$\pi^0 \gamma \gamma^*$

FORM FACTOR

R. Plant

Manchester University.

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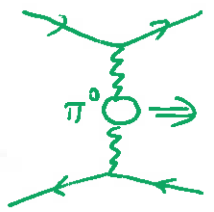
MOTIVATION

- $\Gamma(\pi^0 \to \gamma\gamma) \Leftarrow$ gauge invariance and chiral symmetry.

- $\pi^0\gamma\gamma^*(q^2)$ form factor probes dynamics of axial anomaly — useful test of models of hadron structure.

- Some data obtained by CELLO collaboration at PETRA.



$(e^+e^- \to e^+e^-\pi^0)$

- High-precision measurements are planned at CEBAF.

A NON-LOCAL NJL MODEL

$$S = \int d^4x \; \bar{\psi}(i\not{\partial} - m_c)\psi$$

$$+ \int d^4x_1\, d^4x_2\, d^4x_3\, d^4x_4 \;\; \alpha(x_1, x_2, x_3, x_4)$$

$$\left[\bar{\psi}(x_1)\psi(x_3)\bar{\psi}(x_2)\psi(x_4) + \bar{\psi}(x_1) i\gamma_5\tau^a\psi(x_3)\bar{\psi}(x_2) i\gamma_5\tau^a\psi(x_4)\right]$$

$$+ \;\; [\rho, a_1] \;+\; [\omega] \;+\; [f_1] \;+\; [a_0, \eta]$$

[ ] is chirally symmetric.

Use separable interaction :-

$$\tilde{\alpha}(p_1, p_2, p_3, p_4) = \tfrac{1}{2}(2\pi)^4 G \; f(p_1) f(p_2) f(p_3) f(p_4)$$

$$\delta(p_1 + p_2 - p_3 - p_4)$$

as suggested by instanton-liquid studies.

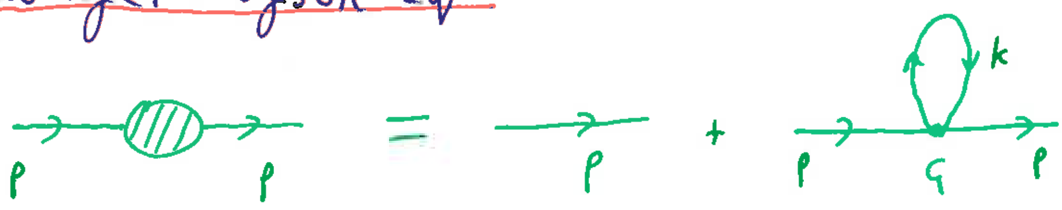
$f(p_i)$: Gaussian

— ensures convergence of loop integrals.

QUARK & MESON PROPAGATORS

In ladder approximation (= LO in N_c^{-1}):

Schwinger-Dyson eq^n

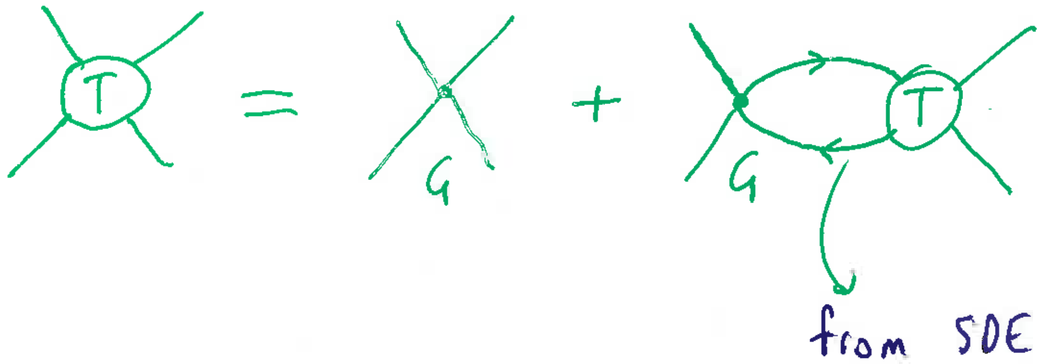


Separable interaction decouples p, k.

$$S^{-1}(p) = \not{p} - m_c - [M(0) - m_c]\, f^2(p)$$

Quark confinement for large enough $M(0)$.

Bethe-Salpeter eq^n



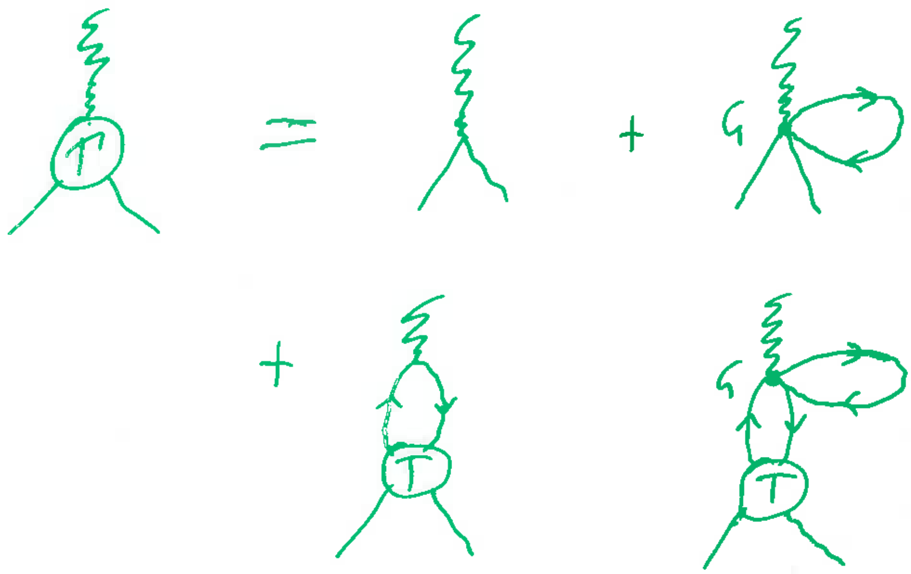
Meson masses from poles in T.

NON-LOCAL CURRENTS.

$$\partial_\mu\left(\tfrac{1}{2}\bar\psi\gamma^\mu\tau^a\psi\right) = i\int\prod_n d^4x_n\ \bar\psi(x_1)\tau^a\psi(x_3)\bar\psi(x_2)\psi(x_4)$$
$$\alpha(x_1,x_2,x_3,x_4)\left[\delta(x-x_1)-\delta(x-x_3)\right]$$
$$+\ \text{similar pieces.}$$

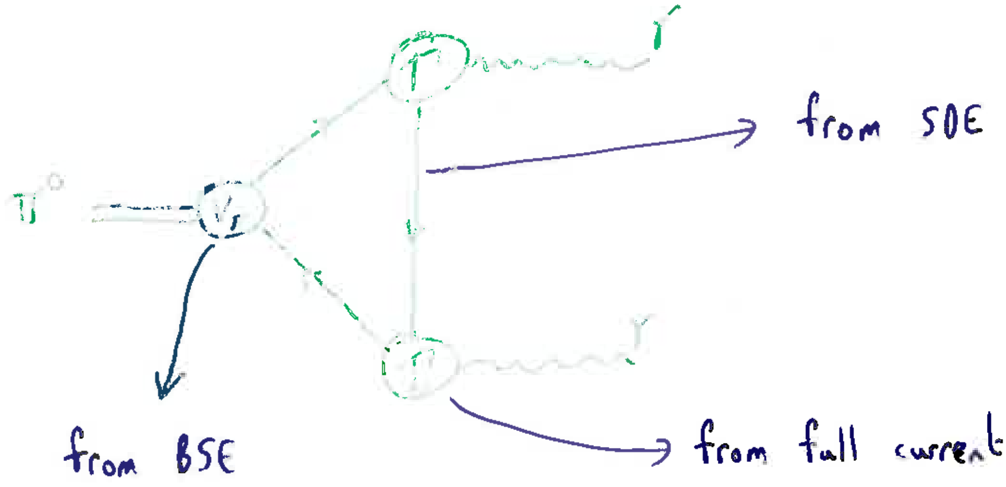
- To satisfy Ward identities, need extra contributions to currents.
- These 4-quark terms ⇒ extra diagrams.

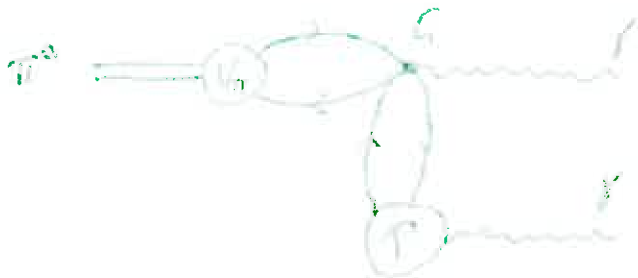
γ_{qq}



- Non-local terms numerically important. eg, ~ 30 to 40 % of f_π.

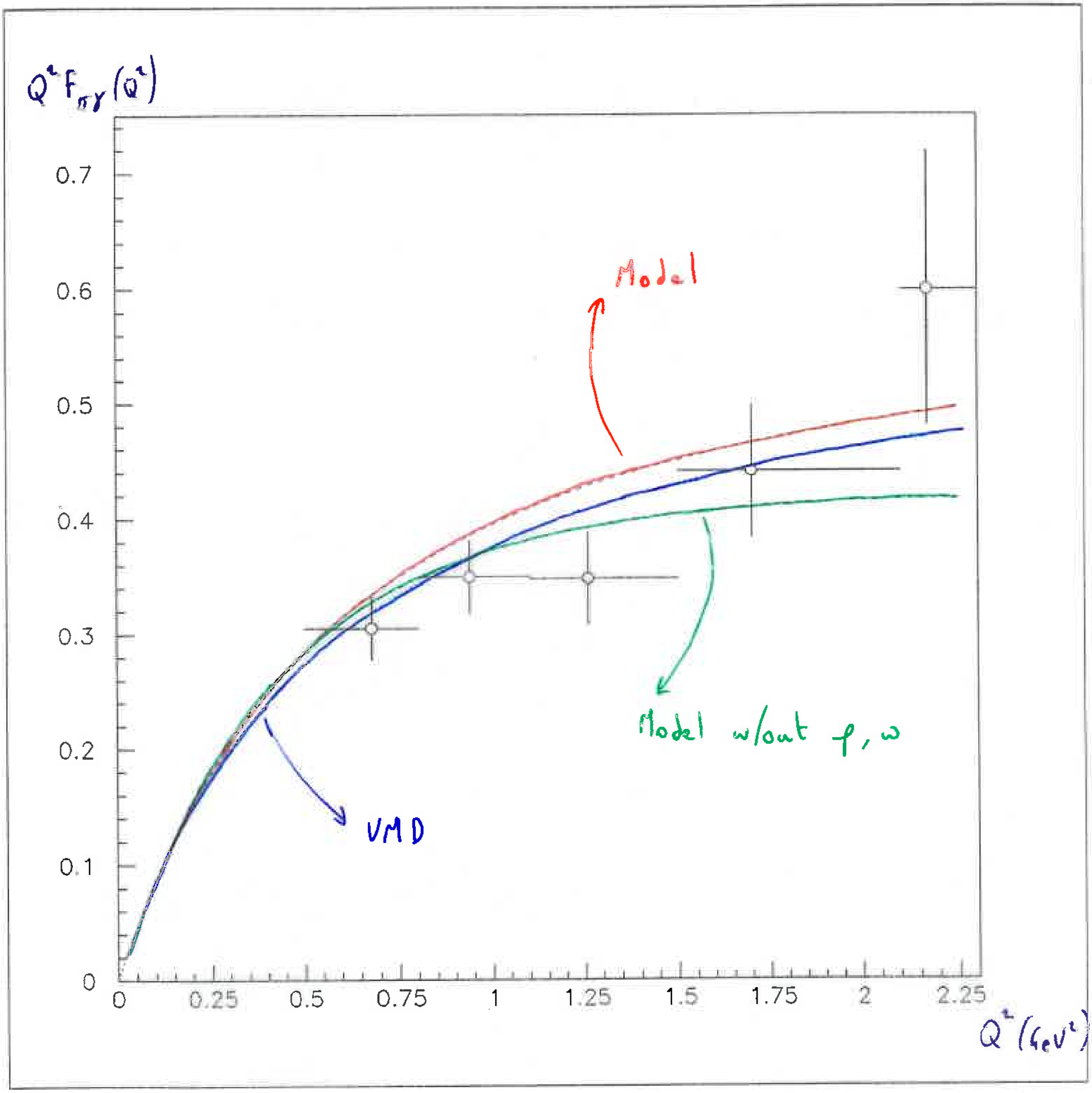
$\pi^0 \to \gamma\gamma$





Needed to satisfy the low-energy theroem.

Fixing the model parameters in the purely-strong sector, we get ...


$Q^2 F_{\pi\gamma}(Q^2)$
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.25
0.5
0.75
1
1.25
1.5
1.75
2
2.25
Q^2 (GeV^2)
Model
Model w/out ρ, ω
VMD

CONCLUSIONS

- The $\pi^0\gamma\gamma^*$ form factor is potentially a good testing ground for models of meson structure.

- There are several models consistent with the data available.

- More accurate data could distinguish between various descriptions of the process.