ISHEPP XIX

JINR, Dubna

Study of Exotic States of Nuclear Matter using Lobachevsky Geometry. Separation of Narrow Resonances. Data Bases of Experiments with Bubble Chambers

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30 September 2008

Institute for Advanced Studies: Relativistic Nuclear Physics Research

- Educational programs
- Planning of experiments
- Verification of theoretical models
- Search of exotic states of nuclear matter
- Lobachevsky space
- Grassman and Clifford vector algebras
- Image recognition

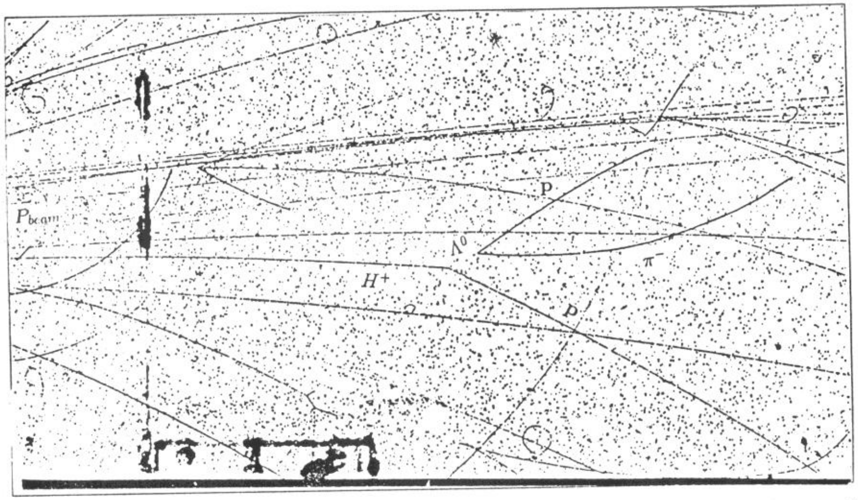


Figure 3: Three-body weak decay of the heavy, stable, positively charged dibaryon fits possible for two hypotheses: $H^+ \to p + \gamma + \Lambda^0$ and $H^+ \to p + \pi^0 + \Lambda^0$.

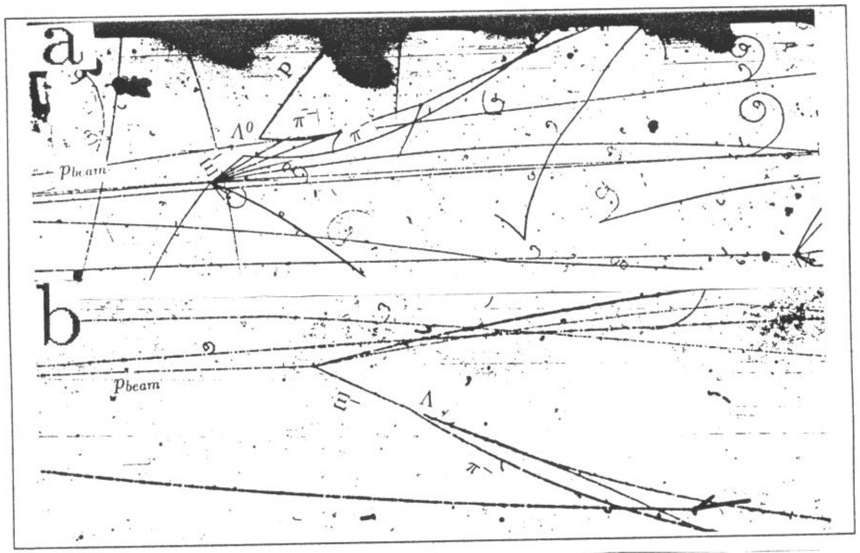
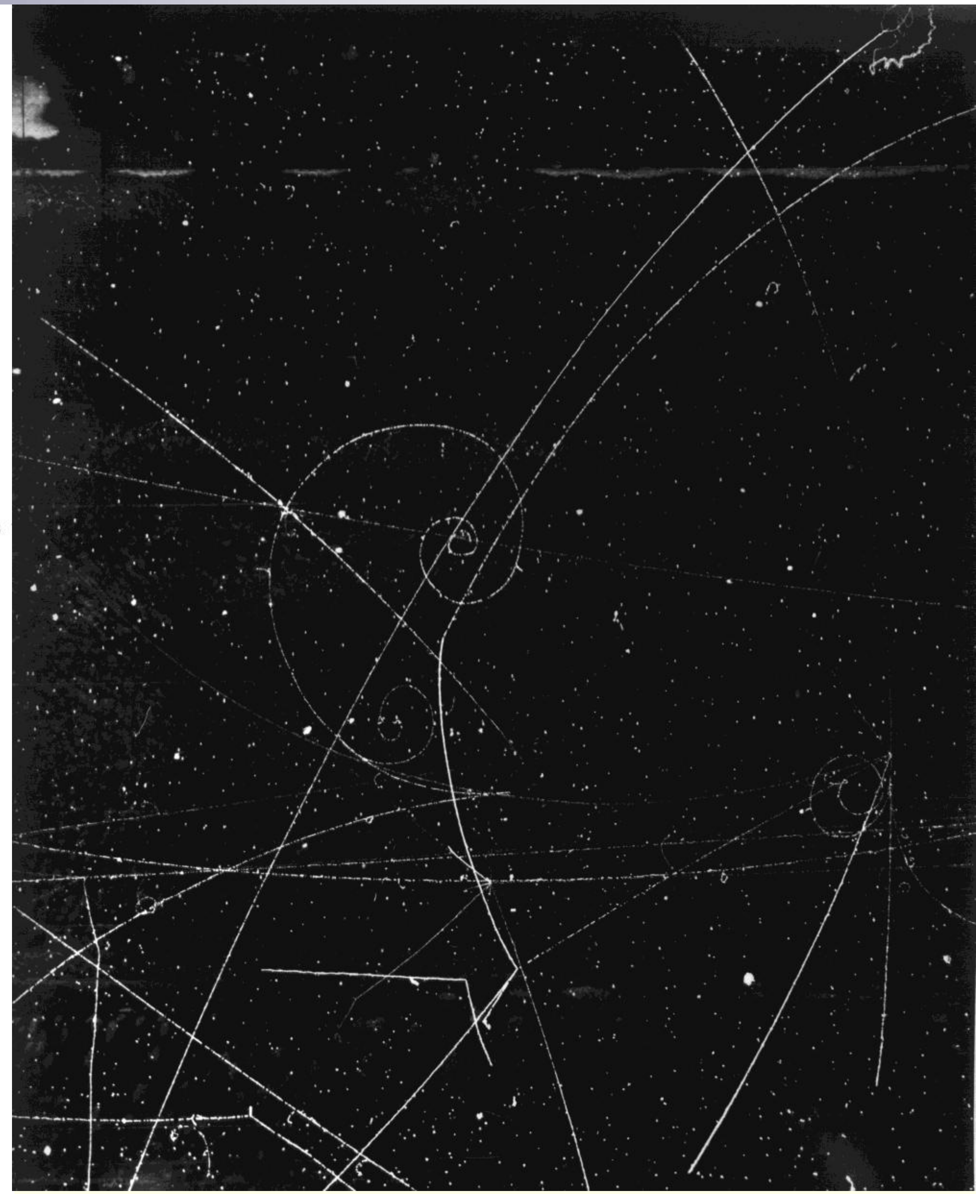
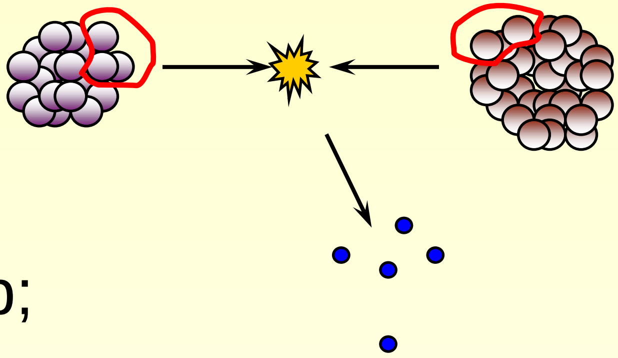


Figure 4: Two body weak decay Ξ^- hyperon $\to \pi^- + \Lambda$: a)first event;b) second event.



Data Bases of Experiments with Bubble Chambers

- 4.2 GeV p, d, He, C, Ta +CH;
- 4.2 GeV p, C + Ta;
- 10 GeV p + CH;
- 40 GeV π + CH (Protvino);
- 5.2, 3.8, 2.2, 1.7, 1.4 GeV/c n + p;
- 2.2, 1.7, 1.4 GeV/c d + p .



Data obtained at BNL, CERN;

Mirabell

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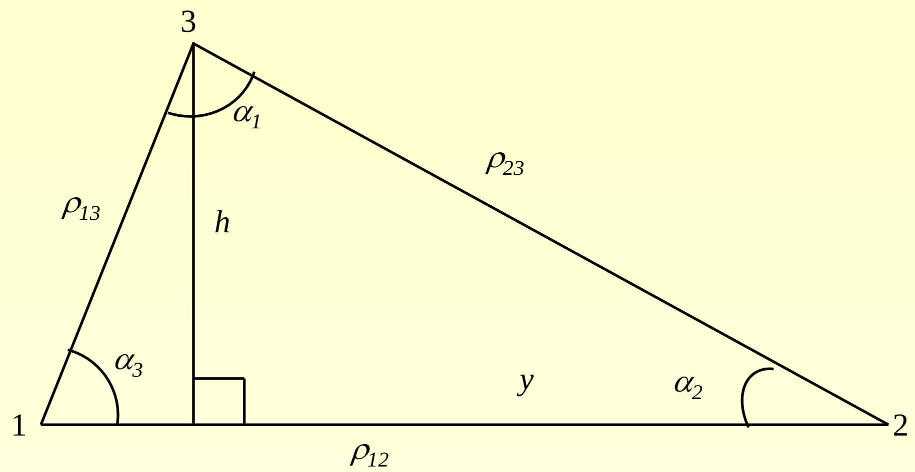
Collaboration

- Kazan State University
- Lobachevsky Institute of Mathematics and Mechanics
- University of Bucharest
- Maritime University of Constanta
- Fock Physics Institute, St. Petersburg State University

- Institute of Nuclear Physics, Moscow State University
- Samara State University
- Perm State University
- CERN

Lobachevsky Space



Longitudinal rapidity $y = \frac{1}{2} \ln \frac{E + p_{\parallel}}{E - p_{\parallel}}$

$$defect = \pi - \alpha_1 - \alpha_2 - \alpha_3$$

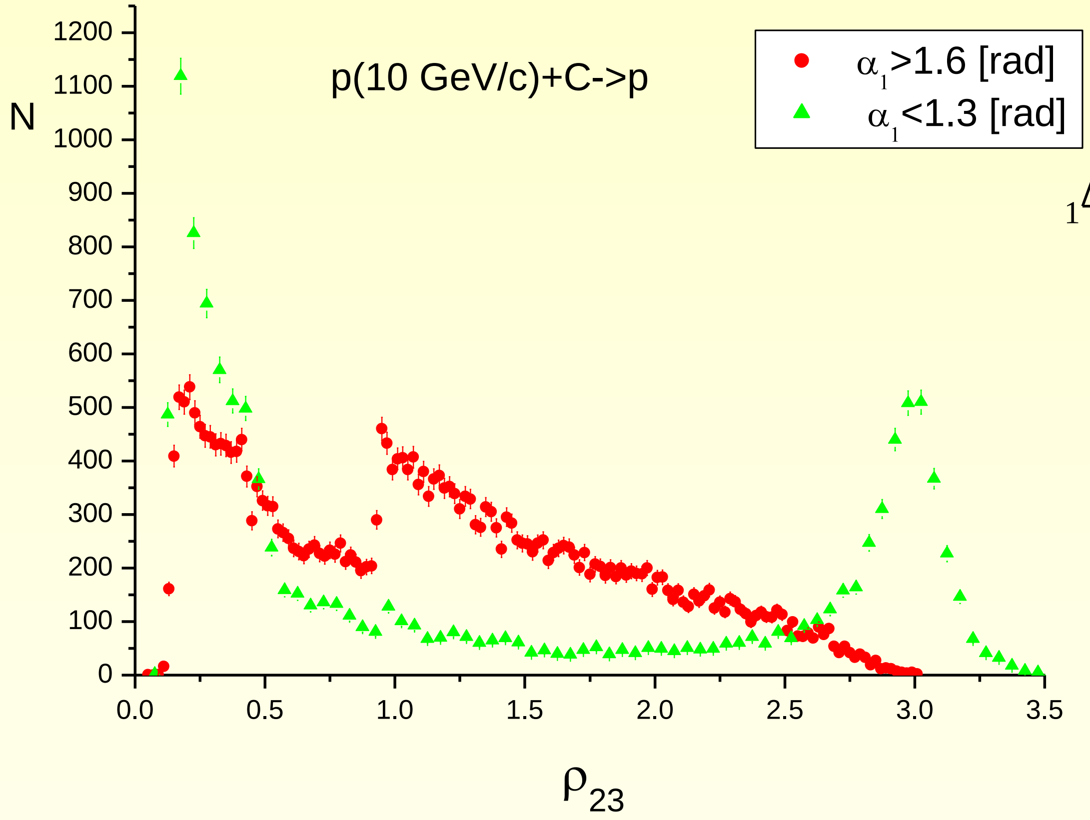
Transverse mass $m_T = \sqrt{m^2 + p_T^{\ 2}}$

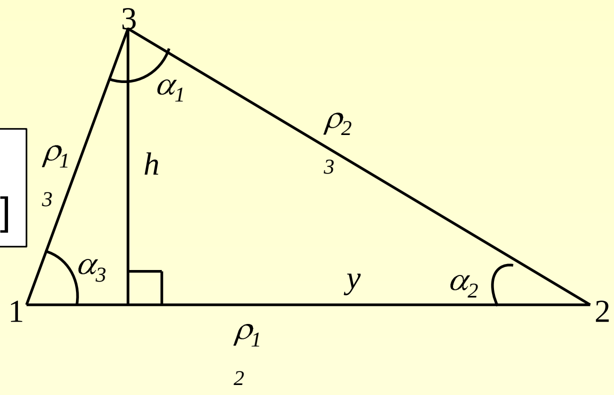
$$perimeter = \rho_1 + \rho_2 + \rho_3$$

Transverse rapidity $\mathrm{ch}\, h = \frac{m_T}{m}$

Angle of Parallelism $\Pi_L(h) = 2 \cdot arctg\left(e^{-h}\right)$

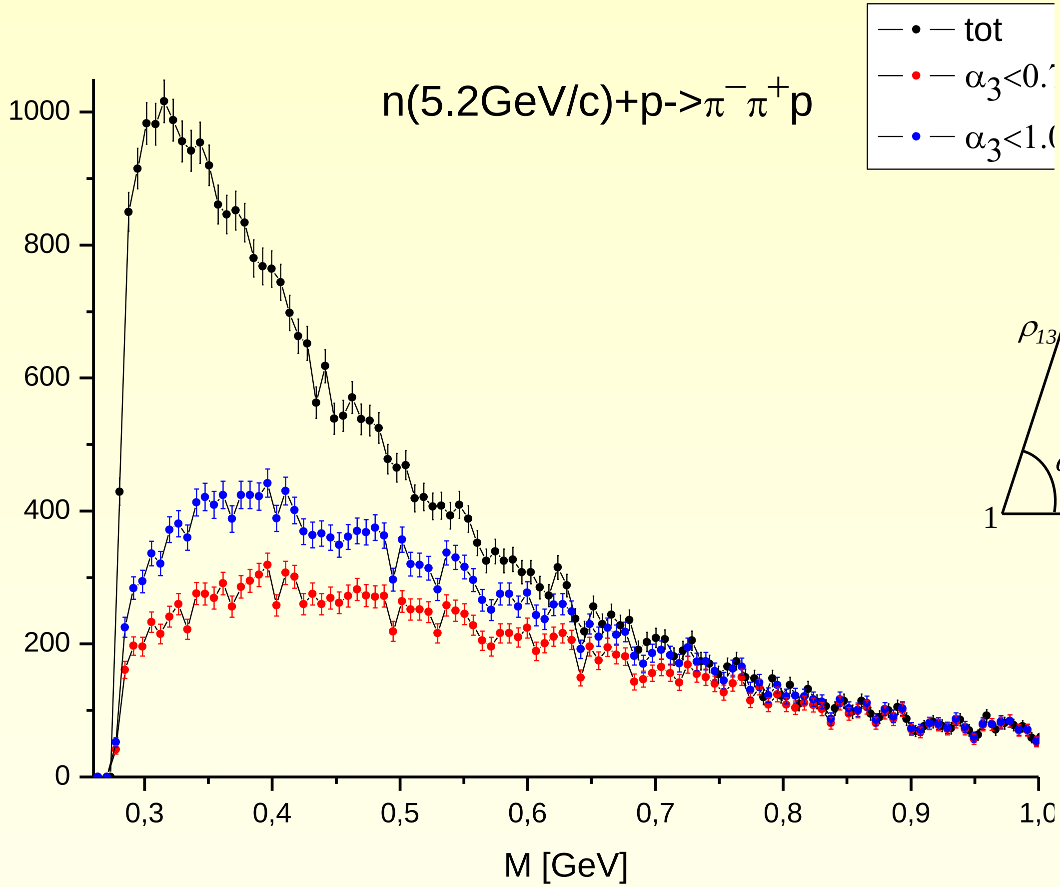
Proton distribution for two angular intervals in p(10GeV/c)+C



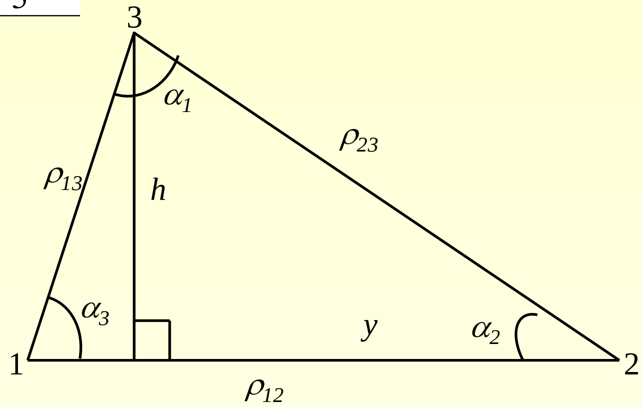


A. A. Baldin, E. G. Baldina, E. N. Kladnitskaya, O. V. Rogachevskii, Phys.Part.Nucl.Lett., vol. 1, no. 4, 7-16 (2004).

n+p->π- 5GeV

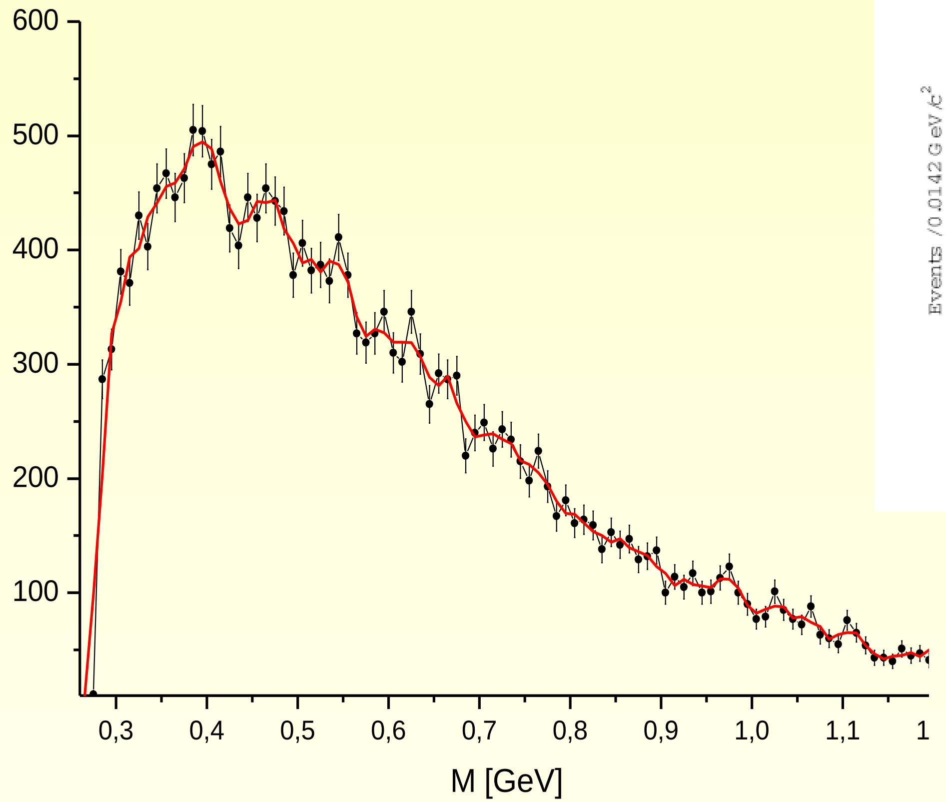


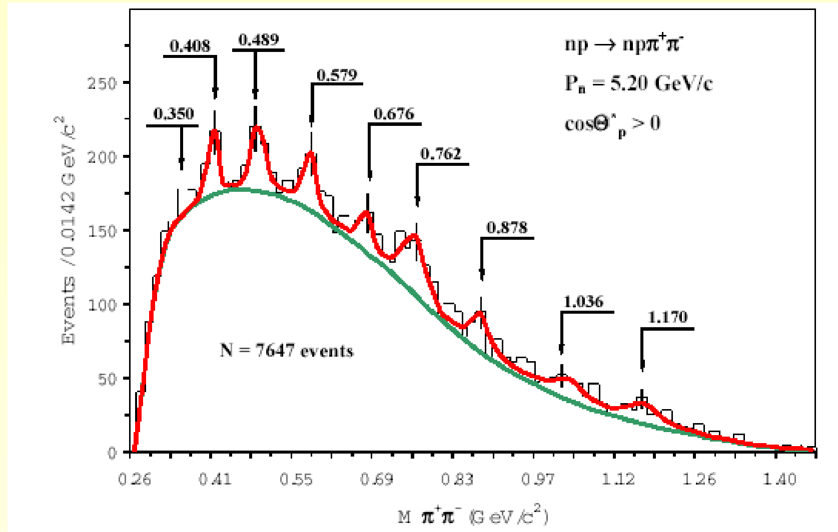
n(5.2GeV/c)+p->π⁻π⁺p
tot
α3<0.7
α3<1.0
1000
800
600
400
200
0
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1,0
M [GeV]



3
α1
ρ23
ρ13
h
α3
y
α2
1
2
ρ12

n+p->π- 5GeV





LOW-MASS (M<1.2 GeV/c^2) σ_0 - MESON PRODUCED IN THE SYSTEM $\pi^+\pi^-$ FROM THE REACTION np → np$\pi^+\pi^-$ AT P_n=5.20 GeV/c

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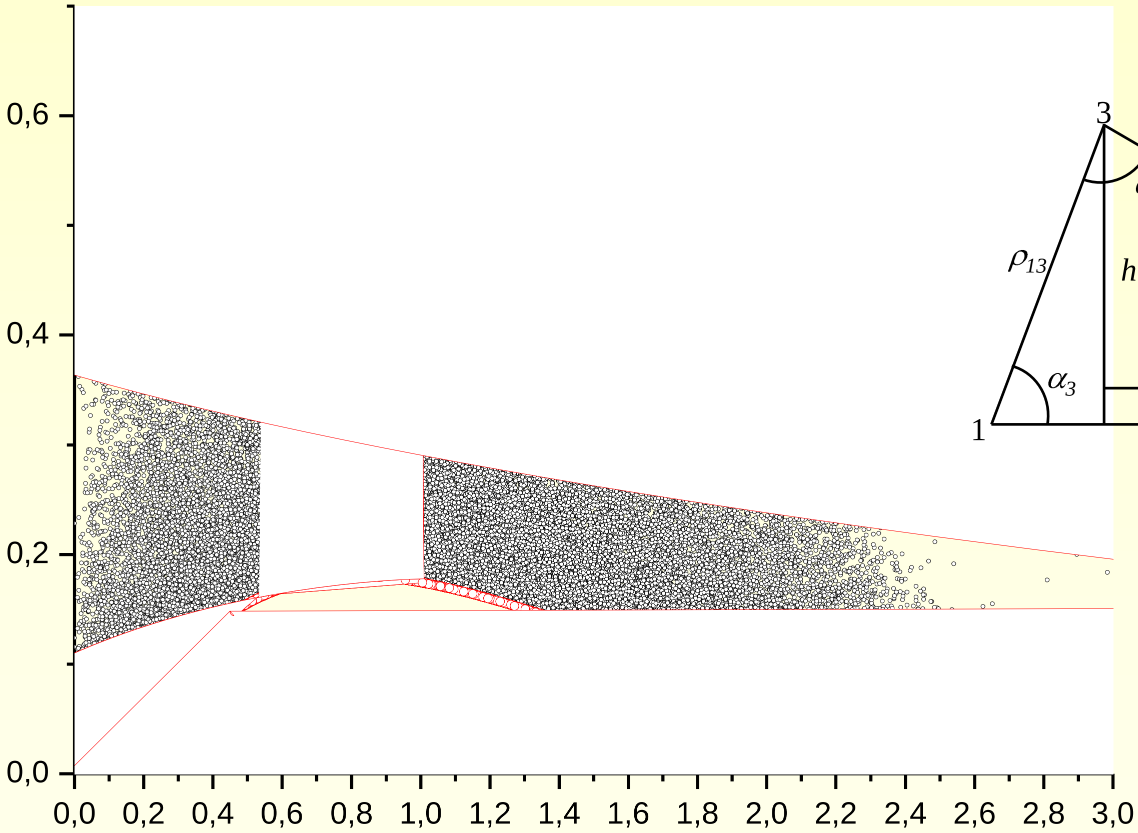
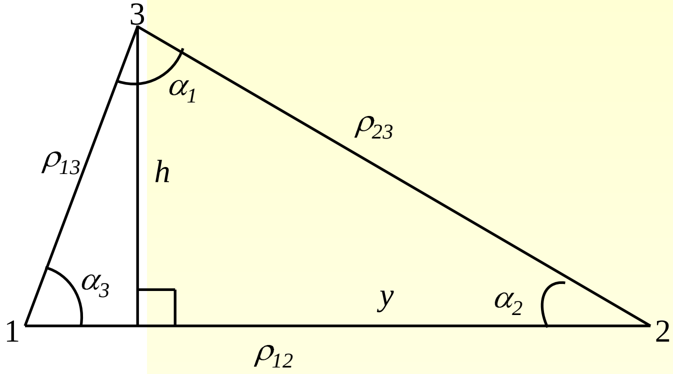
The investigation has been performed at the Veksler and Baldin Laboratory of High Energies, JINR Dubna, 2006.

Lobachevsky Space

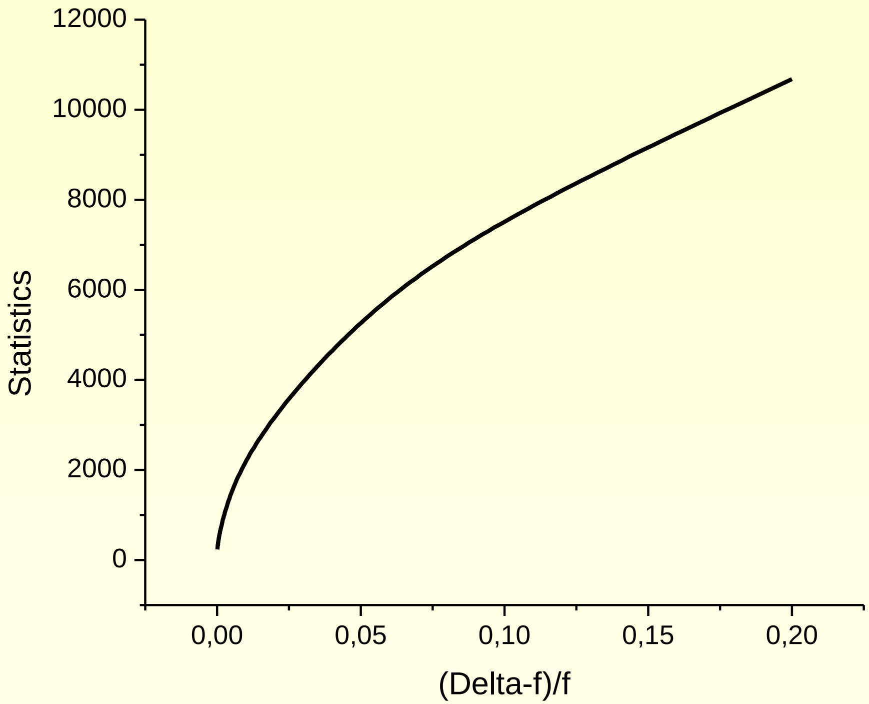
n+p->π^- 5GeV

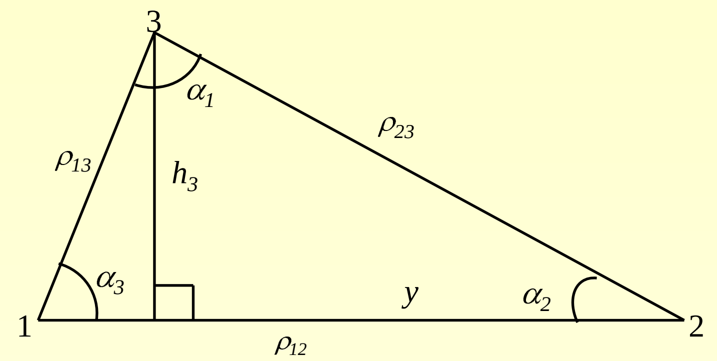




Lobachevsky Space

n+p->π^- 5GeV

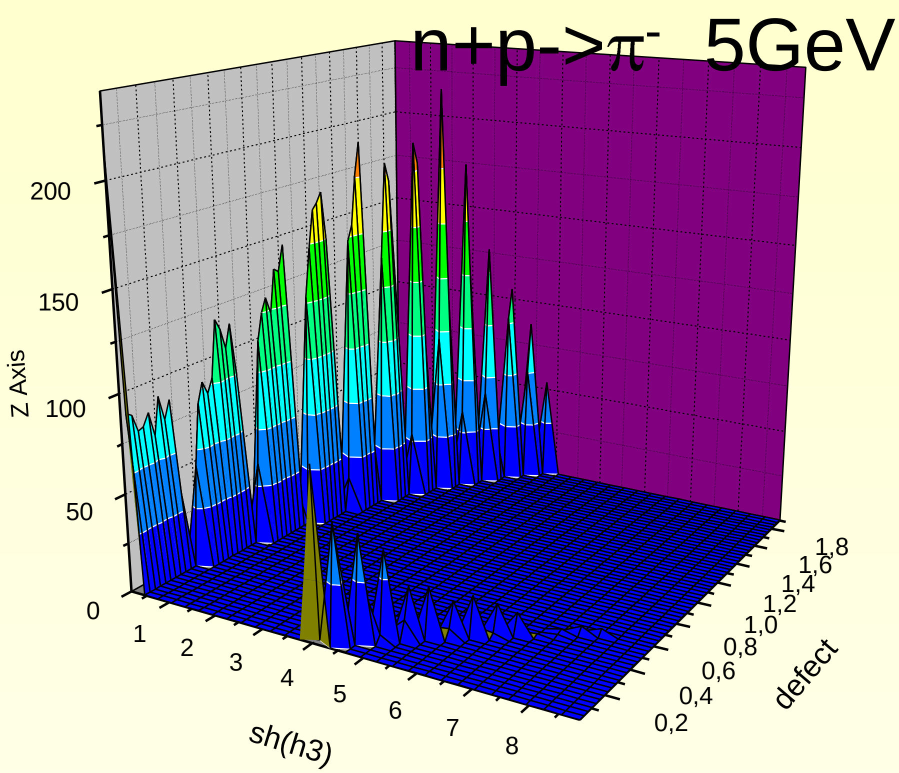


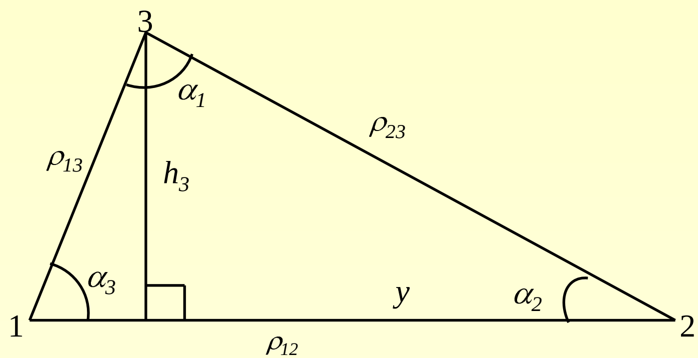


$$\Delta_{12}^{3} = 2\Pi_L(h_3) - \alpha_3$$

$$f(\rho) = 2\left(\Pi_L(\rho) - arctg\frac{th\left(\frac{\rho_1}{2}\right)}{sh(\rho)}\right)$$

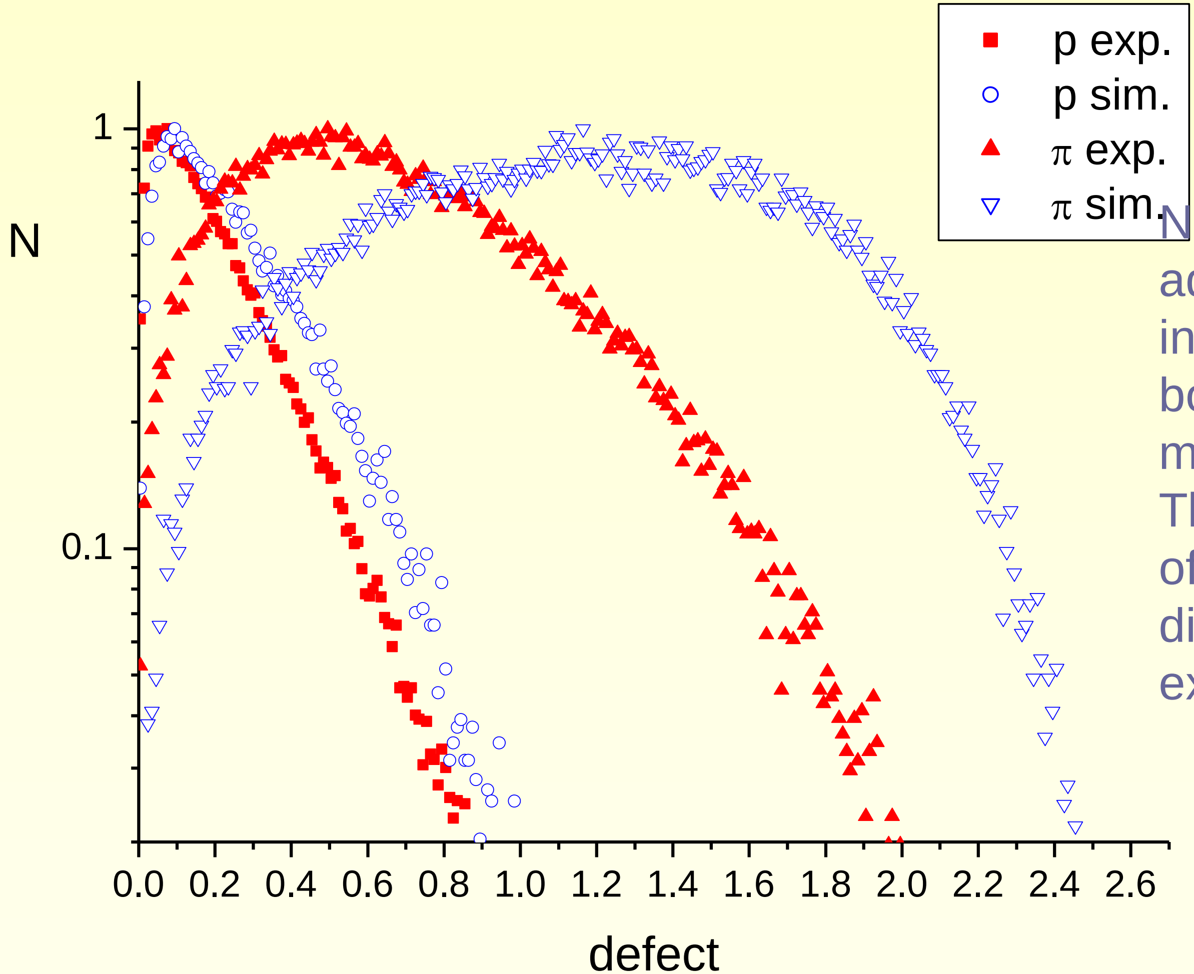
Lobachevsky Space





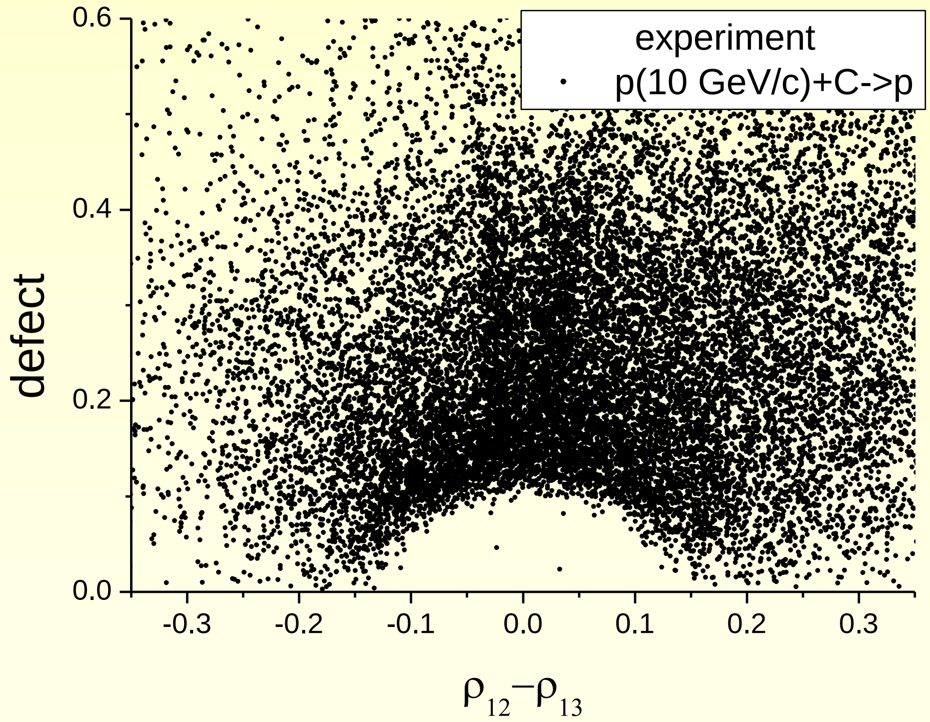
$$defect = \pi - \alpha_1 - \alpha_2 - \alpha_3$$

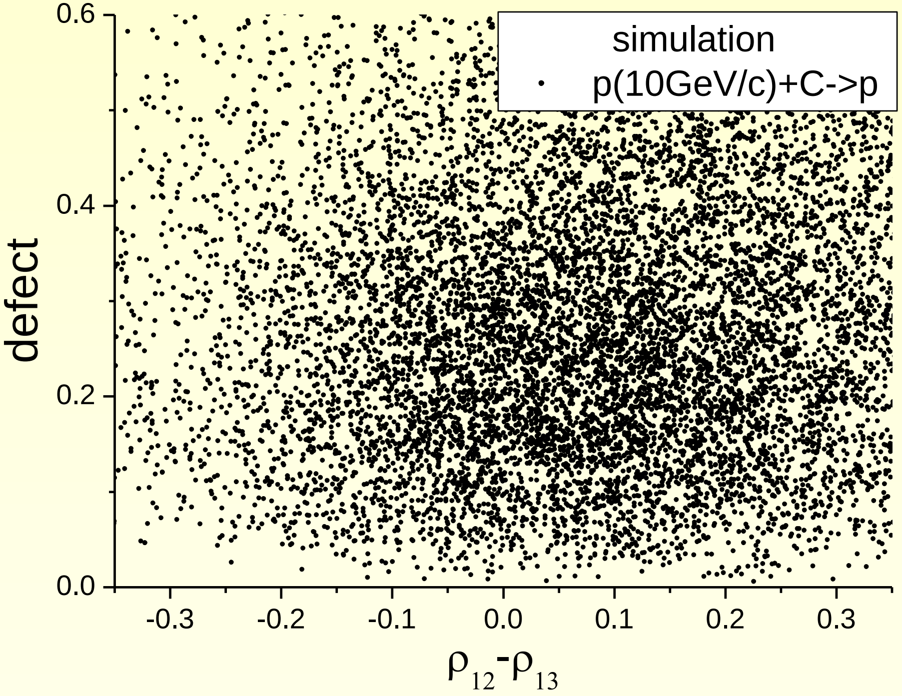
Normalized distributions of defects of triangles formed by all combinations of protons and all combinations of mesons registered in p(10GeV/c)+C

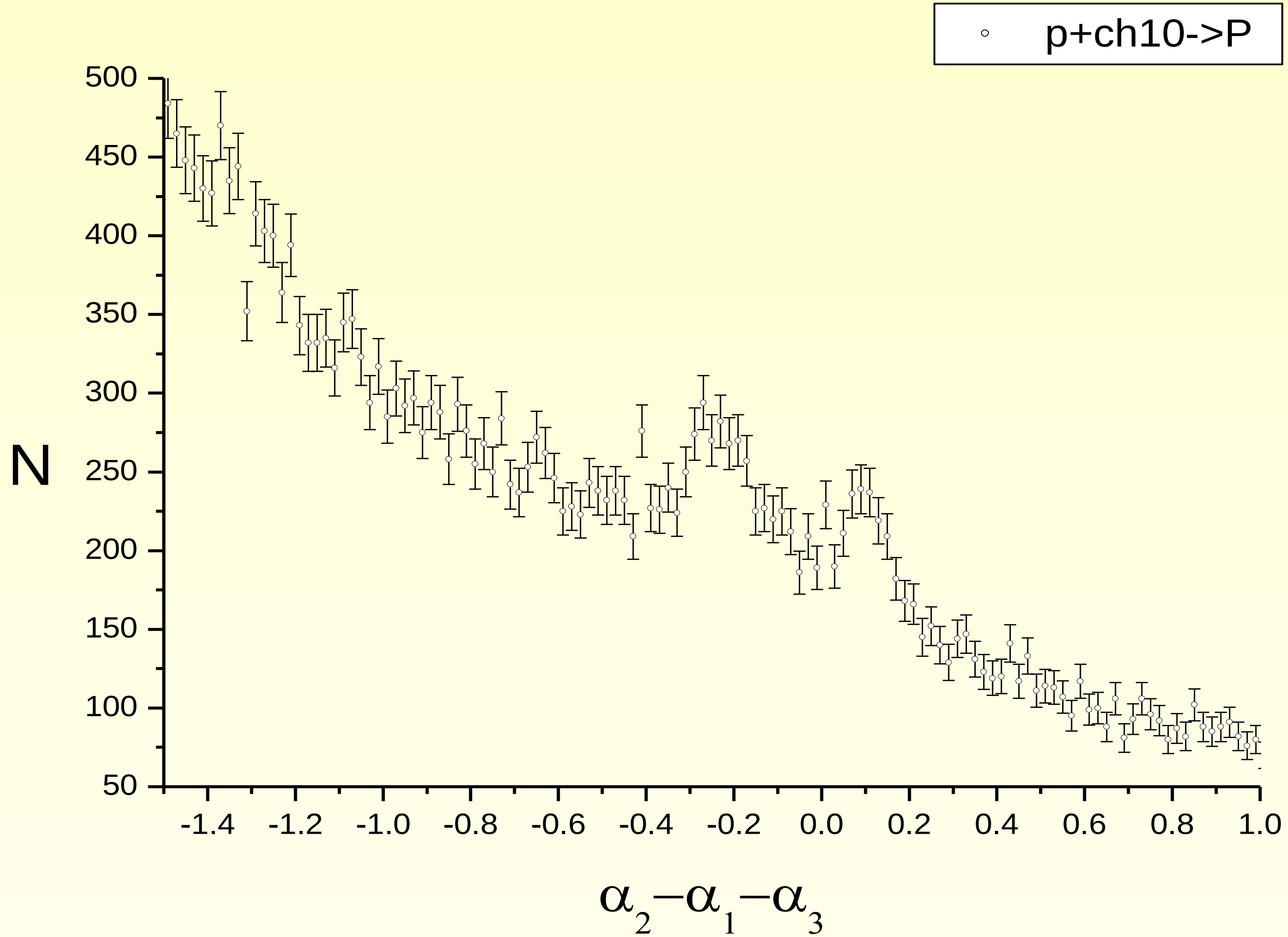


Note, that the model adequately reproduces inclusive spectra of both protons and π - mesons.

The distribution of trios of π-mesons, however, differs noticeably from experimental data.

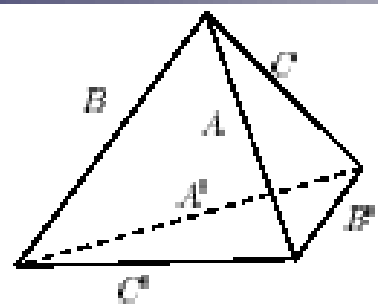

experiment
p(10 GeV/c)+C->p
defect
0.0
0.2
0.4
0.6
-0.3
-0.2
-0.1
0.0
0.1
0.2
0.3
$\rho_{12}-\rho_{13}$


simulation
p(10GeV/c)+C->p
defect
0.0
0.2
0.4
0.6
-0.3
-0.2
-0.1
0.0
0.1
0.2
0.3
$\rho_{12}-\rho_{13}$



p+ch10->P
N
500
450
400
350
300
250
200
150
100
50
-1.4
-1.2
-1.0
-0.8
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6
0.8
1.0
$\alpha_2-\alpha_1-\alpha_3$

Volumes of tetrahedra



$$\begin{aligned}
\alpha_1 &= \exp(i\overline{AB}); \quad \beta_1 = \exp(i\overline{BA}) \\
\alpha_2 &= \exp(i\overline{BC}); \quad \beta_2 = \exp(i\overline{CB}) \\
\alpha_3 &= \exp(i\overline{CD}); \quad \beta_3 = \exp(i\overline{DC}) \\
\alpha_4 &= \exp(i\overline{DA}); \quad \beta_4 = \exp(i\overline{AD}),
\end{aligned} \tag{17}$$

we obtain

$$\begin{aligned}
0 = \frac{1}{\alpha_1\alpha_2\alpha_3\alpha_4} - \beta_1\beta_2\beta_3\beta_4 + z^2(-\frac{\alpha_1}{\alpha_2\alpha_3\alpha_4} - \frac{\alpha_2}{\alpha_1\alpha_3\alpha_4} - \frac{\alpha_3}{\alpha_1\alpha_2\alpha_4} - \frac{\alpha_4}{\alpha_1\alpha_2\alpha_3} \\
+ \frac{\beta_1\beta_2\beta_3}{\beta_4} + \frac{\beta_1\beta_2\beta_4}{\beta_3} + \frac{\beta_1\beta_3\beta_4}{\beta_2} + \frac{\beta_2\beta_3\beta_4}{\beta_1}) \\
+ z^4(\frac{\alpha_1\alpha_2}{\alpha_3\alpha_4} + \frac{\alpha_1\alpha_3}{\alpha_2\alpha_4} + \frac{\alpha_2\alpha_3}{\alpha_1\alpha_4} + \frac{\alpha_1\alpha_4}{\alpha_2\alpha_3} + \frac{\alpha_2\alpha_4}{\alpha_1\alpha_3} + \frac{\alpha_3\alpha_4}{\alpha_1\alpha_2} \\
- \frac{\beta_1\beta_2}{\beta_3\beta_4} - \frac{\beta_1\beta_3}{\beta_2\beta_4} - \frac{\beta_2\beta_3}{\beta_1\beta_4} - \frac{\beta_1\beta_4}{\beta_2\beta_3} - \frac{\beta_2\beta_4}{\beta_1\beta_3} - \frac{\beta_3\beta_4}{\beta_1\beta_2}) \\
+ z^6(\frac{\beta_1}{\beta_2\beta_3\beta_4} + \frac{\beta_2}{\beta_1\beta_3\beta_4} + \frac{\beta_3}{\beta_1\beta_2\beta_4} + \frac{\beta_4}{\beta_1\beta_2\beta_3} \\
- \frac{\alpha_1\alpha_2\alpha_3}{\alpha_4} - \frac{\alpha_1\alpha_2\alpha_4}{\alpha_3} - \frac{\alpha_1\alpha_3\alpha_4}{\alpha_2} - \frac{\alpha_2\alpha_3\alpha_4}{\alpha_1}) + z^8(\alpha_1\alpha_2\alpha_3\alpha_4 - \frac{1}{\beta_1\beta_2\beta_3\beta_4}).
\end{aligned} \tag{18}$$

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ATG

The Regge symmetry is a scissors congruence in hyperbolic space

Yana Mohanty

$$\begin{aligned}
\overline{AB} &= \frac{A+A'+2B'}{4}; \quad \overline{BA} = \frac{2\pi+A-A'+2C'}{4} \\
\overline{BC} &= \frac{A+A'-2B'}{4}; \quad \overline{CB} = \frac{2\pi-A+A'-2C'}{4} \\
\overline{CD} &= \frac{-A-A'-2B}{4}; \quad \overline{DC} = \frac{2\pi-A+A'+2C}{4} \\
\overline{DA} &= \frac{-A-A'+2B}{4}; \quad \overline{AD} = \frac{2\pi+A-A'-2C'}{4}.
\end{aligned} \tag{21}$$

$$\begin{aligned}
(T) = \text{Л}(\overline{AB}+\arg z_-) + \text{Л}(\overline{BA}-\arg z_-) + \text{Л}(\overline{BC}+\arg z_-) \\
+ \text{Л}(\overline{CB}-\arg z_-) + \text{Л}(\overline{CD}+\arg z_-) + \text{Л}(\overline{DC}-\arg z_-) \\
+ \text{Л}(\overline{DA}+\arg z_-) + \text{Л}(\overline{AD}-\arg z_-) + \frac{1}{2}[\text{Л}(\frac{\pi+A-B-C}{2} \\
- \text{Л}(\frac{\pi+B-A-C}{2}) - \text{Л}(\frac{\pi+C-A-B}{2}) + \text{Л}(\frac{\pi+B'-A'-C}{2}) \\
+ \text{Л}(\frac{\pi+A+B+C}{2}) + \text{Л}(\frac{\pi+C-A'-B'}{2}) + \text{Л}(\frac{\pi-A'+B'+C}{2}) \\
- \text{Л}(\frac{\pi+A'+B'+C}{2}) + \text{Л}(\frac{\pi+A'-B-C'}{2} - \text{Л}(\frac{\pi+A+B'+C'}{2}) \\
- \text{Л}(\frac{\pi+A-B'-C'}{2}) + \text{Л}(\frac{\pi+B'-A-C'}{2}) - \text{Л}(\frac{\pi-A'-B+C'}{2}) \\
\text{Л}(\frac{\pi+A'-B+C'}{2}) + \text{Л}(\frac{\pi+A'+B+C'}{2}) + \text{Л}(\frac{\pi-A-B'+C'}{2})],
\end{aligned} \tag{23}$$

where the quantities with bars are given by (21), and z_- is the solution of the quadratic equation (18) with the negative square root.