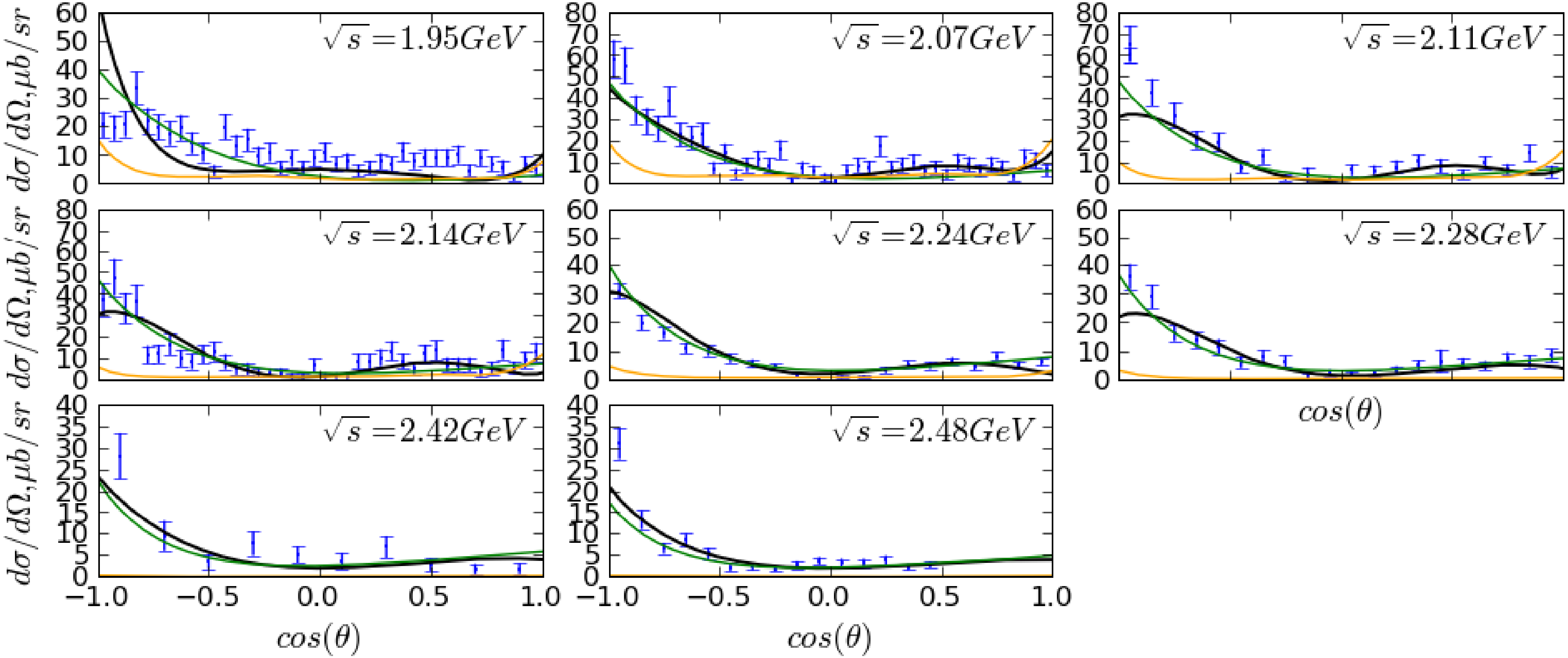
$K^{-}p \to K^{+}\Xi^{-}$

previous version

full version

contribution of higher resonances





$K^- p \rightarrow K^0 \Xi^0$

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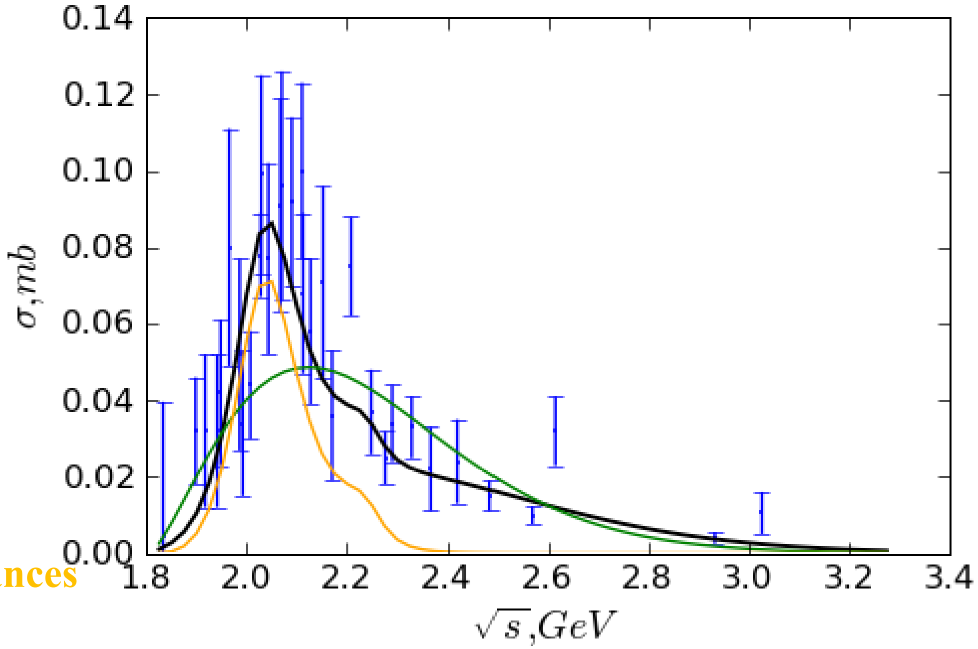
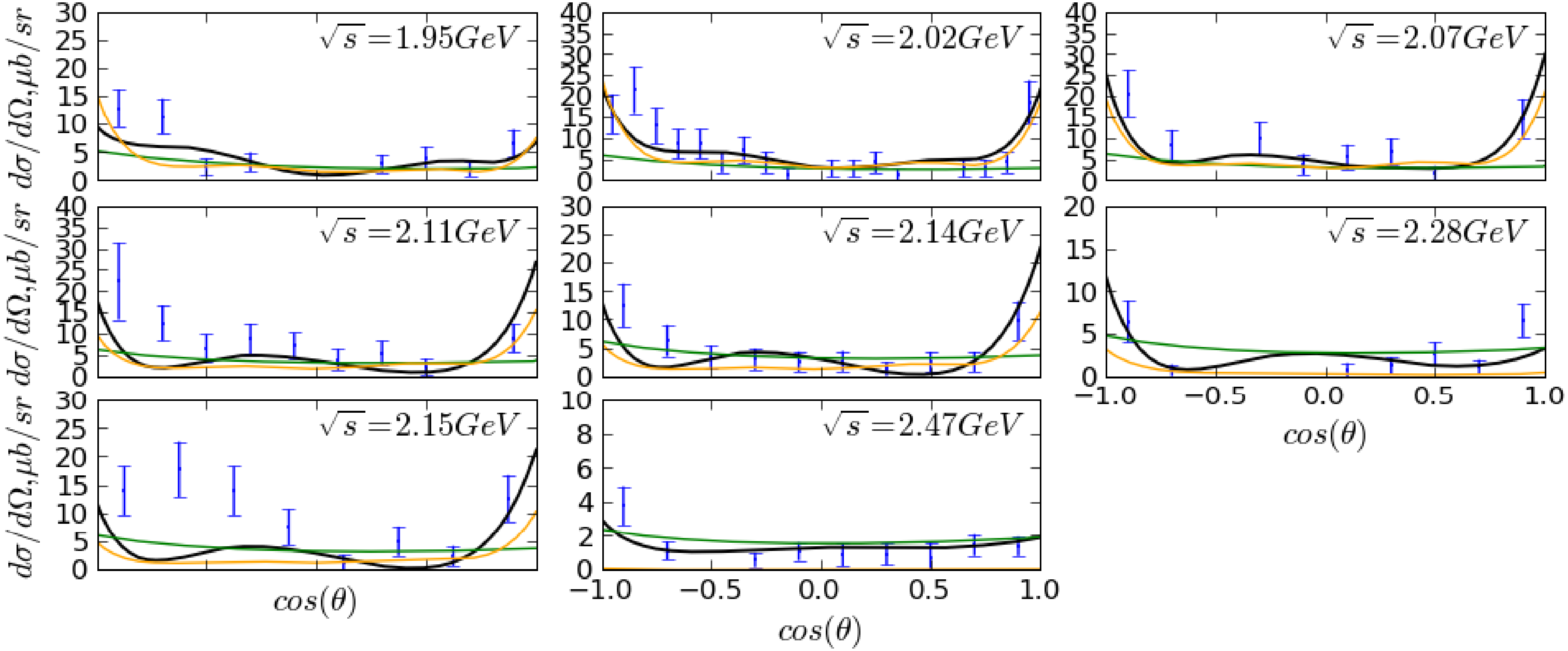




Addition of high-mass *s* channel resonances improves the agreement considerably

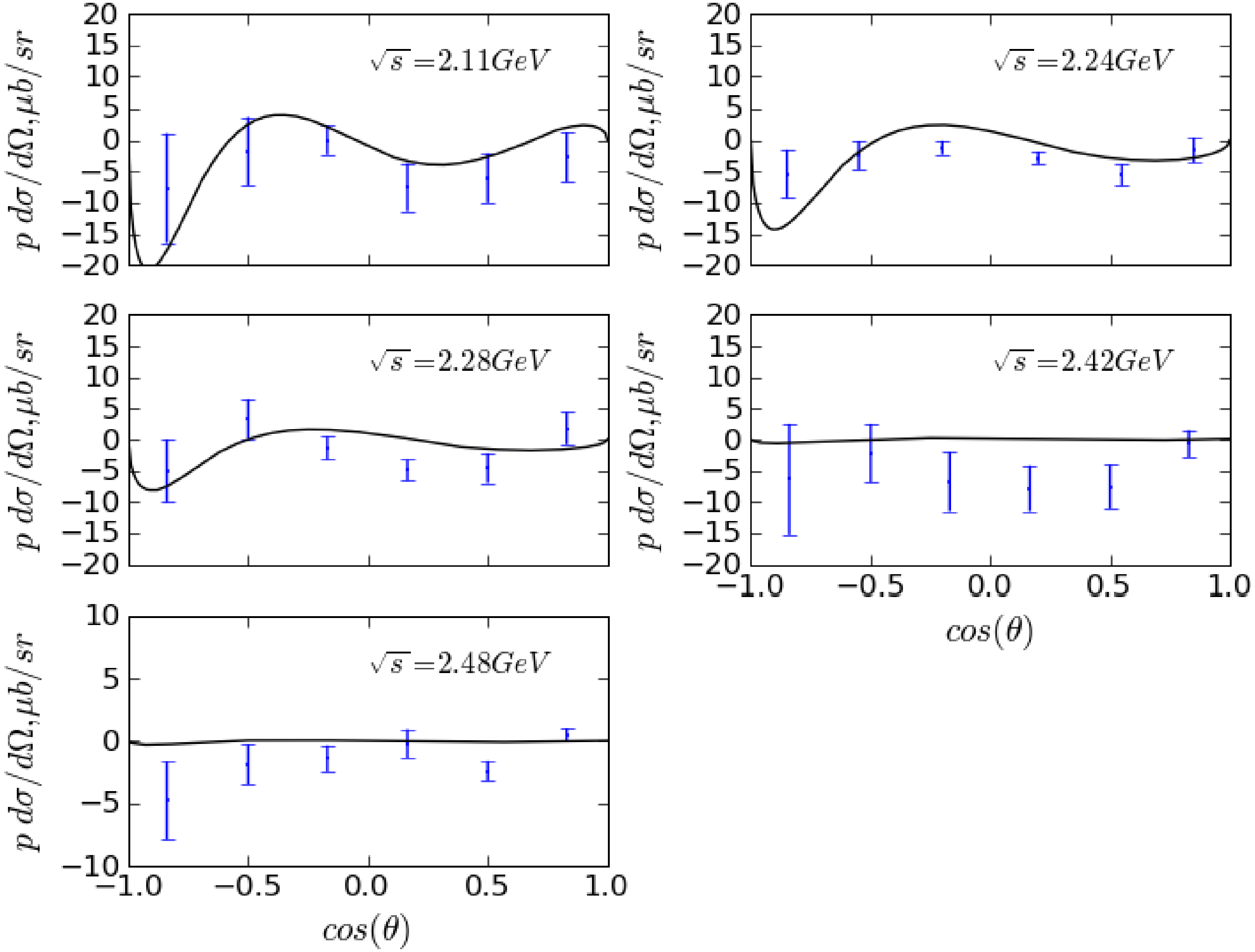
Partial widths for the $K\Xi$ decay channel are:
0.17 MeV for $\Sigma(2030)$
0.86 MeV for $\Sigma(2250)$,
which corresponds to the branchings about 0.1% and 1%, respectively (not in contradiction with PDG)

The $K^-p \to K^0\Xi^0$ reaction is predominantly resonance, contrary to the $K^-p \to K^+\Xi^-$ one

Sizable Ξ polarization appears

Ξ polarization appears from interference of the non-spin-flip and spin-flip amplitudes. The spin-flip amplitude leads to production of unnatural parity states on a 0^+ nuclear target (for instance, of the 2^- state from the ground state doublet in $^{12}_{\Xi}Be$)

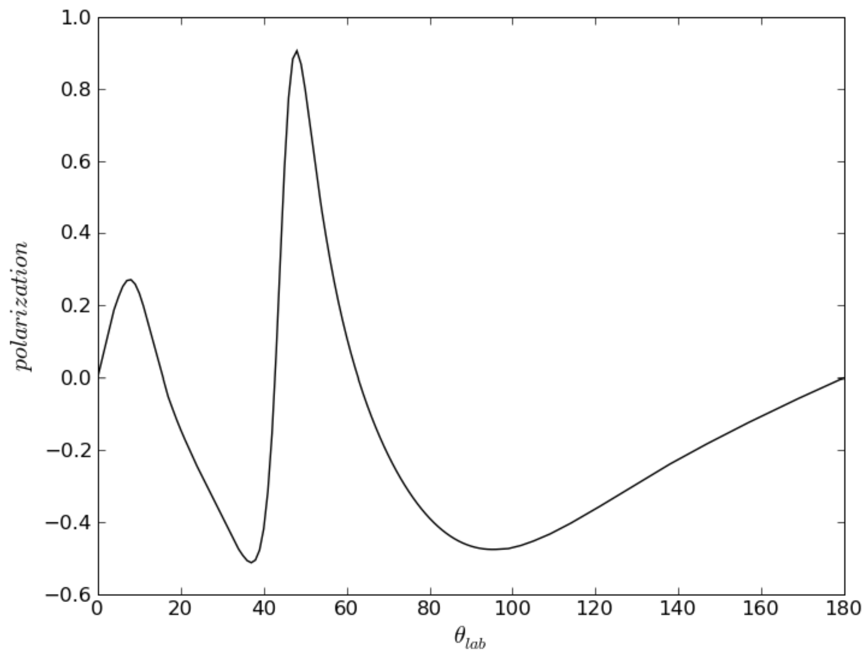
Ξ polarization in the $K^-p \rightarrow K^+\Xi^-$ reaction



These data were not included to the fitting procedure, therefore, the comparison with the calculation may be considered as an independent check

Is the elementary spin flip amplitude important for the Ξ hypernuclear production?

The polarization in the *lab* system at k_{lab}=1.8 GeV/c



At forward angles the polarization is not high!

Therefore, the spin-flip amplitude can be neglected in hypernuclear calculations, at least, in the first stage

Conclusion

*A phenomenological model for the $\bar{K}N \rightarrow K\Xi$ reaction is developed. At the first time, a consistent description of the the averall data is obtained.

*Account of high-mass resonances is important for successful description of the data, though from the existing data one unables to extract resonance parameters and branching ratios reliably.

*The $K^{-}p \rightarrow K^{0}\Xi^{0}$ is more sensitive to resonance contribution than the $K^{-}p \rightarrow K^{+}\Xi^{-}$ one.

*The amplitude of the reaction is obtained including the spin-flip contribution, which is helpful for studies of Ξ hypernuclear production. At the kinematical conditions of J-PARC, the spin-flip amplitude is not of great importance.

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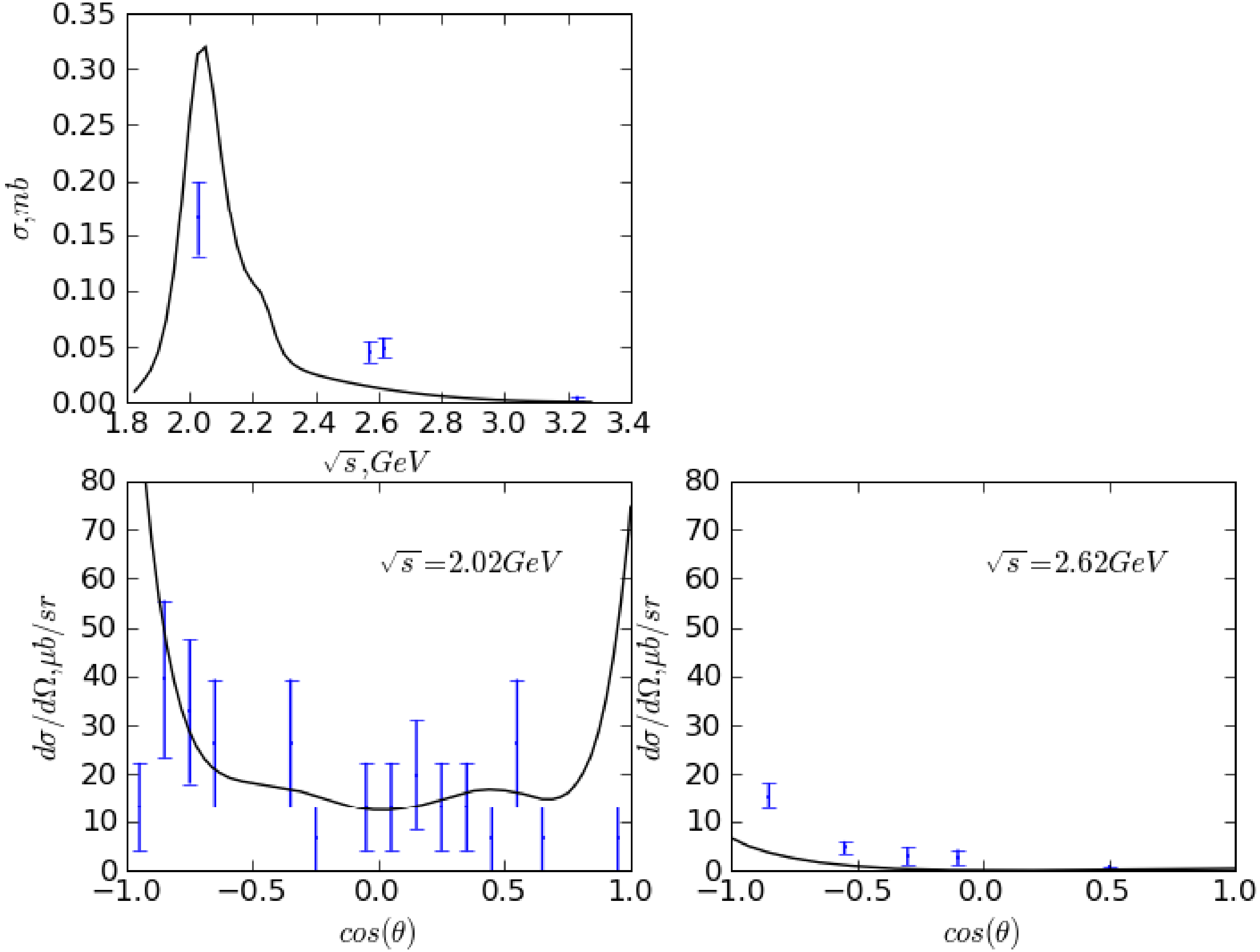
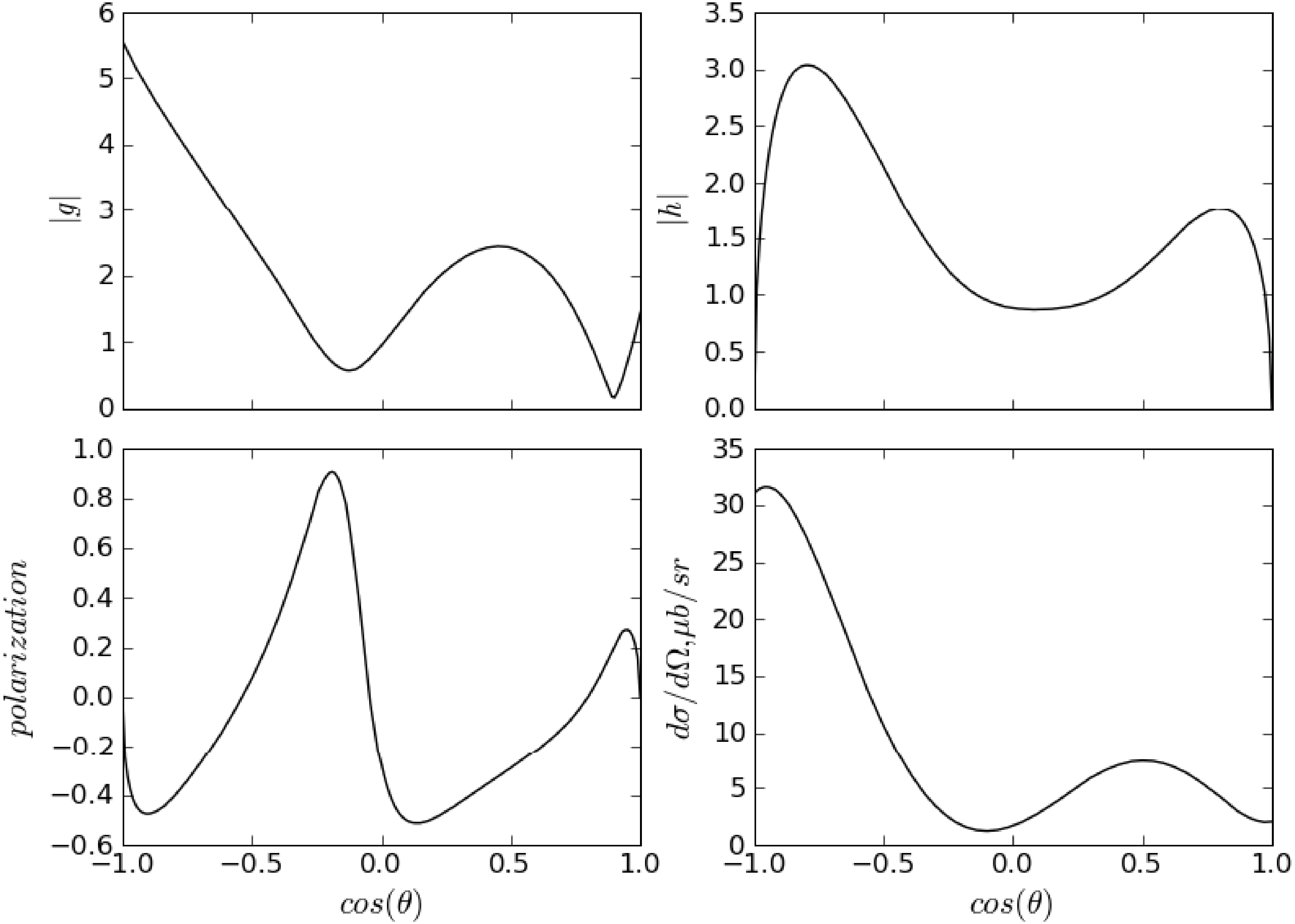
Thank you!

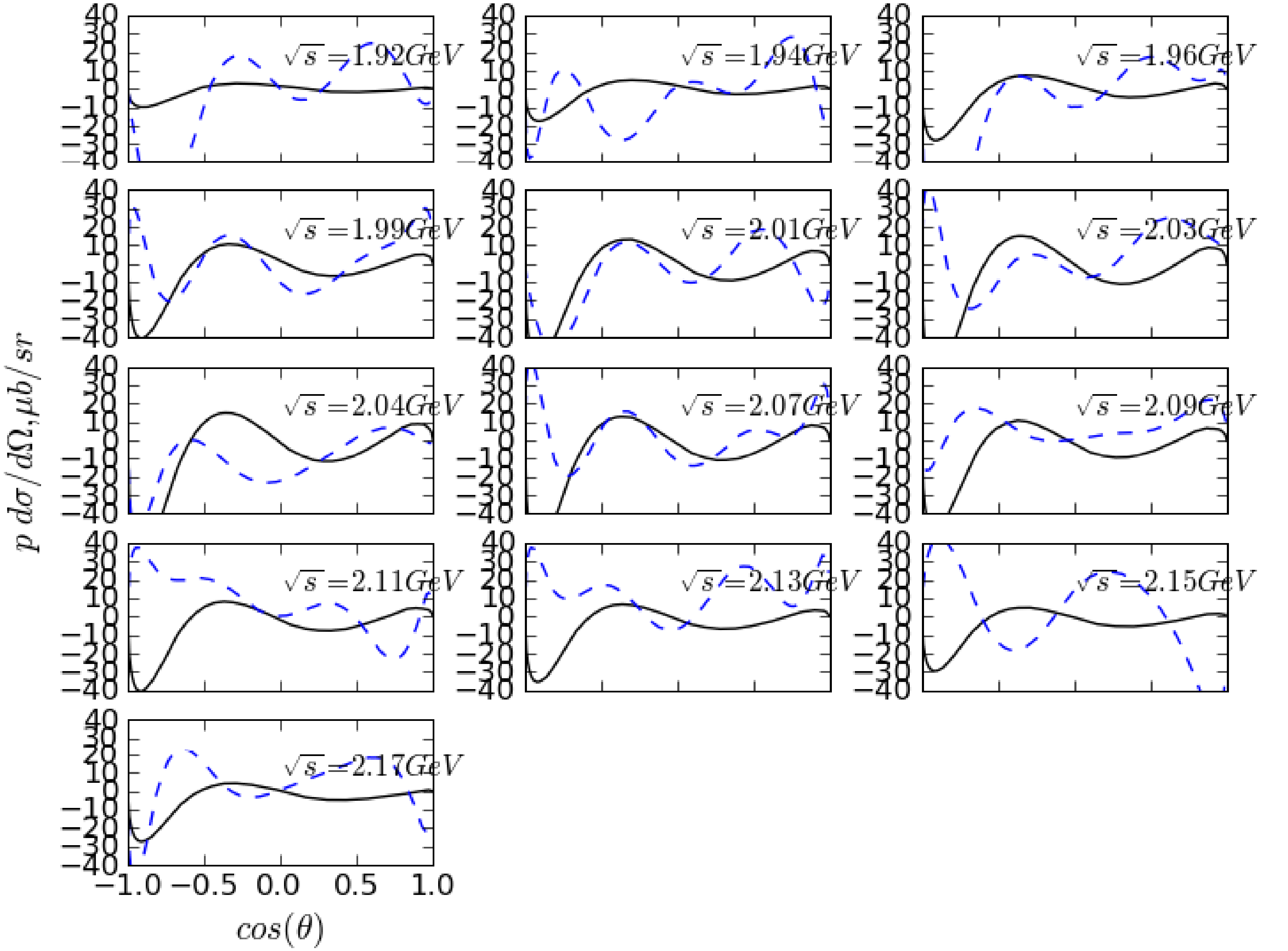
Backup slides

$K^- n \rightarrow K^+ \Xi^-$



cm amplitudes, E=2.15 GeV




$\sqrt{s} = 1.92 GeV$
$\sqrt{s} = 1.94 GeV$
$\sqrt{s} = 1.96 GeV$
$\sqrt{s} = 1.99 GeV$
$\sqrt{s} = 2.01 GeV$
$\sqrt{s} = 2.03 GeV$
$\sqrt{s} = 2.04 GeV$
$\sqrt{s} = 2.07 GeV$
$\sqrt{s} = 2.09 GeV$
$\sqrt{s} = 2.11 GeV$
$\sqrt{s} = 2.13 GeV$
$\sqrt{s} = 2.15 GeV$
$\sqrt{s} = 2.17 GeV$
$p\ d\sigma/d\Omega, \mu b/sr$
$cos(\theta)$
−1.0 −0.5 0.0 0.5 1.0
40 30 20 10 0 −10 −20 −30 −40