EFFECTS OF GLUON POLARIZATION IN THE DURHAM POMERON

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PLAN OF THE TALK

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2. Pomeron and the Durham model
3. Numerical example
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1. INTRODUCTION

According to the present-day point of view, diffractive processes are to be understood in terms of two-gluon exchange mechanism, and the old concept of Pomeron has to be replaced with a new field theory object, the generalized two-gluon distribution function. It is not yet clear, however, to what extent does the two-gluon language fit the known properties of conventional Pomeron [1]. Durham model [2].

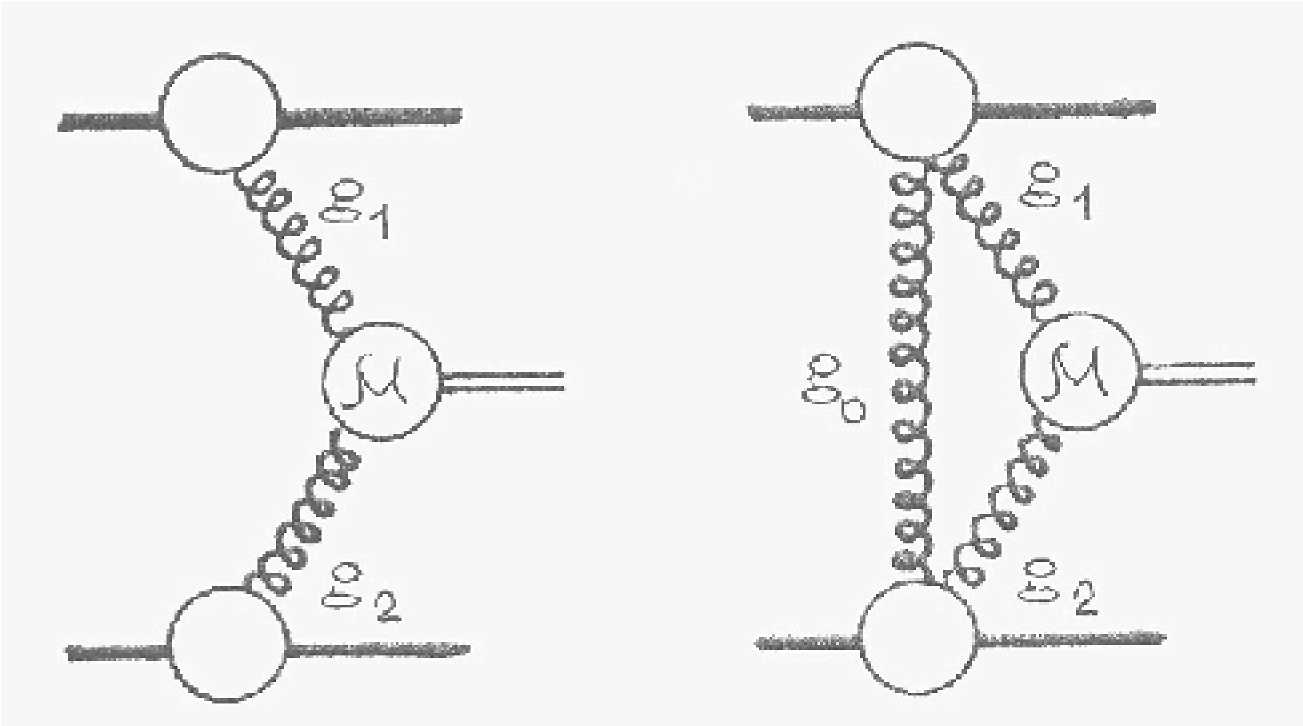
The Pomeron is considered to be a scalar object with positive parity, $J^{PC} = 0^{++}$, hence, the polarization vectors of the both gluons must be parallel to each other.

Do we have any chance to verify this prediction experimentally?

The answer is yes, see below.

The idea is to compare the production cross sections of pseudoscalar and scalar mesons in inclusive and exclusive channels.

2. POMERON IN THE DURHAM MODEL



Inclusive Exclusive

An important element in common, the gluon-gluon fusion subprocess.
Sensitive to corrrelations between the gluon polarization vectors.

PROPERTIES OF THE GLUON-GLUON FUSION

Interaction Lagrangians (for on-shell gluons)

$$\mathcal{L}(gg0^+) \propto e_1^\mu e_2^\nu g_{\mu\nu} \quad \text{results in} \quad d\sigma/d\varphi \propto \cos^2\varphi \qquad (1)$$

$$\mathcal{L}(gg0^-) \propto \epsilon_{\mu\nu\alpha\beta} e_1^\mu e_2^\nu k_1^\alpha k_2^\beta \quad \text{results in} \quad d\sigma/d\varphi \propto \sin^2\varphi \qquad (2)$$

where φ is the azimuthal angle between the recoil protons.

In the inelastic case, the gluons g_1 and g_2 are uncorrelated and contribute to the production of both pseudoscalar and scalar mesons.

In the diffractive case, the presence of an additional gluon g_0 makes all the gluons polarized in the same plane. Then, the production of scalar mesons is allowed, while the production of pseudoscalar mesons is suppressed or forbidden.

3. NUMERICAL EXAMPLE

Production of $\eta_c\,(J^{PC}=0^{-+})$ and $\chi_c\,(J^{PC}=0^{++})$ mesons.

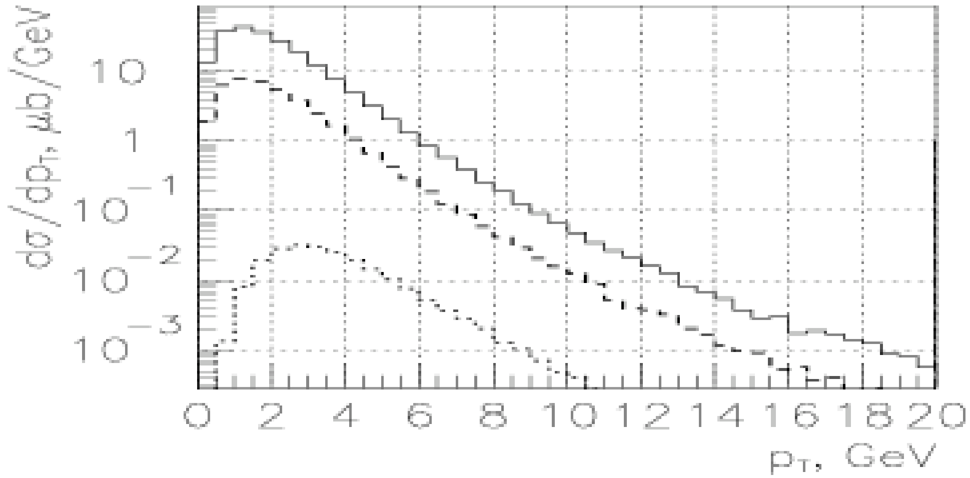
Approach:
perturbative QCD and nonrelativistic bound state formalism.
Perturbative creation of a heavy quark pair, where spin projection operators [3, 4] guarantee the proper quantum numbers.

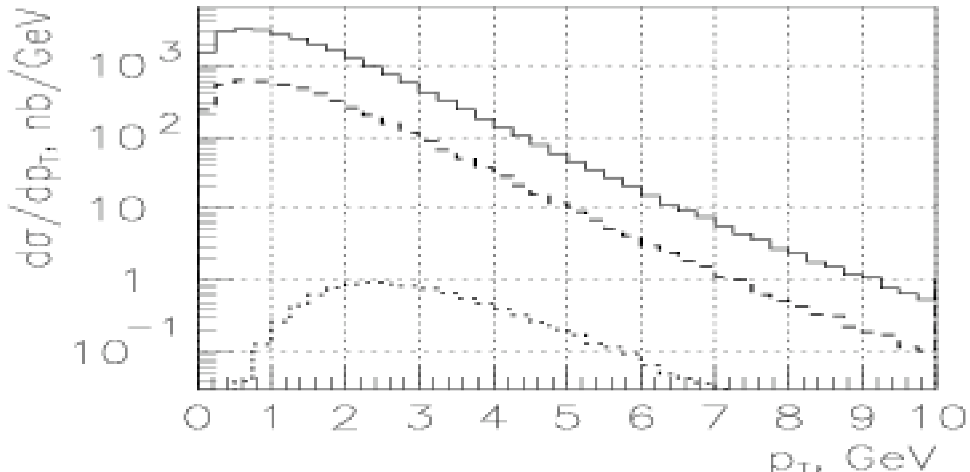
$$\mathcal{P}(^1S_0) \equiv \mathcal{P}(S{=}0, L{=}0) \;=\; \gamma_5\,(\not{p}_c + m_c)/(2m_c)^{1/2} \quad (3)$$
$$\mathcal{P}(^3P_0) \equiv \mathcal{P}(S{=}1, L{=}1) \;=\; (\not{p}_{\bar{c}} - m_c)\;\not{\epsilon}_S\,(\not{p}_c + m_c)/(2m_c)^{3/2} \quad (4)$$

Gluon polarization vectors are taken in the form [5] $e^\mu = k_t^\mu/|k_t|$. Fits both collinear and k_t-factorization. Standard calculation of the matrix elements, then convoluted with unintegrated gluon distributions [6].

Probability of forming a meson is determined by the wave function.
$|\mathcal{R}_\eta(0)|^2 = |\mathcal{R}_\psi(0)|^2 = 0.8\ \mathrm{GeV}^3$, known from leptonic decay width;
$|\mathcal{R}'_\chi(0)|^2 = 0.075\ \mathrm{GeV}^5$, taken from potential model [7].

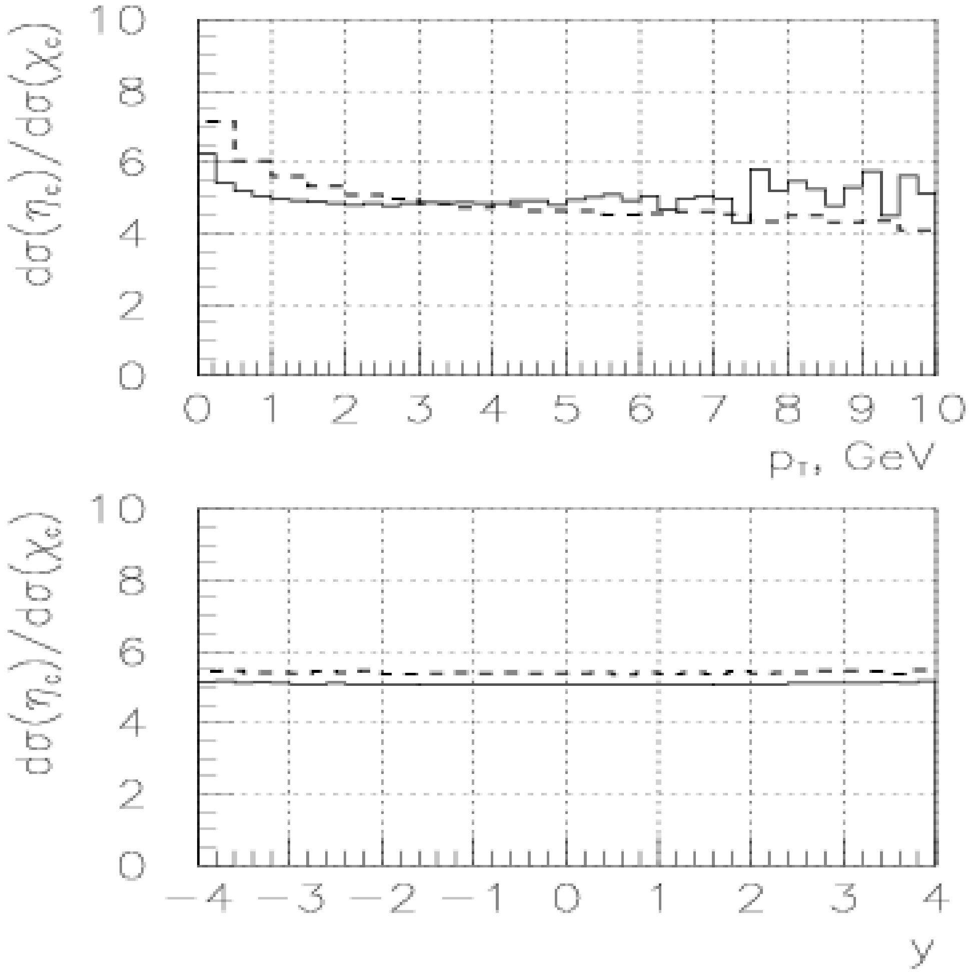
Inclusive p_t distributions at the Tevatron and RHIC





Solid, η_c from gluons with perpendicular polarization vectors; dashed, χ_c from gluons with parallel polarization vectors; dotted, χ_c from gluons with perpendicular polarization vectors

Ratio of the production rates $d\sigma(\eta_c)/d\sigma(\chi_c)$



Solid histograms, RHIC conditions;
dashed histograms, Tevatron conditions.

4. CONCLUSIONS

Measuring the production cross sections of pseudoscalar and scalar mesons in inclusive and exclusive channels can yield important information on the polarization state of the interacting gluons.

Would be extremely useful if these measurements are accompanied by measuring the azimuthal dependence of the cross section.

Whether or not will the Durham model receive support from the data, the information obtained by these measurements will shed more light on the nature of diffractive processes and, in particular, will stimulate further refinement of the concept of generalized gluon distributions.

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