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ORSAY

Final results of the analysis of charged pion pair production in proton and antiproton annihilation within an effective meson theory

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Content

Introduction

Motivation

Effective meson theory and Crossing symmetry

Results for Charged particles pbar p → π+π- , π-p → p π- , K+K-

- Angular distribution
- S-dependence

Summary

Motivation: pbar p -> $\pi^+\pi^-$

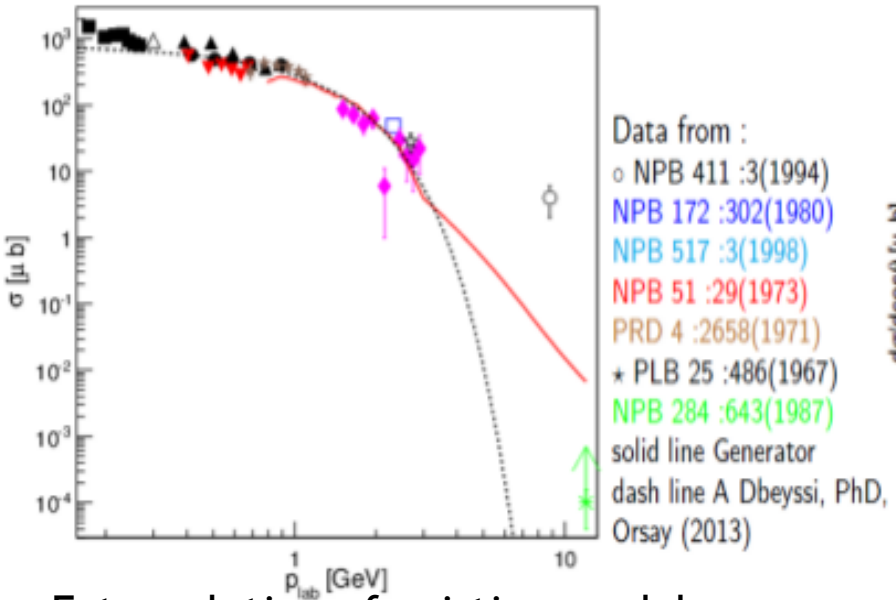
- The reaction $\bar{p}p \to e^+e^-$ allows to measure electromagnetic proton form factors.
- The reaction $\bar{p}p \to \pi^+\pi^-$ is the main background :
  - has a large cross section,
  - contains information on the quark content of the proton
  - allow to test different QCD models

It is necessary to fully understand the process $\bar{p}p \to \pi^+\pi^-$

Motivation: model for $\pi^+\pi^-$

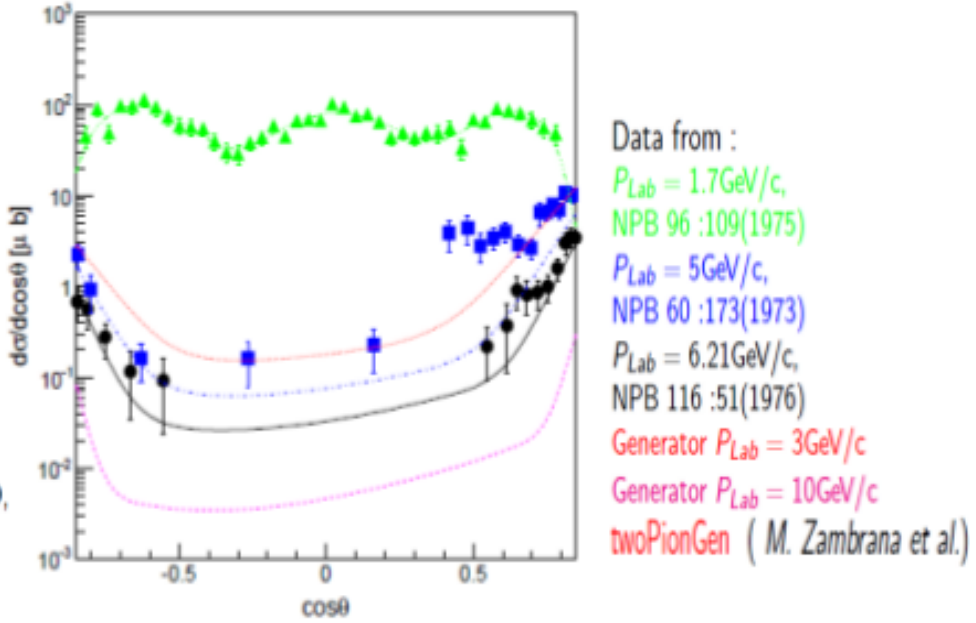
Few experimental data at the PANDA energies to constrain the models

Total cross section



Extrapolation of existing models to Panda range is risky

Differential cross section

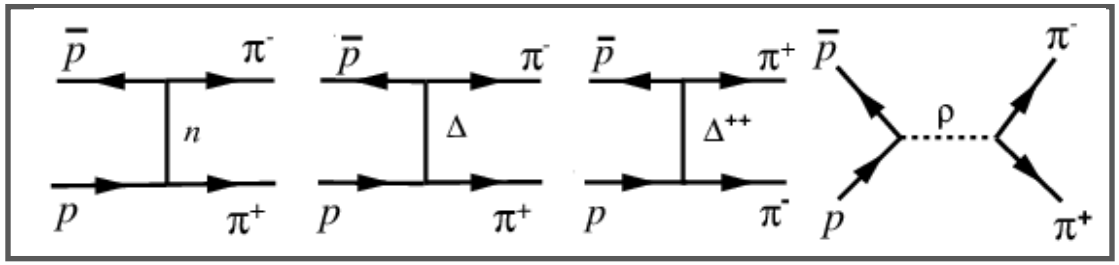


Few and incomplete angular distributions data of annihilation(6 sets of $\pi^+\pi^-$ in panda energy region)

$\bar{p}p \rightarrow \pi^+\pi^-$

Model of production $\pi^+\pi^-$

$$\frac{d\sigma}{d\Omega} = \frac{1}{2^8\pi^2}\frac{1}{s}\frac{\beta_\pi}{\beta_p}\overline{|\mathcal{M}|^2}$$



$$\mathcal{M} = \mathcal{M}_n + \mathcal{M}_{\Delta^0} + \mathcal{M}_{\Delta^{++}} + \mathcal{M}_\rho.$$

$$F_{N,\Delta}(x) = \frac{\mathcal{N}_{N,\Delta}\cdot M_0^4}{\left[(x-\Lambda_{N,\Delta}^2)\log\frac{(x-\Lambda_{N,\Delta}^2)}{\Lambda_{QCD}^2}\right]^2},$$

➞ **logarithm form factors**

➞ **no Regge factors**

- Regge factors not well extrapolation to time like region
- Regge factors give none physic parameters

➞ **not yet in Regge regime**

$$x = s,\ t,\ u$$

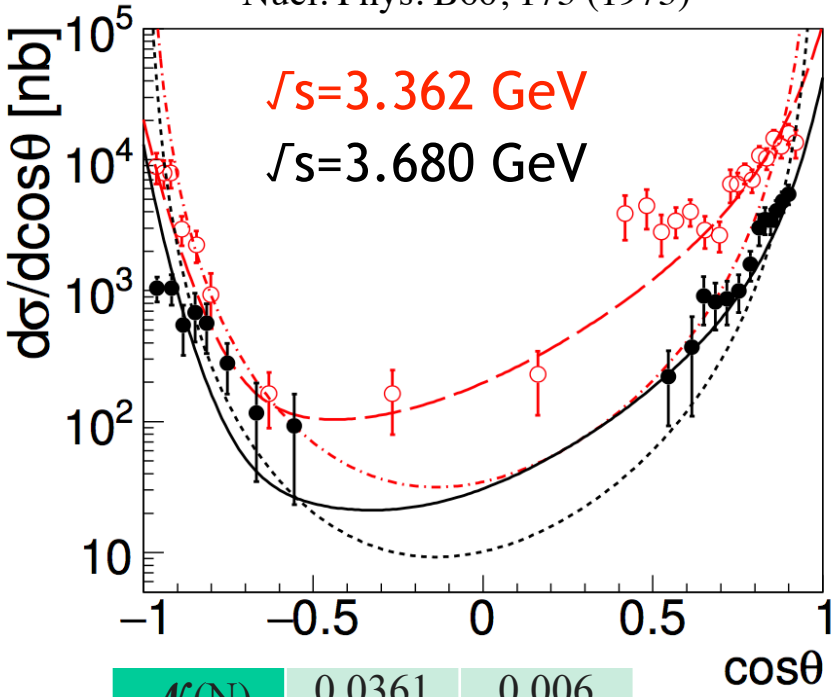
$M_0 = 3.86$ GeV is a scale parameter

$\Lambda_{QCD} = 0.3$ GeV is the QCD scale parameter

Results and Comparison

Nucl. Phys. B116, 51 (1976)

Nucl. Phys. B60, 173 (1973)

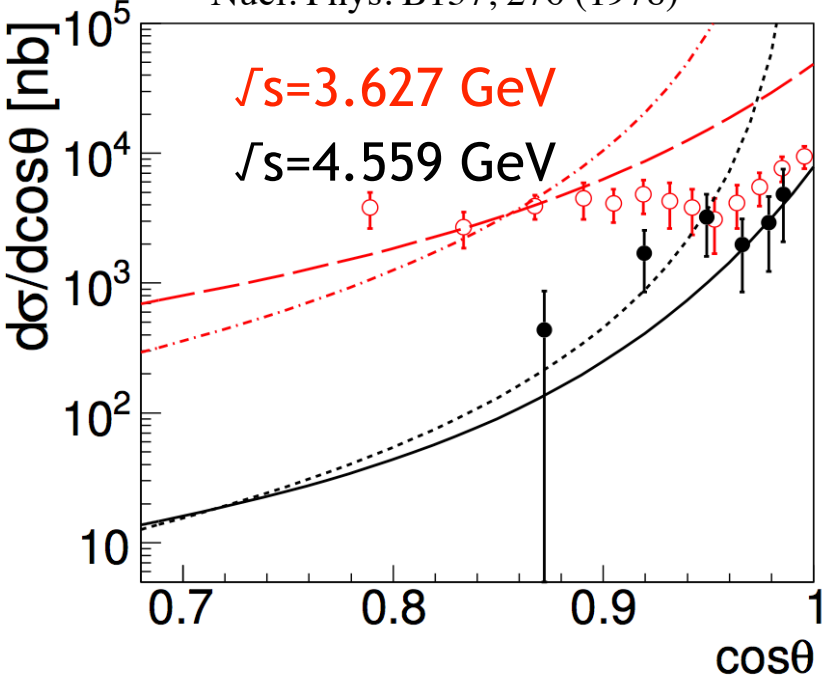


$\mathcal{N}$(N)	0,0361	0,006
$\mathcal{N}(\Delta)$	0,041	0,003
Λ(N)	2,25	0,09
$\Lambda(\Delta)$	1,05	0,04

$\chi^2/ndf = 1.99$

Phys. Rev. Lett. 39, 378 (1977)

Nucl. Phys. B137, 276 (1978)



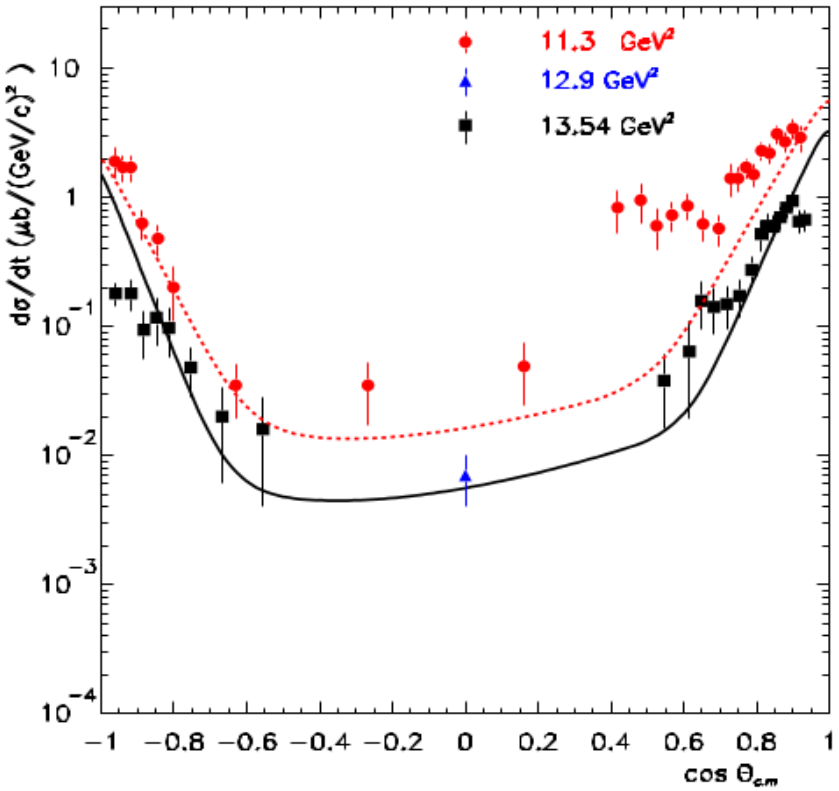
Our Model

Model from paper:PRD 8, 287(1973)

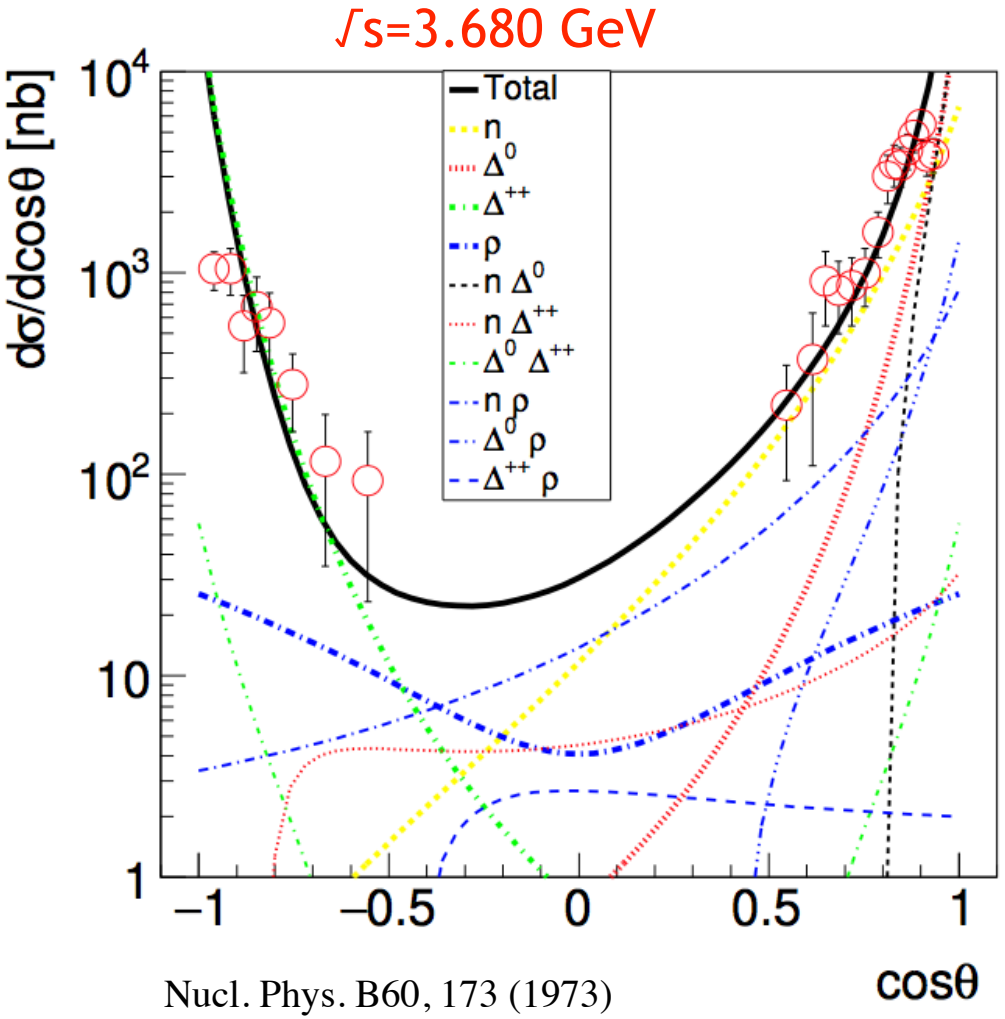
Model comparison

Same sets of data described by the model from ref: EPJ A 46 (2010) , 291-298

- The logarithmic form factors have better data description at forward and backward region



Components of this model



Nucl. Phys. B60, 173 (1973)

Forward mainly from n and **Δ0**

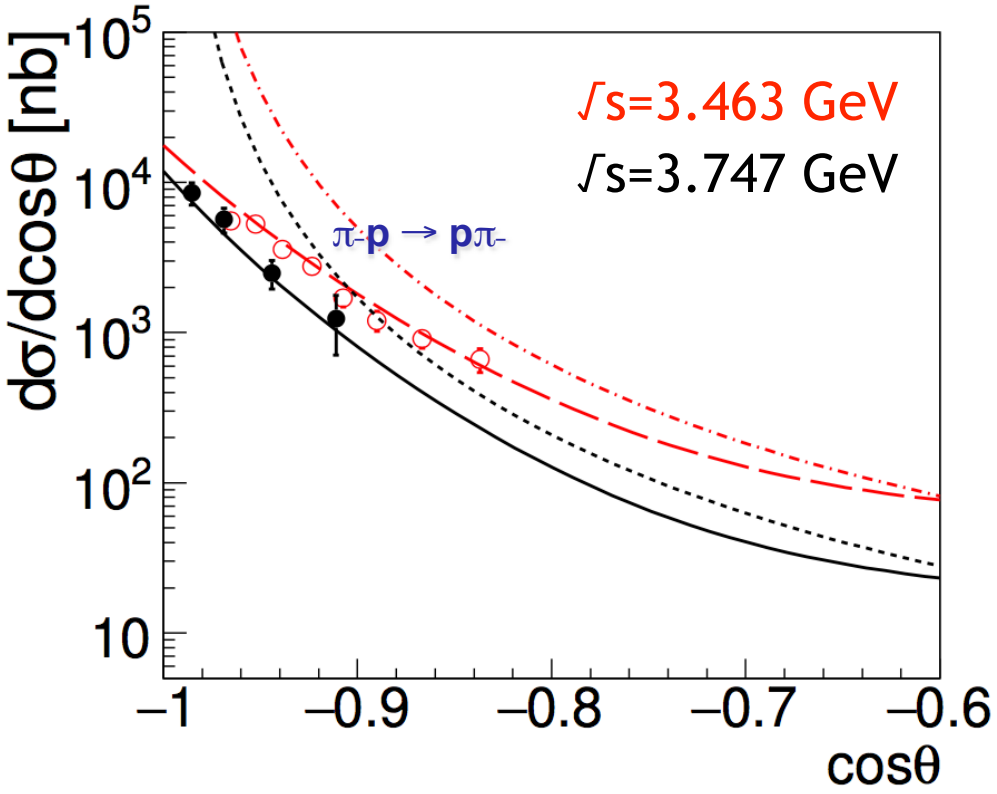
Backward mainly from **Δ++**

s-channel from ρ and interferences

Crossing symmetry of the model

Phys. Rev. 181, 1794 (1969)

Nucl. Phys. B 25, 385(1971)



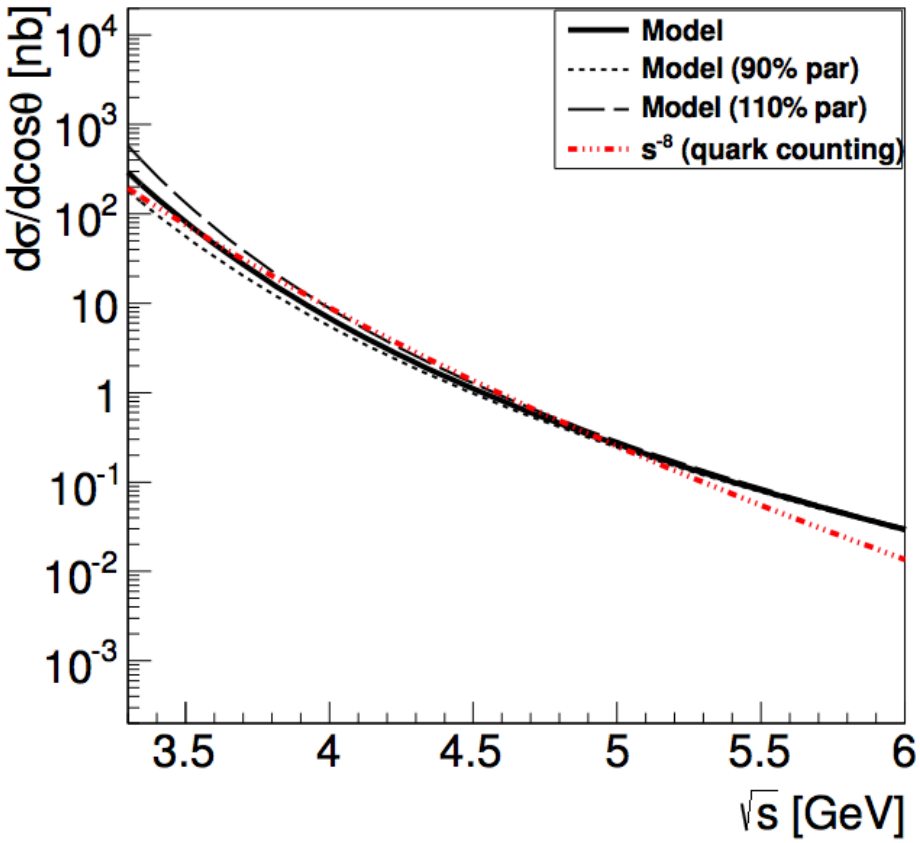
- using crossing symmetry from pπ- elastic to get more experiment data in the backward region

Our Model

Model from paper:PRD 8, 287(1973)

S-dependence $\bar{p}p \rightarrow \pi+ \pi-$

compare to quark counting rules at 90 degree



PRL (1973) 31. 18.

S. J. Brodsky, G. R. Farrar

Scaling Laws at Large Transverse Momentum

LETTERE AL NUOVO CIMENTO (1973) 5 14

V. A. Matveev et al.

Automodelity in Strong Interactions.

$$d\sigma/dt \sim s^{2-n} f(t/s)$$

$$d\sigma/dt \sim s\text{-}8\, f(t/s)$$

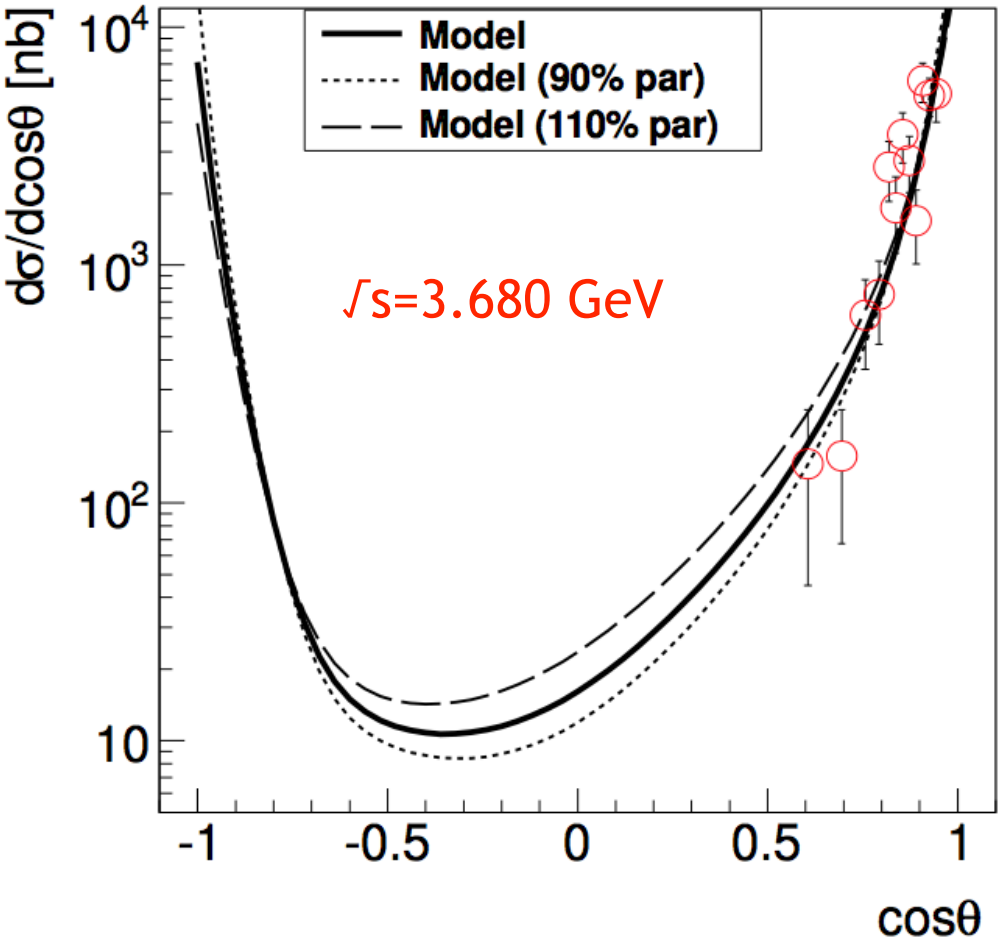
Calculation $\bar{p}p \rightarrow K^+ K^-$

V. Anisovich, Phys. Lett. B 364, 195 (1995).

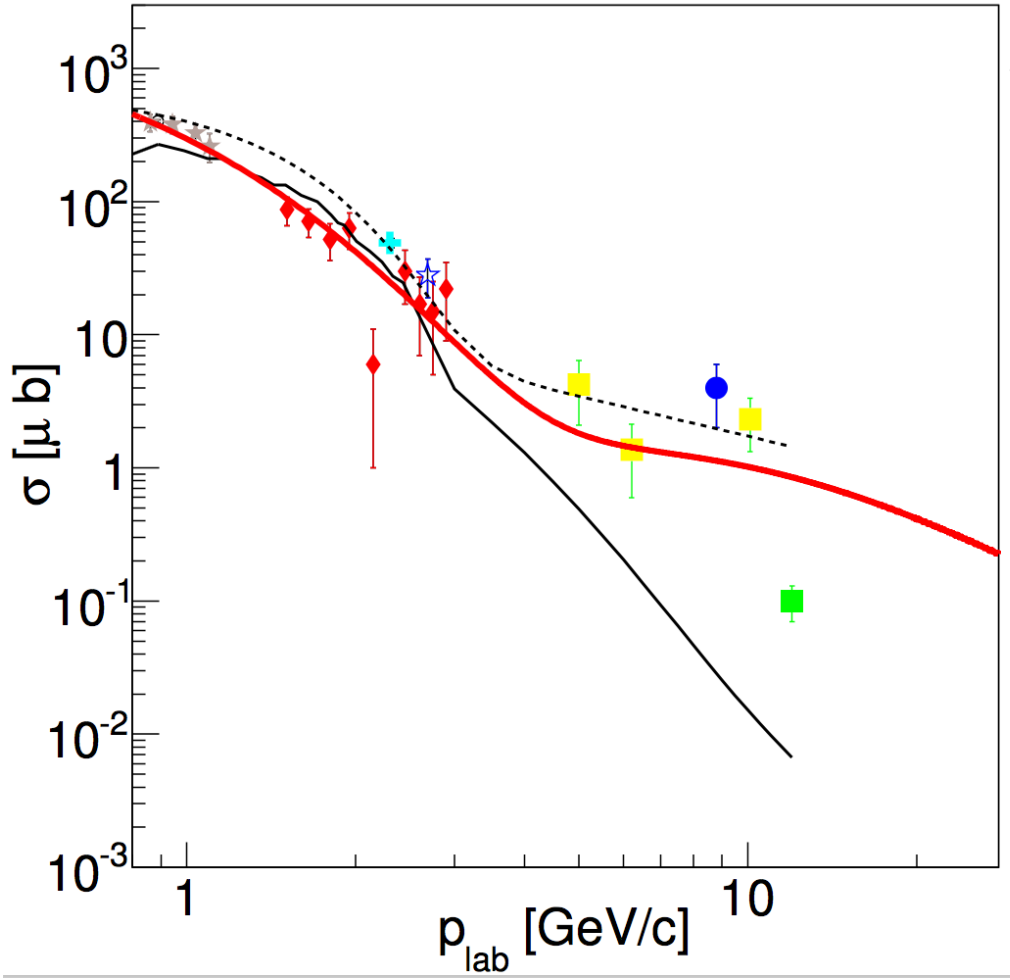
- Prediction through SU3 symmetry with no change of parameters.

$$\sigma(\pi^-\pi^+) : \sigma(K^-K^+) = 1 : \frac{4\lambda}{3}, \text{ where } \lambda = 0.4$$

- Evaluate the total cross section, from the integrated cross section σ(pbar+p→K^+ +K^-)=2.1±0.8mb.



Total cross section pbar p → π+ π-



- Black dashed line modified from A Dbeyssi PhD

$$\sigma = a \cdot e^{-(b \cdot p_{lab} + c \cdot p_{lab}^2 + d)} + \frac{e}{p_{lab}}$$

Added term →

- Red solid line - our model
- Black solid line -generator

Same figure from Page 3

Yellow points from the integration of reduced angular distribution.

Summary

- We have built a promising model based on effective Lagrangian to describe 2 meson production in pbar p annihilation

- We reproduced existing $\pi^+\pi^-$ - data

- We reproduced π^+p, π^-p using crossing symmetry

- Charged kaon channel obtained from SU3 symmetry: K^+K^-

- Encouraging results on angular distributions and the expected s dependence have been obtained

Thank you!