2 meson Generalized Distribution Amplitudes: a useful tool for B decay study ?

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Success of partonic description of exclusive processes

- $\gamma^* N \to \gamma N'$ and $\gamma^* N \to \rho N'$ forward ,
$-t \ll Q^2 \leq s$

Generalized Parton Distributions $\to$
Femtoscopy of nucleons / Orbital spin structure.

- $\gamma^* \gamma \to M M'$ near threshold $W^2 \ll Q^2 \sim -t$

Generalized (2 Meson) Distribution Amplitudes
$\to$ Femtoscopy of hadronization process.

Success ...(2)

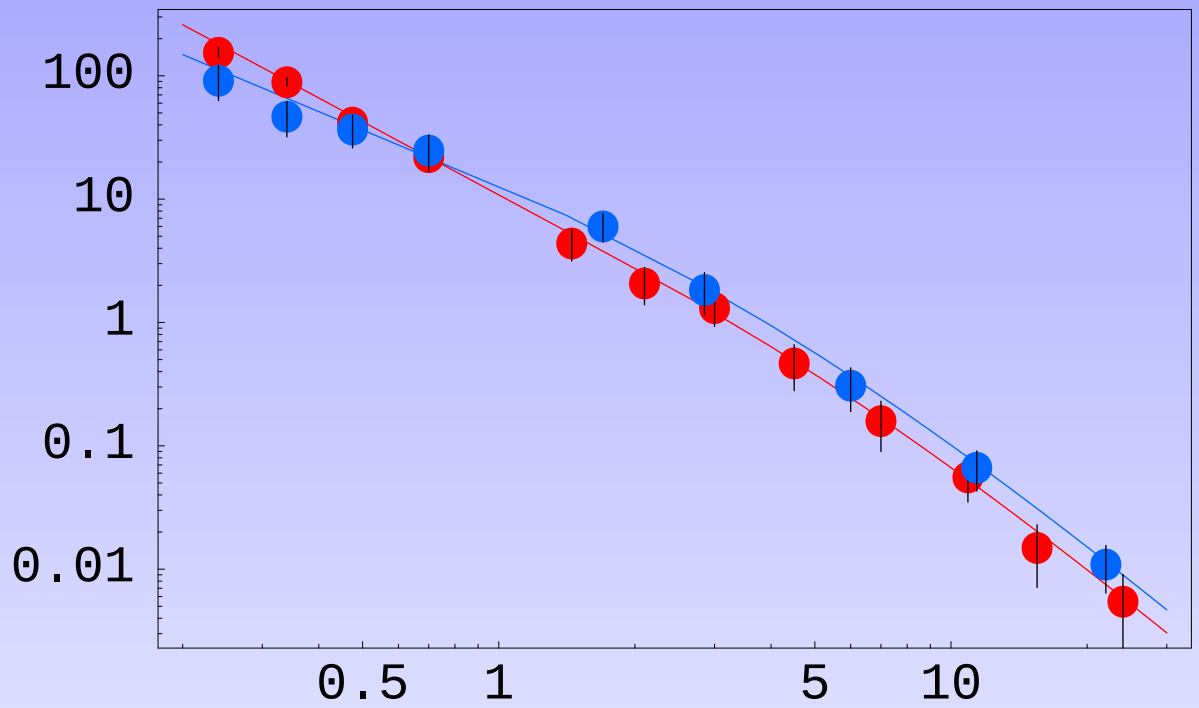
Many exclusive reactions are described in terms of the parton model :
Theoretical tool: QCD factorization

$$\mathcal{M}_{\gamma^*\gamma\to\mathcal{M}\mathcal{M}'} \sim \int dz \;\; GDA(z,\zeta,W^2)\cdot CF(z)$$

GDA = generalized distribution amplitudes describing soft processes ($\bar{q}q \to MM'$ or $gg \to MM'$)
CF = perturbatively calculable coefficient functions describing hard scattering ($\gamma^*\gamma \to \bar{q}q$ or gg)
$\longrightarrow Q^2$ scaling of Amplitude

$\longrightarrow$RGE, QCD evolution under control

Success ...(3)



Q^2 dependence of $\gamma^*\gamma \to \rho^+\rho^-$ and $\gamma^*\gamma \to \rho^0\rho^0$

From DAs to GDAs

- **Recall** definition of ρ meson Distribution Amplitudes

$$\langle \rho | \bar{\psi}(z) \gamma^{\mu} \psi(-z) | 0 \rangle = f_{\rho} M_{\rho} p^{\mu} \epsilon.n \int_0^1 du e^{i(u-\bar{u})p.z} \Phi(u)$$

$$n = \text{light cone + direction}$$

- **Generalized distribution amplitudes (GDA)** are defined in the quark-antiquark case, as

$$\Phi_q^{\pi\pi}(z, \zeta, W) = \int \frac{d\lambda}{2\pi} e^{-i\lambda z (p+p')^+} \langle \pi(p')\pi(p) | \bar{\psi}(\lambda) \gamma^+ \psi(0) | 0 \rangle$$

Gauge link between $\bar{\psi}(\lambda)$ and $\psi(0)$: QCD gauge invariance

Kinematics

Sudakov parametrization of hadrons momenta :

$$p = \zeta\, n + \frac{\vec{p}^{\,2} + m_\pi^2}{2\zeta} n^* + p_\perp \qquad p_\perp^2 = -\vec{p}^{\,2}$$

$$p' = \bar{\zeta}\, n + \frac{\vec{p}^{\,\prime\,2} + m_\pi^2}{2\bar{\zeta}} n^* + p'_\perp\,, \qquad \bar{\zeta} = 1 - \zeta\,,$$

$W^2 = (p + p')^2 =$ squared energy of the $\pi\pi$ system

W^2-dependence on hadron transverse momenta

enters via the modulus squared of $\vec{\mathcal{D}} = \frac{\vec{p}}{\zeta} - \frac{\vec{p}^{\,\prime}}{\bar{\zeta}}$

z, ζ dependence

QCD evolution + Lorentz invariance (Polynomiality)
$\longrightarrow$ Double expansion in Gegenbauer Polynomials

$$\Phi_q = 6z\bar{z}\sum_n\sum_{l=0}^{n+1} B_{nl}(W^2)C_n^{3/2}(2z-1)C_l^{1/2}(2\zeta-1)$$

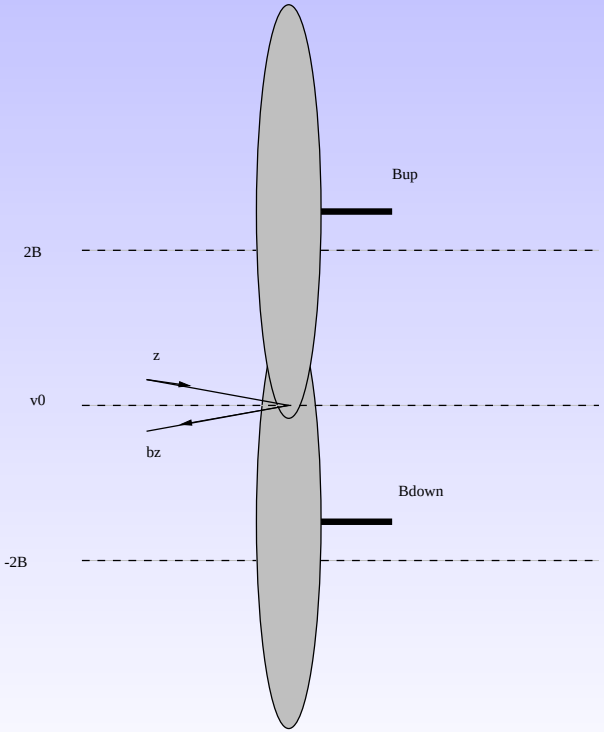
- ✓ z and ζ dependence under control
  $Q^2 \to \infty$: asymptotic GDA $n=0 \quad l=0,1$
  $\zeta \to \cos\theta_{CM}$ dependence (Legendre $P_l(\theta)$)
- ✓ FSI in $B_{nl}(W^2) = |B_{nl}(W^2)|e^{i\delta(W^2)}$
  use your knowledge of $\pi\pi, K\pi, \rho\pi$ amplitudes.
  (including phases)

W^2 dependence

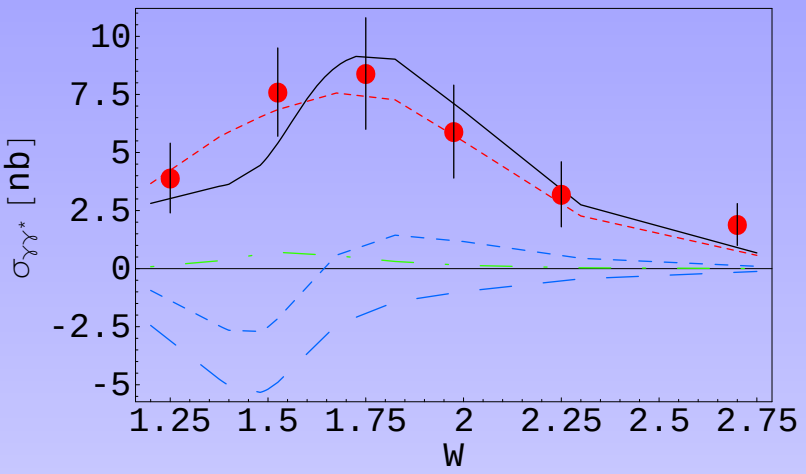
W^2 dependence maps impact representation

$$(\vec{b} = -\frac{\vec{B}}{\zeta} \qquad \vec{b}' = \frac{\vec{B}}{1-\zeta})$$

$$F(z,\zeta,|\vec{B}|) = \int_0^\infty \frac{d\vec{\mathcal{D}}^2}{4\pi}\ J_0(|\vec{B}||\vec{\mathcal{D}}|)\ \Phi^{\pi\pi}(z,\zeta,W)$$



W^2 dependence



3 body decays of B mesons

Interest of GDAs :

- ✓ include FSI between two mesons in a hard exclusive process
- ✓ well-defined hadronic object with controlable modelling
- ✓ $\pi\pi$ $\pi\eta$ $\rho\rho$ cases already studied

QCD factorization $\longrightarrow$ Success of GDAs in $\gamma^*\gamma$ reactions (and $ep \to e'MM'p'$)

What about Factorization in B decay?
In which kinematics are GDAs useful ?

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