

A SUM RULES CALCULATION  
IN THE  
LIGHT-CONE REPRESENTATION

## THE MAIN POINT

COMPARE WITH: SHIFMAN, SNAPSHOTS OF HADRONS IN  
*PARTICLE PHYSICS AND FIELD THEORY*

RESONANCE REGION HAS BUMPS

PQCD HAS NO BUMPS

HAVE TO FIX THIS

PROPERLY REGULATED PQCD = LCPQCD

SO LCQ ALSO NEEDS A FIX

# THE FIX

QCD CORRECTIONS TO  $\Pi^{\mu\nu}$

$$\Pi_{\mu\nu}(q^2) = (q_\mu q_\nu - q^2 g_{\mu\nu})\Pi(q^2)$$

$$\Pi(Q^2) = \frac{1}{\pi} \int ds \frac{\text{Im} \Pi(s)}{s + Q^2} + \text{Const.}; \quad Q^2 = -q^2$$

CALCULATE  $\Pi(Q^2)$ : PQCD + NPQCD

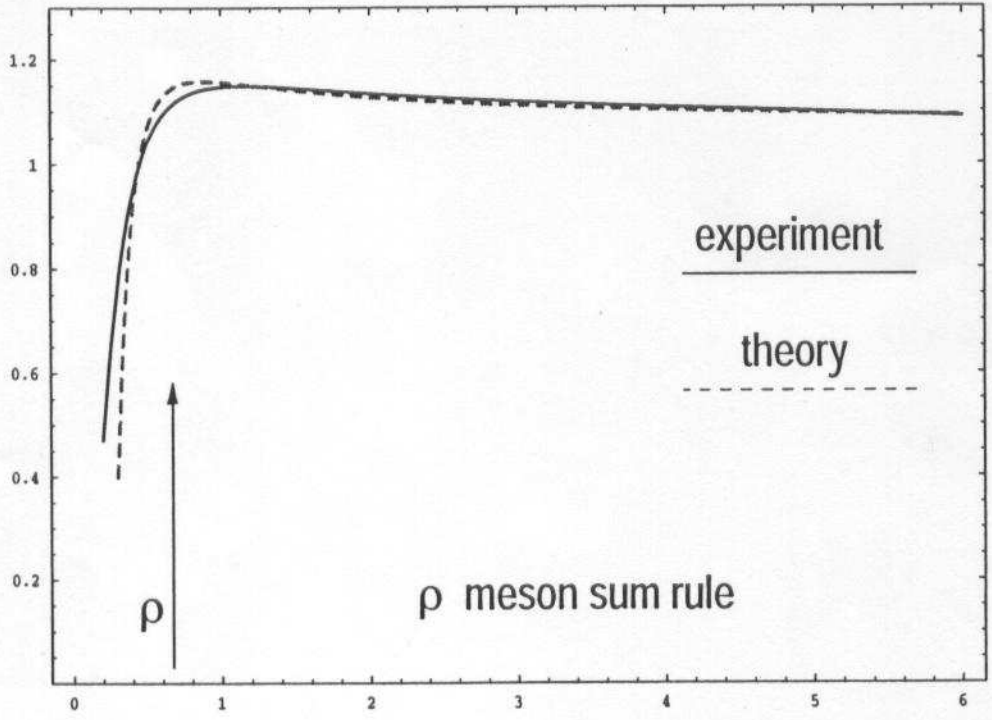
NPQCD = OPERATOR PRODUCT EXPANSION

NOTE: BOREL TRANSFORM  $\rightarrow \tilde{\Pi}(M^2)$

DATA + FIT + SR + BT  $\rightarrow$  “EXPERIMENTAL”  $\tilde{\Pi}(M^2)$

THEORETICAL  $\tilde{\Pi}(M^2)$

$$\frac{4}{9} \left( \ln \left[ \frac{M^2}{e\gamma\Lambda^2} \right] \right)^{-1} \left\{ 1 + \dots \right\} - x_{4q} \frac{448\pi^3}{81M^6} \alpha (\langle \bar{\psi}\psi \rangle)^2 + \dots$$



# THE VACUUM IN LCQ

ZERO-MODE FIELDS DRESS THE BARE VACUUM

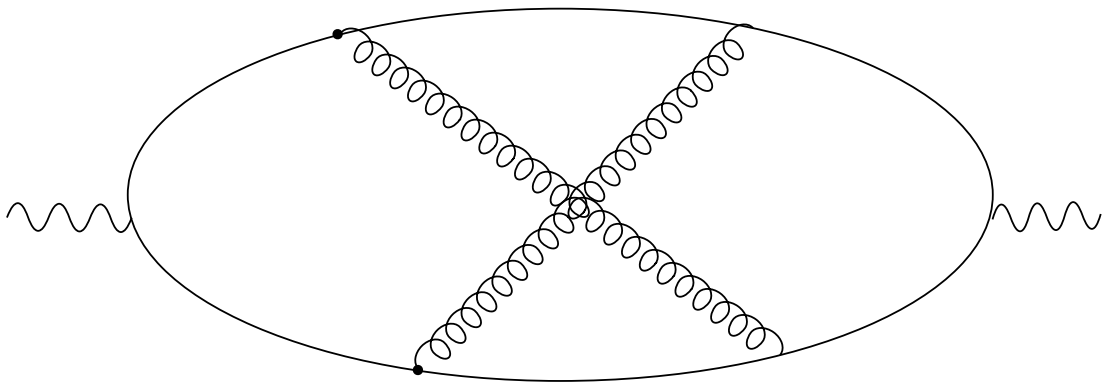
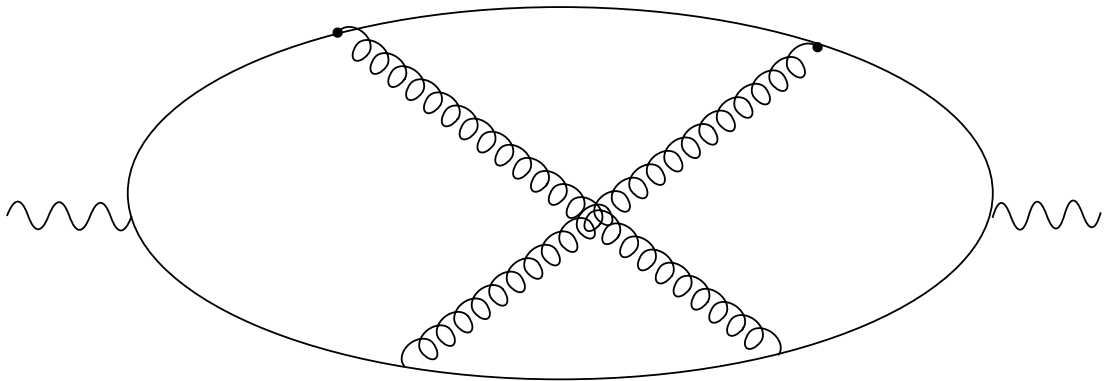
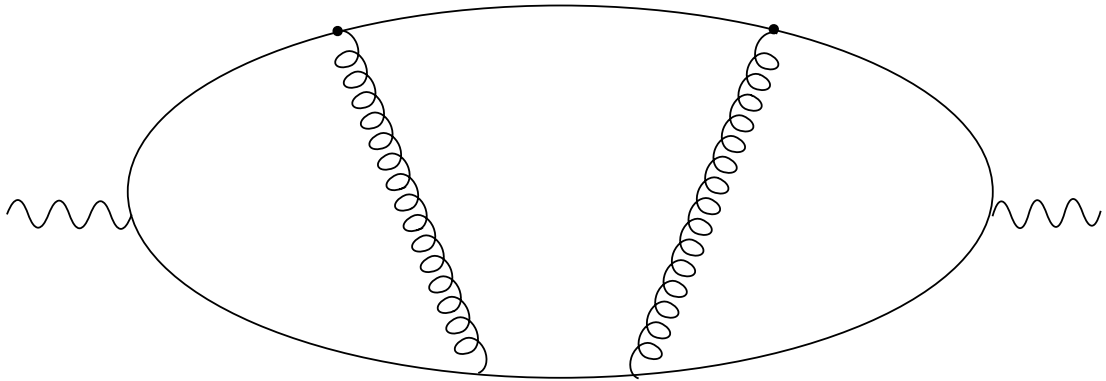
THESE FIELDS ARE INTEGRATION CONSTANTS

EFFECTIVE THEORY USES USUAL LQFS (BARE VACUUM)

EXACT EFFECTIVE THEORY

- PHYSICAL STATES ARE USUAL LCO  $|\Omega\rangle$
- $\{S_{ET}\} = \{S_{FT}\}$
- $\Psi_{ET} = \mathcal{P}\Psi_{FT}$

ET DYNAMICS INCLUDES INDUCED OPERATORS



# THE QUESTION OF THE SIGN

EARLIER FORMULA

$$\frac{4}{9} \left( \ln \left[ \frac{M^2}{e\gamma\Lambda^2} \right] \right)^{-1} \left\{ 1 + \dots \right\} - x_{4q} \frac{448\pi^3}{81M^6} \alpha (\langle \bar{\psi}\psi \rangle)^2 + \dots$$

WE WILL HAVE

$$\frac{4}{9} \left( \ln \left[ \frac{M^2}{e\gamma\Lambda^2} \right] \right)^{-1} \left\{ 1 + \dots \right\} \pm \frac{C}{M^2} \alpha + \dots$$

IF THE SIGN IS NEGATIVE THERE IS A BUMP

IF THE SIGN IS POSITIVE THERE IS A PROBLEM

# SUMMARY

VACUUM EFFECT APPEAR AS INDUCED OPERATORS IN LCQ

I.O. GIVE  $Q^{-n}$  TERMS IN THE POLARIZATION OPERATOR

NEGATIVE SIGN  $\rightarrow \rho$  PEAK

- FIX I.O. CONSTANT
- OTHER CALCULATIONS

POSITIVE SIGN WILL HAVE TO BE FIXED