Strangeness Production and YN Interaction

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Possibilities:

- ELASTIC ΛN SCATTERING

  PROBLEM: SHORT LIFE TIME OF $\Lambda \Longrightarrow$

  SCARCE DATA SET EXISTS

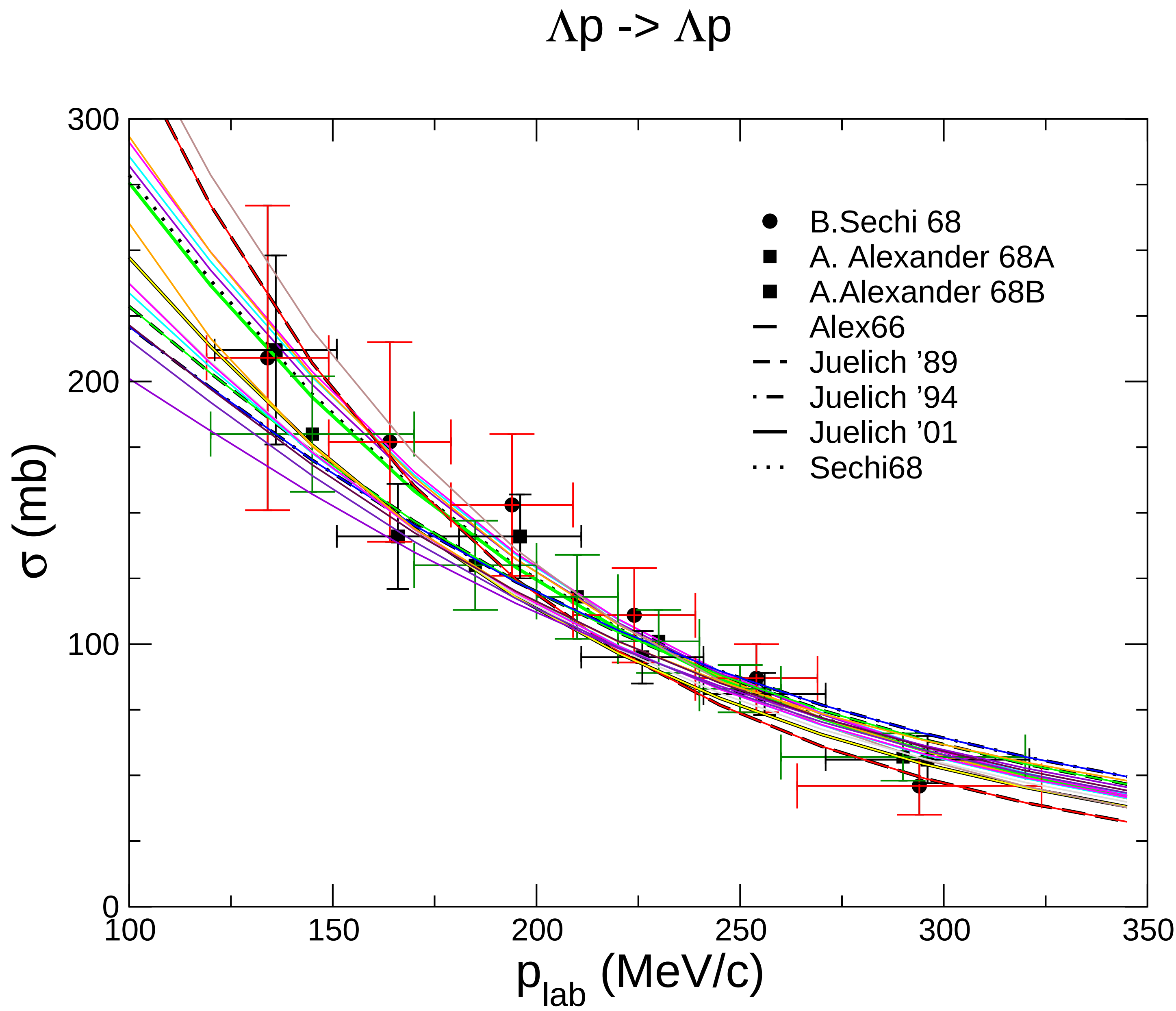
  (G. Alexander et al., Phys. Rev.**173** (1968) 1452; B. Sechi-Zorn, et al., Phys. Rev. **175**, 1735 (1968))

ONLY A FEW HUNDRED EVENTS

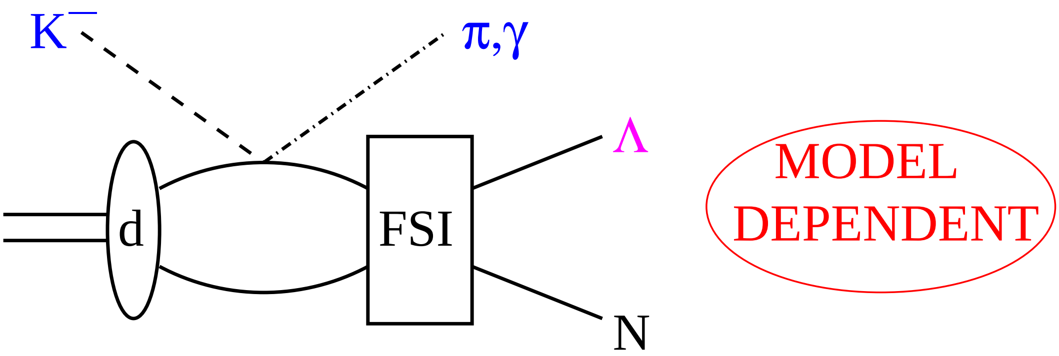
$\Longrightarrow$ SCATTERING PARAMETERS
ONLY BADLY DETERMINED !

$$a(S=0) = -0.7 \div -2.6 \text{ fm}$$
$$a(S=1) = -1.7 \div -2.15 \text{ fm}$$

(V.G.J. Stoks,T.A. Rijken Phys. Rev. C **59**, 3009 (1999))


Λp -> Λp
σ (mb)
p_lab (MeV/c)
0
100
200
300
100
150
200
250
300
350
B.Sechi 68
A. Alexander 68A
A.Alexander 68B
Alex66
Juelich '89
Juelich '94
Juelich '01
Sechi68

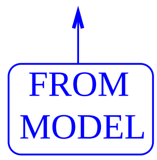
- Production reactions with low momentum transfer



a) $K^- d \rightarrow \pi^- p \Lambda$

(T.H. Tan Phys. Rev. Lett. **23**, 395 (1969))

$$a \approx a(S=1) = -2.0 \pm 0.5 \text{ fm}$$



b) $K^- d \rightarrow \gamma n \Lambda$

(R.L. Workman and W. Fearing Phys. Rev. C **41**, 1688 (1990); K.P. Gall, et al.,Phys. Rev. C **42**, 475 (1990); W.R. Gibbs, Phys. Rev. C **61**, 064003 (2000))

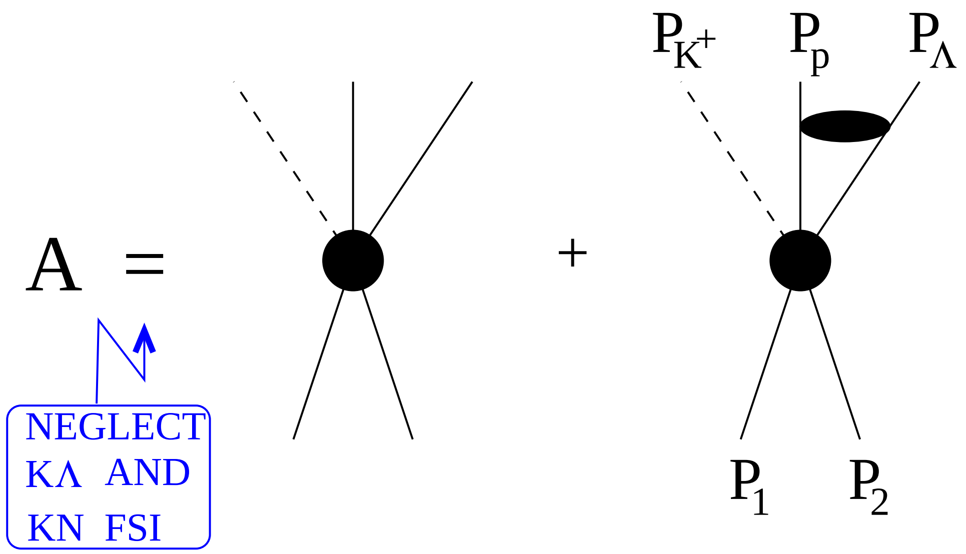
Problems:

- Theoretical errors not under control
- sensitive to short range ΛN

- <u>Production reactions with large momentum transfer</u>

$pp \longrightarrow pK^+\Lambda$

ASSUME POINT-LIKE PROD. OPERATOR



$t = (P_K - P_1)^2$

$m^2 = (P_p + P_\Lambda)^2$

$s = (P_1 + P_2)^2$

● IS A CONSTANT WITH RESPECT TO VARIATIONS IN m^2

Dispersion relation technique :

$$A(s,t,m^2) = \exp\left[\frac{1}{\pi}\int_{s_0}^{\infty}\frac{\delta(m'^2)}{m'^2 - m^2 - i0}dm'^2\right] \times \Phi(s,t,m^2)$$

Scattering length extraction

Effective range approximation: $\frac{1}{|D(k)|^2} = \frac{k^2+\beta^2}{k^2+\alpha^2}$

$$a_S = \lim_{M^2 \to s_0} \frac{1}{2\pi} \left(\frac{m_\Lambda + m_p}{\sqrt{m_\Lambda m_p}} \right) \mathbf{P} \int_{s_0}^{s_{max}} dm^2 \sqrt{\frac{s_{max} - M^2}{s_{max} - m^2}} \times \frac{1}{\sqrt{m^2 - s_0}(m^2 - M^2)} \log \left\{ \frac{1}{p'} \left(\frac{d^2\sigma_S}{dm^2 dt} \right) \right\}$$

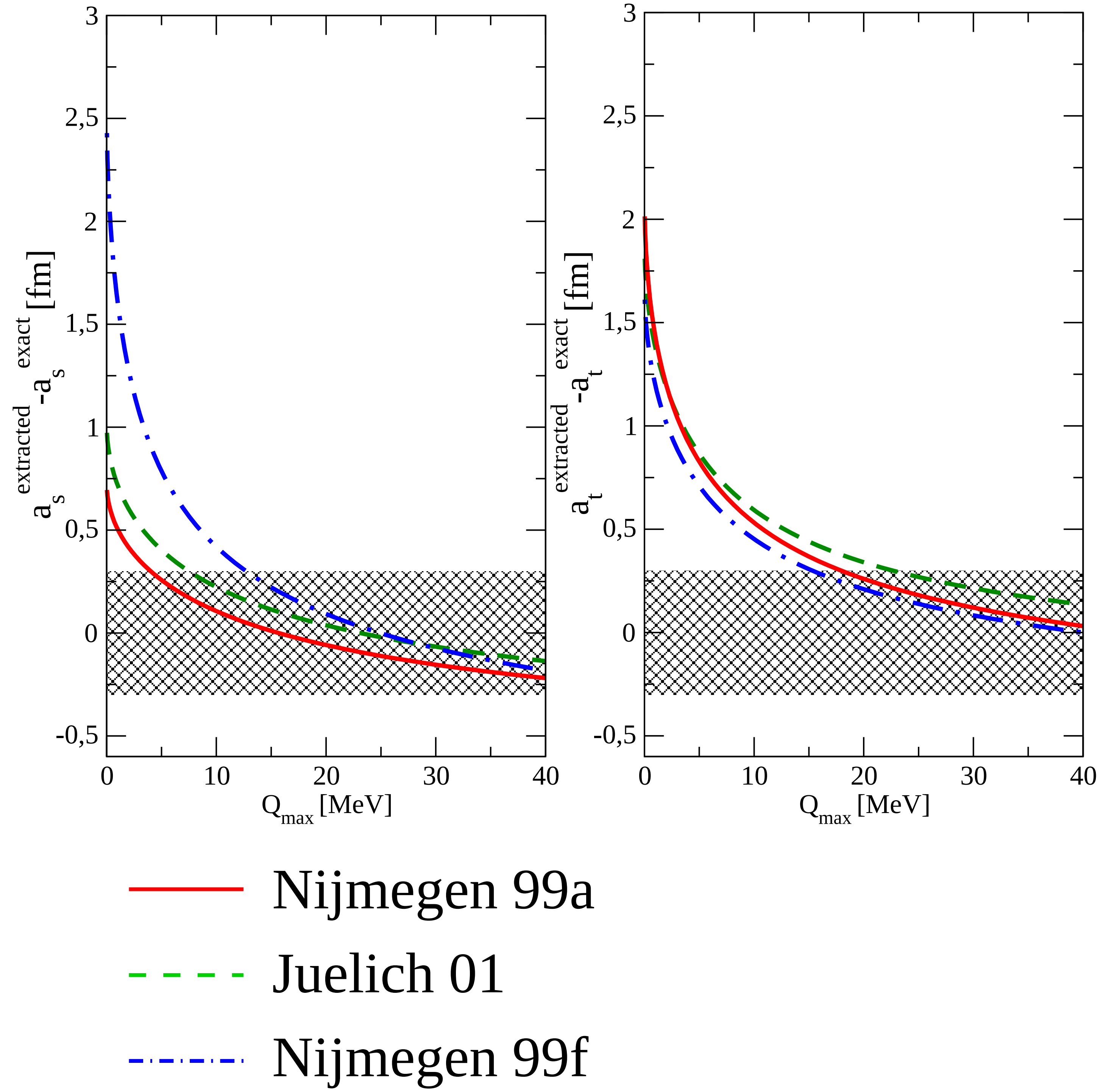
Relevant scales: $a, r \Longrightarrow Q_{max} \sim 20 - 40$ MeV

(N.I.Muskhelishvili, *"Singular Integral Equations"*, 1953;
R. Omnes, Nuovo Cim. **8**, 316 (1958);
W.R.Frazer and J.R.Fulco, Phys. Rev. Lett. **2**, 365 (1959);
B.V.Geshkenbein, Yad.Fiz.**9**,1232(1969), Phys.Rev.D **61**)

Comparison with model calculations

(A. Gasparian, Phys. Lett. B **480**, 273 (2000))

$\Delta a \sim 0.3$ fm



$\vec{p}\vec{p} \longrightarrow pK^+\Lambda$

Special kinematical conditions ($q_{\Lambda N}$ is small)

$+$

parity conservation

$+$

Pauli principle (for initial protons)

$\Downarrow$

$$A_{0y}\sigma_0(\theta = 90^\circ),$$

$$(1 - A_{xx})\sigma_0(\theta = 90^\circ \text{ or } \phi = 90^\circ) =$$

spin triplet contributions only,

$$(1 + A_{xx} + A_{yy} - A_{zz})\sigma_0(\theta = 90^\circ) =$$

spin singlet contributions only.

Further Applications

$$D_{yy}\sigma_0(\theta = 90^\circ) =$$

triplet-singlet interference only.

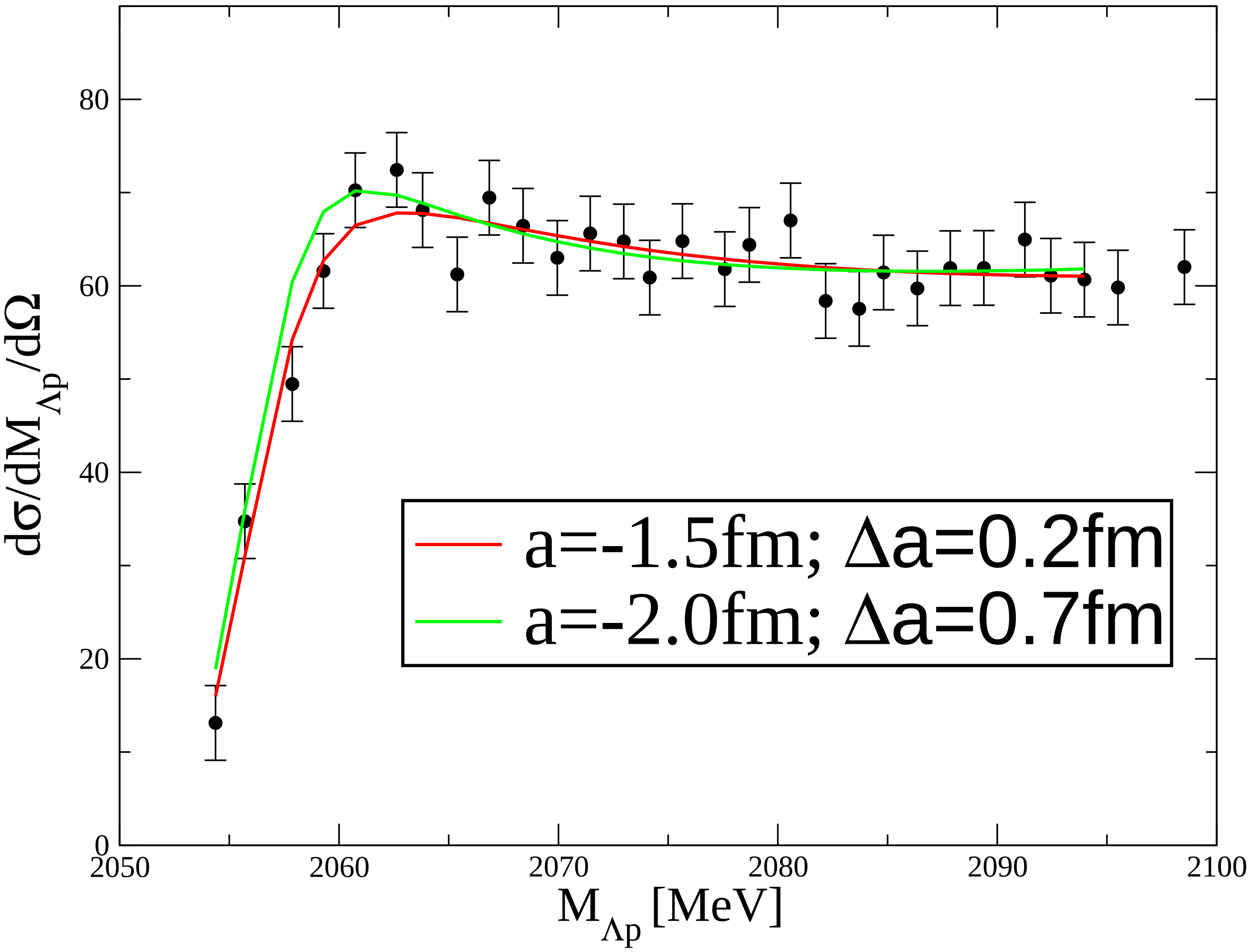
$$\frac{D_{yy}}{A_y} = Im\left\{ \exp\left[\frac{1}{\pi}\int_{s_0}^{\infty} \frac{\delta_s(m'^2) - \delta_t(m'^2)}{m'^2 - m^2 - i0} dm'^2\right] \times \Phi(s,t,m^2) \right\}$$

$$pp \to p\Sigma^+ K^0 \Longrightarrow a_{p\Sigma^+}$$

Testing the method

$$\frac{d\sigma}{dM_{\Lambda p}d\Omega} = C_0 \exp\{\frac{C_1}{C_2 - M^2_{\Lambda p}} + \ \ldots\}$$

$\times$Phase Space



Summary

- A method for the determination of the ΛN scattering lengths in a model independent way is presented.
- Theoretical errors are under control.
- The polarization observables allow one to separate spin singlet and spin triplet states.
- $\frac{D_{yy}}{A_y}$ possibly allows one to extract $a_s - a_t$.
- $pp \rightarrow p\Sigma^+ K^0 \Longrightarrow a_{p\Sigma^+}$.
- A good mass resolution is needed to get a reasonable accuracy in the determination of the $a_{\Lambda N}$.