# DUBNA
# Baldin ISHEPP XXII, September 15-20, 2014

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## Symmetry, small parameters and spin-particle reactions

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Small parameters at asymptotic energies we have in two approaches …

# A.M. BALDIN - 2014

## Dubna

## Internat. conf.

- Russia
- Germany
- Italy
- USA
- GB (Engl. Scotland) ...

Russia
USA
Georgia
.. ..

Charl - 2014
Moscow.

Internat. colaborat

18.09.2014

Scotland

YES

or

NO ?

(to be or not to be).

Macloren

# Mclorem (UK Scotland)

$$f(x) = \sum_{1}^{\infty} a_n x^n$$

$x_n \sim 0$ Small parameter

$$a_0 + a_1 x + a_2 x^2 + \cdots$$

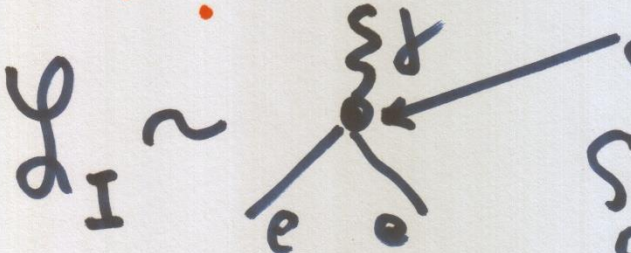
Hierarchy $(a_n \sim a_x)$

$$a_0 > a_1 x > a_2 x^2 > \cdots$$

Perturbation theory

# Feyman (USA)

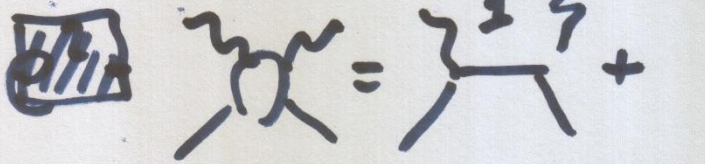
EM-interact.

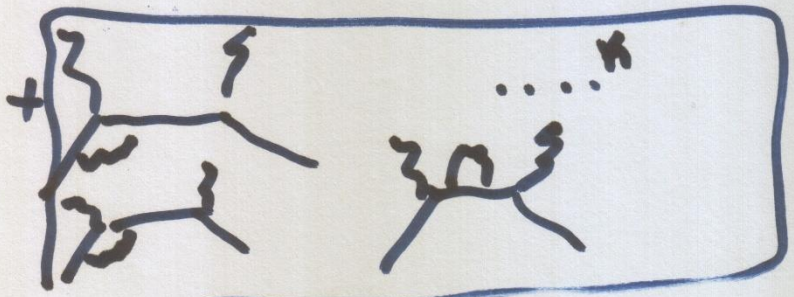


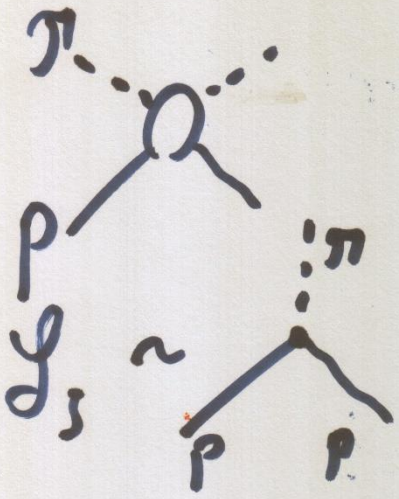

$\alpha = \frac{1}{137} = e^2$

Small parameter

$$S = \sum (e^2)^n S_n \qquad (S_n \sim f_n)$$








$g_s \sim$

Strong Interv.

$g \approx 14.$

no small parameter

$$f = f_0 + g^2 f_1 + g^4 f_2 + \dots \; ?$$

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General approach

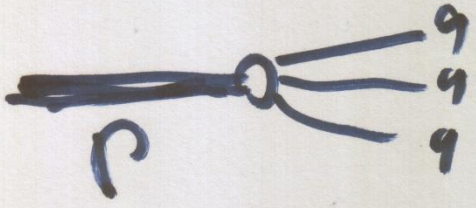
DR. S-matrix.

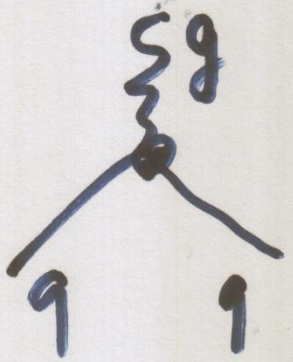
Dubna

N.N. Bogolyubov

$$f(x) = f_0 + \int_0^\infty \frac{f(t)dt}{t-t} \dots$$

# QCD

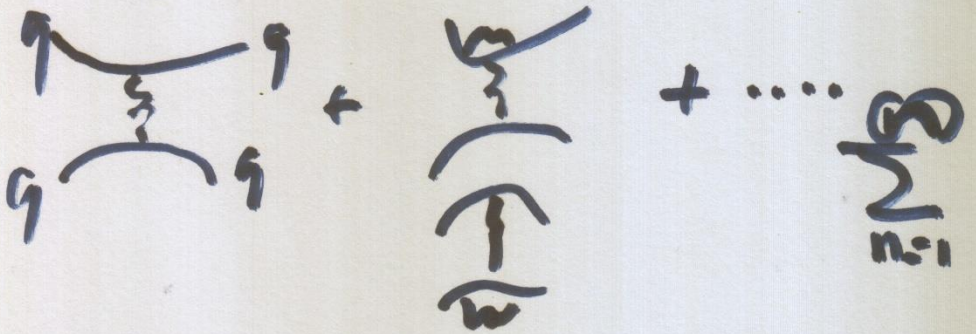



$\alpha(P_\perp)$.

Dynamic small parameter

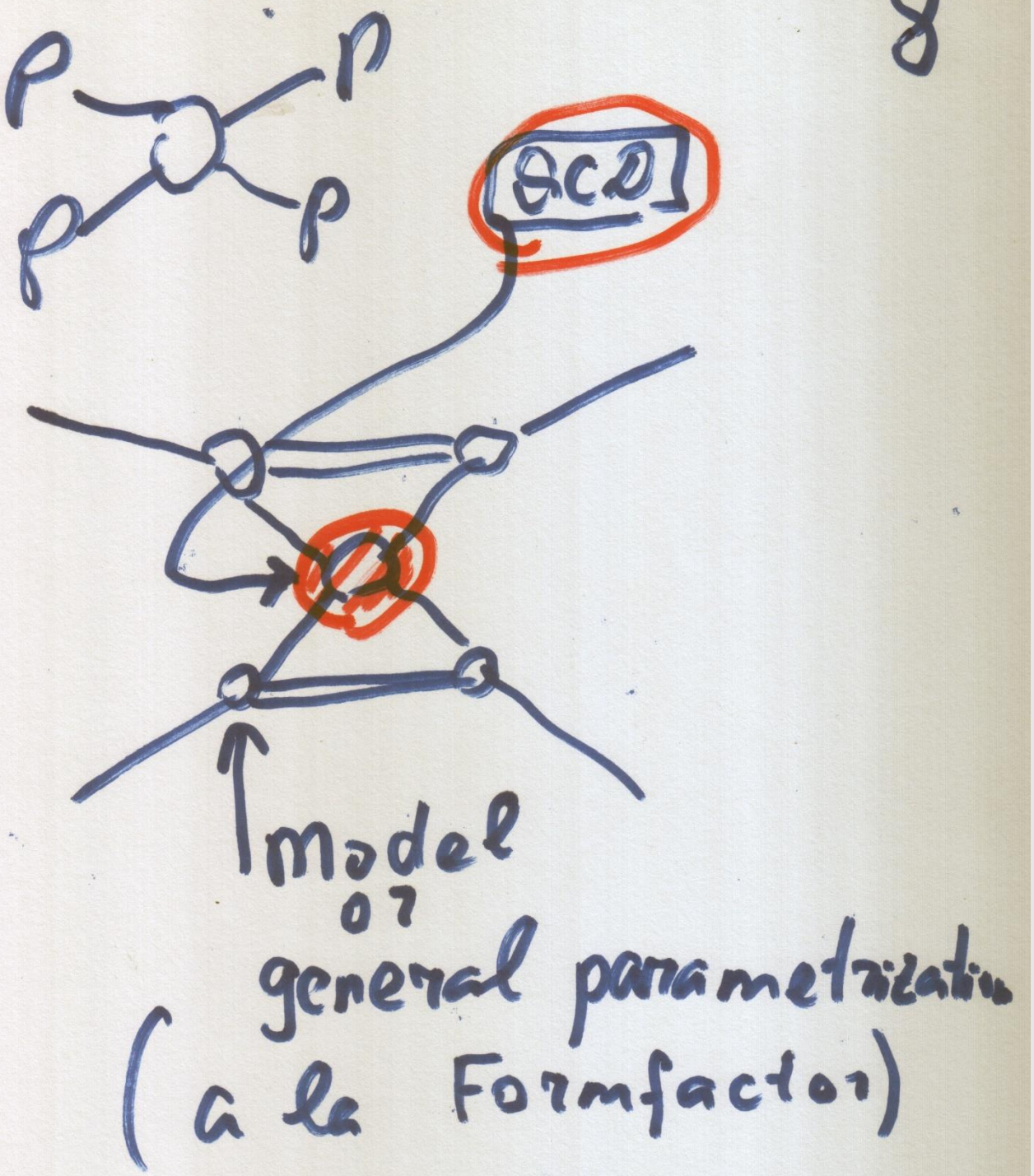
$P_\perp \to \infty$.




I approx

II app

Pertubat. theory

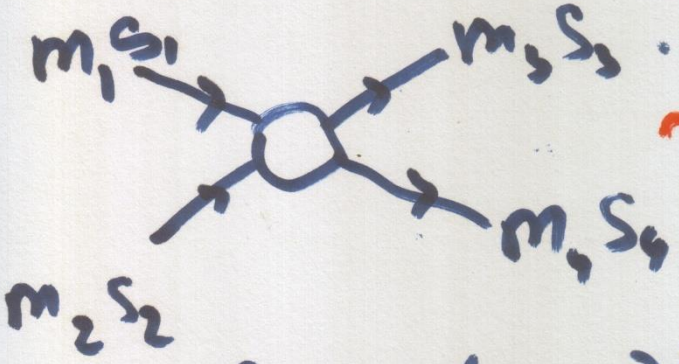

p
p
p
p
BCD
model
or
general parametrization
(a la Formfactor)

# SYMMETRY

↳ Conservation $E, \vec{P}, J$.

particle.

Symmetry: m, Spin.




$\sim f_{\lambda_3 \lambda_4 \lambda_1 \lambda_2}(s,t)$

$N = (2s_1+1)(2s_2+1)(2s_3+1)(2s_4+1)$

functions (Amplitudes).

Helicity amplitudes

$\theta = 0$. ⟶ ⟵

Additional Symmetry

$N \to n$

$\theta = \pi$. $N \to \kappa$.

$$f_{\lambda_i} = \underbrace{\left(\sin\frac{\theta}{2}\right)^{|\lambda-\mu|}\left(\cos\frac{\theta}{2}\right)^{|\lambda+\mu|}}_{\text{Kinematic factors (Conservation, inv...)}} \hat{f}_{\lambda_i}$$

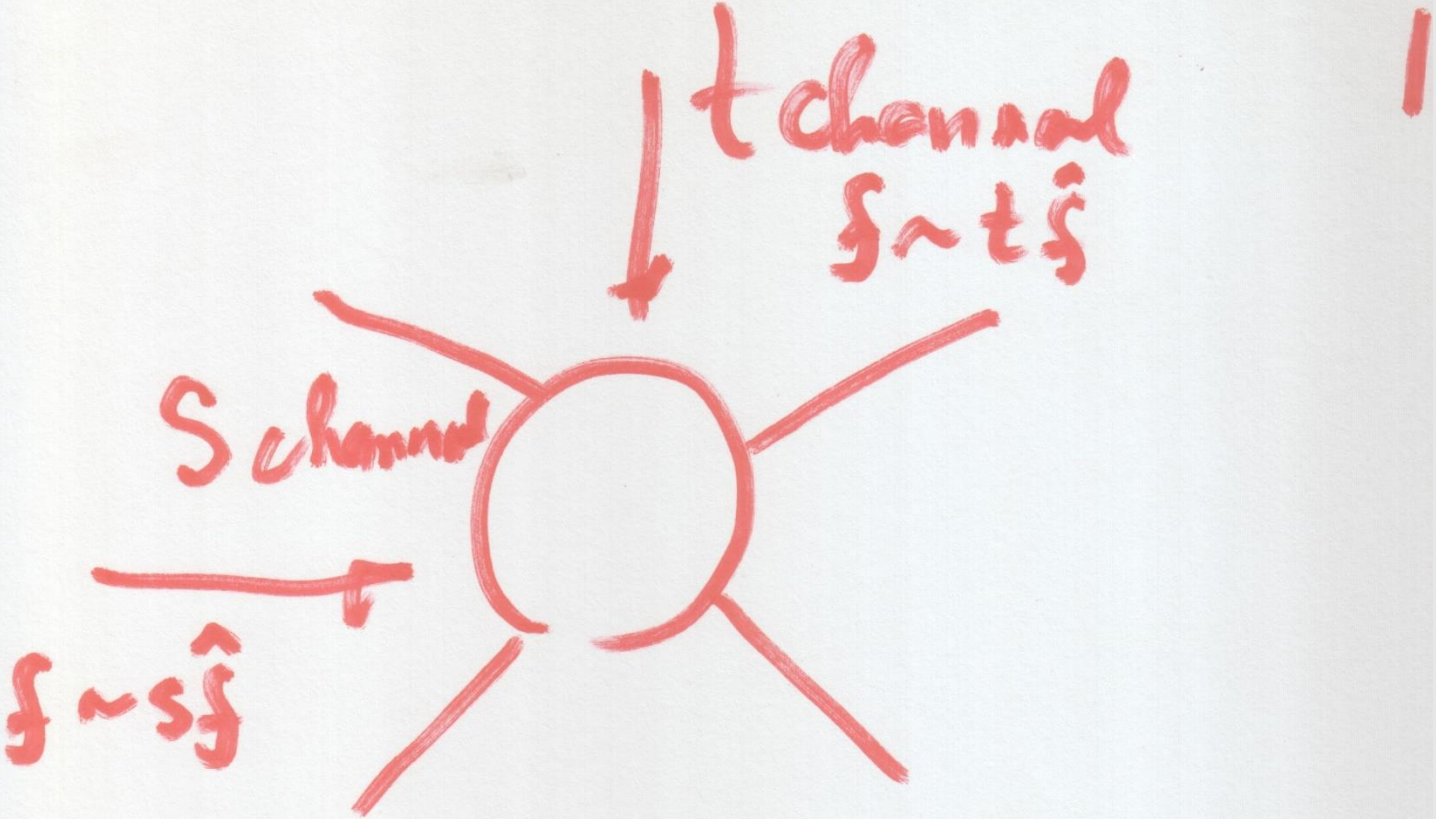
as $\theta \to 0$

$\sin\frac{\theta}{2}$ ~ small param. (SP)

$\theta \to \pi$

$\cos\frac{\theta}{2}$ ~ SP

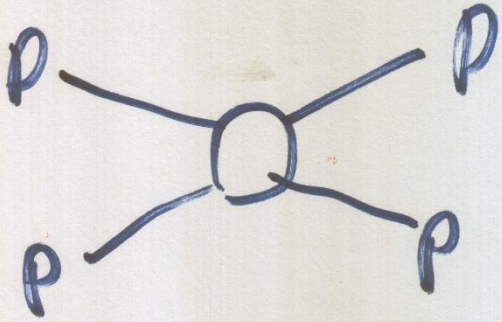
OK




Crossing SYMMETRY

$$f_{\lambda_i} = \sum K_{\vec{\lambda}}(s,t) \cdot D_{\vec{\lambda}}(s,t)$$

Kinematics Dynamics




$mm \to mm$ Spin-0 mj

$$f \sim \left(\frac{\sqrt{\cdot\cdot}}{m}\right)^{\cdot\cdot}\left(\frac{\sqrt{\cdot\cdot}}{m}\right)^{\cdot\cdot}\left(\frac{\sqrt{\cdot\cdot}}{m}\right)^{\cdot\cdot} D$$

$\sqrt{\cdot\cdot}$

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$pp \to pp$

$$f_1 = \left(\frac{m}{\sqrt{s}}\right)^2 D_1 \qquad f_4 = \sin^2\frac{\theta}{2} D_4$$

$$f_2 = \left(\frac{m}{\sqrt{s}}\right)^2 D_2 \qquad f_5 = \frac{\sqrt{s}}{m} D_5$$

$$f_3 = \cos^2\frac{\theta}{2} D_4$$

E ↑ $\boxed{\frac{m}{\sqrt{s}} \ll 1}$ Small parameter.

# Hierarchy

$|S_3\rangle \gg \square, \square \gg \square, \square$

$\theta = 90° \quad f_5 = 0.$

$$A_{nn} = \frac{2\,\mathrm{Re}(f_3 f_4^*)}{f_3^2 + f_4^2} \to 1.$$

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IF: $\left(\frac{m}{\sqrt{s}}\right)^4 D_1 D_1^* \ll \frac{1}{4}\sin^2\theta\, D_3 D_3^*$

$A_{nn} \to 1$

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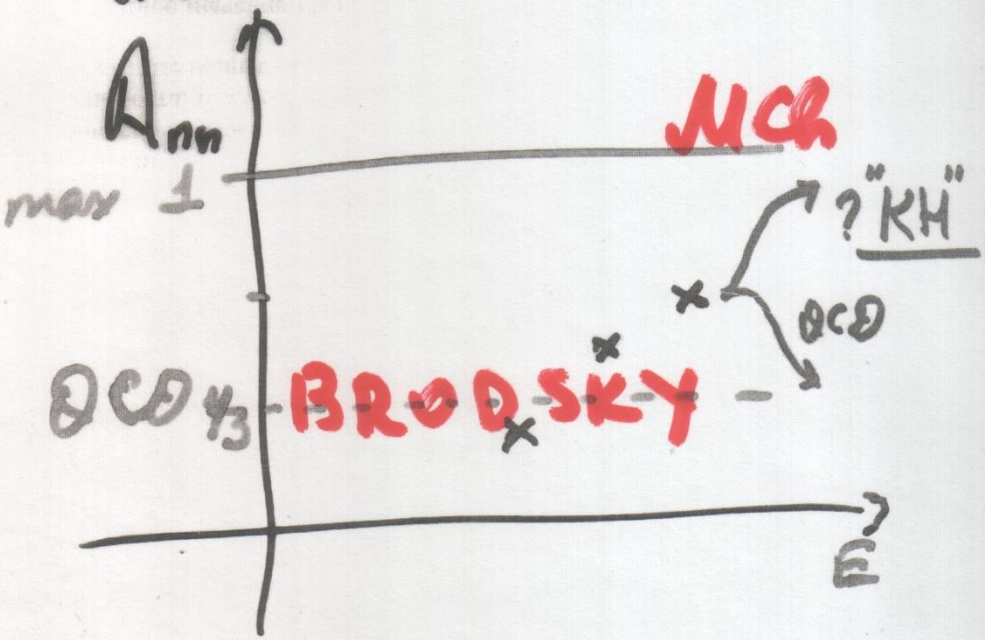
Parameters: $A_{nn}$ $A_N$ $A_{el}$

$\frac{d\sigma}{d\Omega}$ - cross section.




$A_{nn}(3,81) = 0,26$ A.D. Krisch (1985)

$(4,79) = 0,52$ G. Bunce et al. (1992)

$(5,56) = 0,59$

$T_{p_\perp^2}$ (Gev)$^2$

FORMALISM FOR HELICITY AMPLITHDES FOR ANY MASSES AND ARBITRARY SPIN

2 PARTICLE --- 2 JETS

2PARTICLE --- N PARTICLE REACTIONS

A lot of diagrams …

Helisity approach …

Small parameters at asymptotic energies we have in two approaches …

Благодарности:

IVAN !