Hall D Theory

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To support Hall D experimental program

- continued development of the physics case

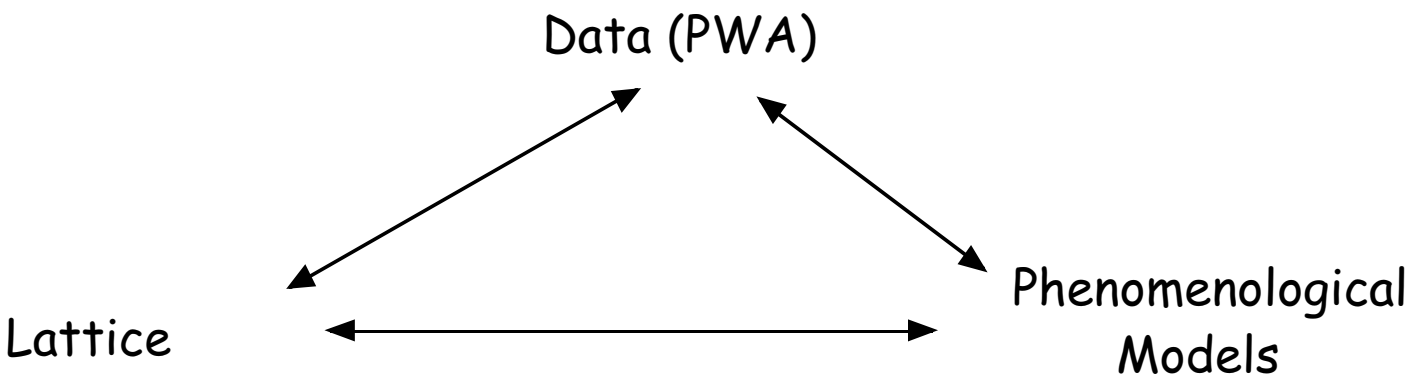
- MC & data analysis

  - development of models of photoproduction,
  - establishing the importance of photoproduction parameters
    e.g. beam polarization, energy
  - development of PWA techniques and algorithms

- support activities

  - workshops,

Use meson (exotic) spectrum to understand Strong QCD



Things we expect to learn :

- ...so far

  Valence sector : properties of the static confining potential, (including fine structure), parameters of the bag, dynamical χ symmetry breaking, ...

  -> parametrization + indirect data

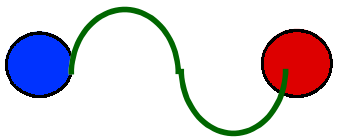
- Exotic spectroscopy : handle on the dynamic properties,

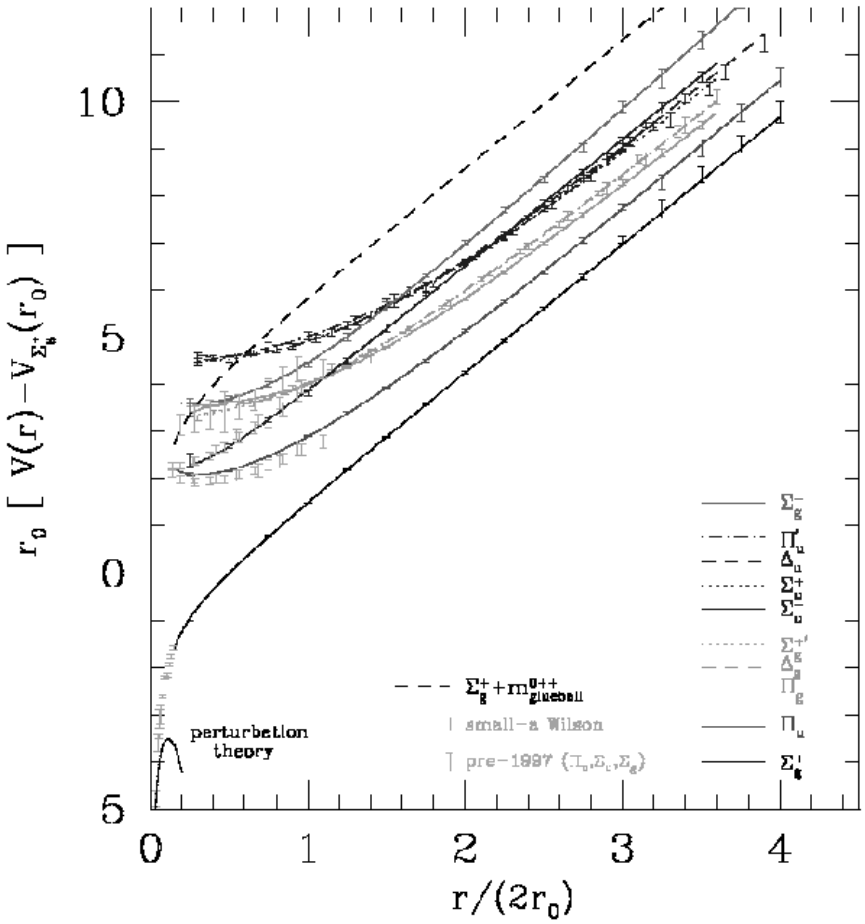
  e.g. propagation of nonperturbative gluons, strong quark-gluon interactions, decays and pair production
  origin of color screening and residual meson-meson interactions.

Hybrid decays : Model Predictions

sensitive to the nonperturbative gluon dynamics

constituent, bag, flux tube





- S+P decay modes dominate

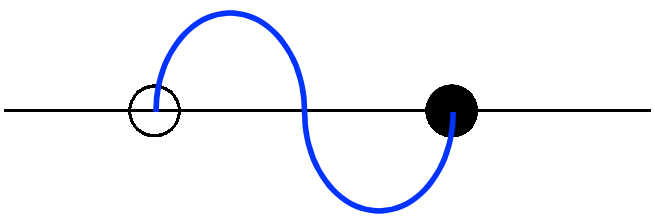
1^{-+} (1.8 GeV)	$b_1\pi$	$f_1\pi$	$\rho\pi$	
PSS	S 73 D 1	S 9 D 0.04	P 13	Γ MeV
IKP	S 51 D 11	S 14 D 7	P 12	

IKP = Isgur,Kokoski,Paton, PRL'1985

PSS = Page,Swanson,Szczepaniak, PRD'1999

Why Photoproduction :

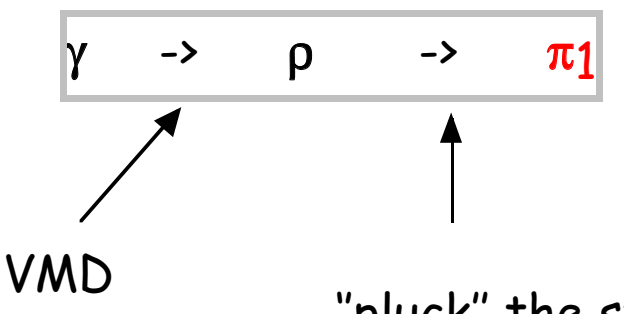
In the flux tube model all low lying exotic quantum numbers come from $S_{QQ} = 1$



$P = P_{QQ}\,\eta(-)^{Lg+1}$

$C = C_{QQ}\,\eta(-)^{Lg}$

$\rho \rightarrow \pi_1 \qquad 1^{--} \rightarrow 1^{-+} \qquad L_g=1,\ \eta=1,\ S_{QQ}=1$



Heavy hybrids ?

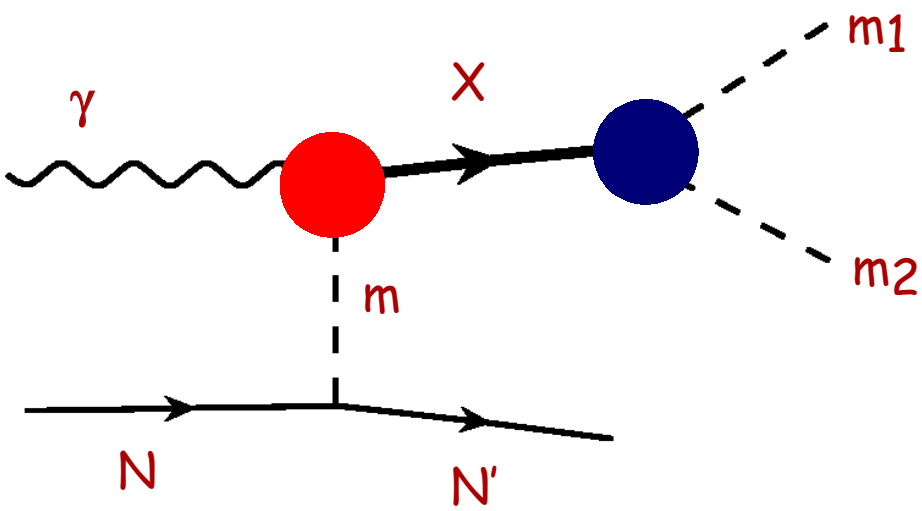
small cross sections

e^+e^- hybrid wave functions at the origins are small (ang.mom.

Partial wave amplitudes in exotic decays

Sensitive to strong QCD and models of soft glue

In peripheral production, s>>t ...



... complementary information comes from production and decay amplitudes

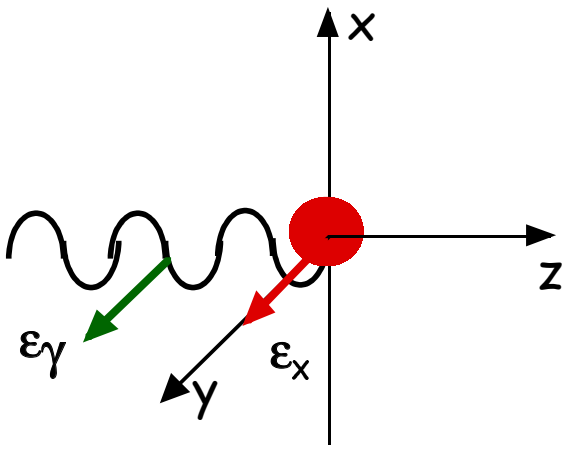
Linear polarization is crucial in determining naturality of t-channel exchanges

PWA + Eγ + t -dependence → properties of exotic mesons

Disentangling the exotic wave

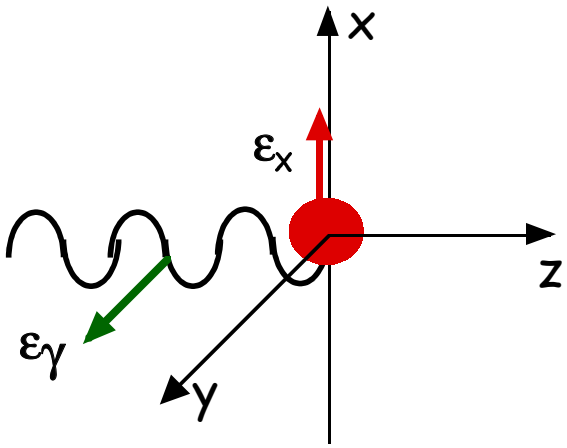
Linear photon polarization → Correlation between polarization and naturality of the produced resonance

parity



Unnatural

a_1, π_2

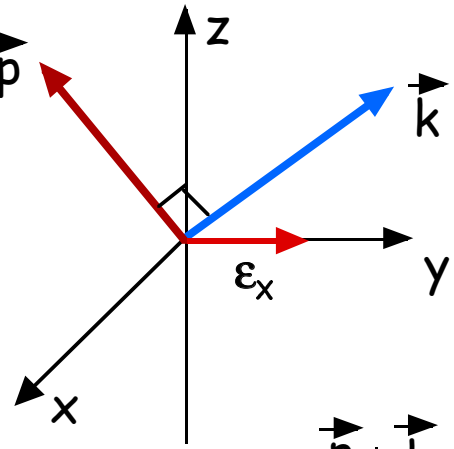


Natural

a_2, π_1

$\vec{X} \to \vec{\rho}^0(-k)\,\pi^+(k) \to (\pi^+(p)\,\pi^-(-p))_{-k}\,\pi^+(k)$

Polarization of the resonance → Correlation between $\vec{p}, \vec{k}$



$\vec{p} \perp \vec{k}$

e.g. ε_γ = **y** :

$$W_{\pi_2}(\Omega_{\mathbf{k}}, \Omega_{\mathbf{p}}) = (p_y k_z + p_z k_y)^2$$

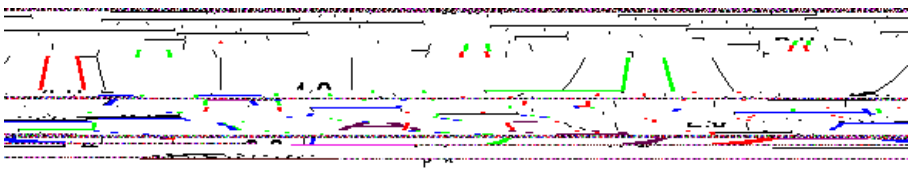
$$W_{\hat{\rho}_2}(\Omega_{\mathbf{k}}, \Omega_{\mathbf{p}}) = (p_y k_z - p_z k_y)^2$$

>> Pure π_1 wave ! <<

$\vec{X} \to \vec{\rho}^{o}(-k)\,\pi^{+}(k) \to (\pi^{+}(p)\,\pi^{-}(-p))_{-k}\,\pi^{+}(k)$

Γ_{π_1} = 100-200 MeV,

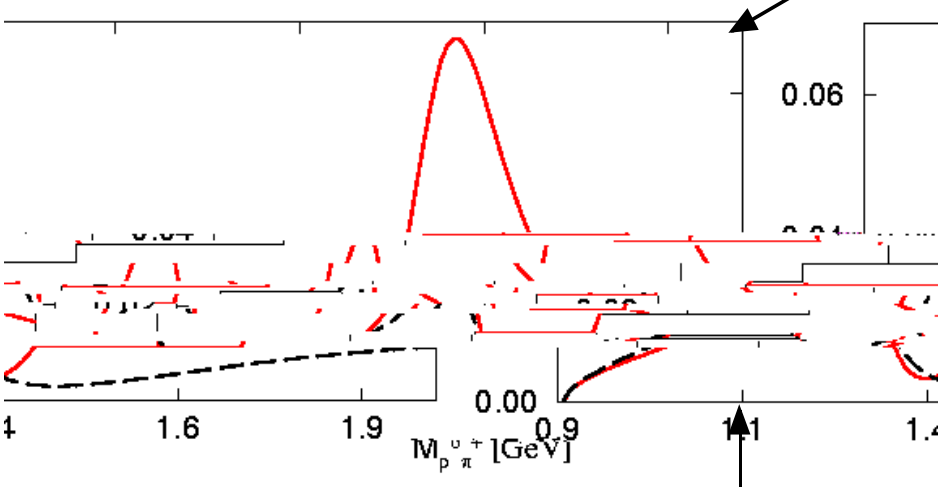
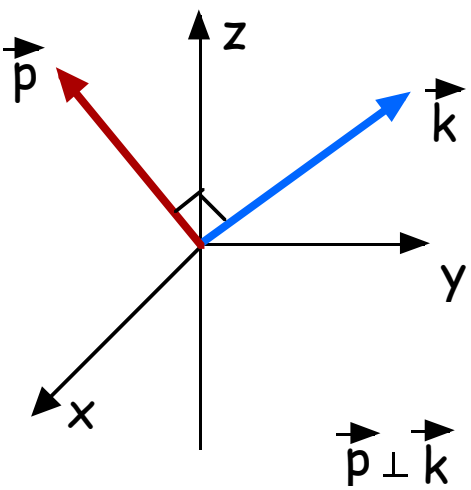
$\Gamma_{\pi_1 \to \gamma\pi}$ = 200



$\delta d\sigma$ [μb/ GeV srad^2]

$$\delta d\sigma = d\sigma_{\epsilon_\gamma = \mathbf{x}} - d\sigma_{\epsilon_\gamma = \mathbf{y}}$$

with π_1



without π_1