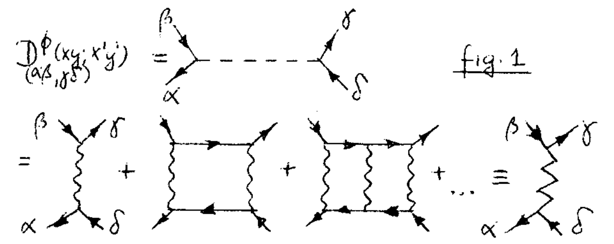

fig. 1

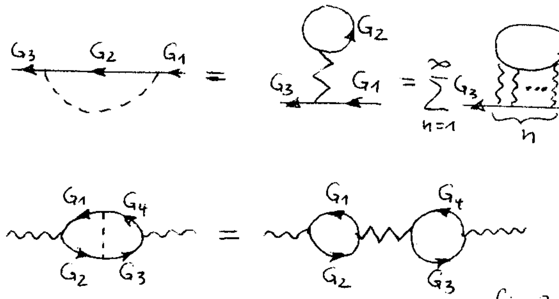

fig. 2

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Note Added

H.Kleinert has informed us that he has obtained similar results using bilocal techniques /4/ (see also the contributions tothis conference).

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HADRONIZATION OF QUARK THEORIES AND BILOCAL QED

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There are two approaches to strong interactions: Colored quark gluon theory (QCD) and the dual model. Either approach is powerful where the other has its weaknesses. In QCD, currents, their light cone properties, and their conservation laws (CVC,PCAC) can be studied without much effect. The spectrum, on the other hand, is very hard to calculate /1/. The opposite holds for dual models. Here the spectrum is obvious while proper currents have not yet been constructed.

Much work could be saved if the two approaches were, in fact, equivalent. Then one or the other could be used depending on whether long or short-range questions are to be answered.

We have been able to establish an equivalence of this type /2,3/ for the simplified situation where gluons are color singlets with an arbitrary mass μ. Since quarks may have several flavours, this theory might be called quantum flavour dynamics (QFD). Using functional methods, we have transformed QFD into an equivalent bilocal field theory whose bare quanta propagate and interact just like hadrons in dual diagrams (only the dynamical property of duality itself is missing due to the absence of colour). Photons interact with hadrons via a current field identity. The bare quanta are quark-antiquark bound states as they arise from ladder exchange of gluons.

Since QFD contains a spontaneously broken chiral symmetry it gives naturally rise to massless π, K, etc.,mesons. The small physical masses of these mesons are obtained by introducing a small bare mass term.

In the limit of a large gluon mass, hadronized QFD simplifies considerably. The bilocal fields become local and describe π, ρ, σ, A, mesons in the standard σ model

Lagrangian /4,5,3/ . This special case of hadronization is the four-dimensional analogue of the transition from the Thirring model to the sine-Gordon equation /6/ . In solid-state physics it corresponds to the derivation of the Ginzburg-Landau equation from an electron Hamiltonian.

The σ model is known to account reasonably well for low-energy meson physics. Our derivation /5,3/ yields additional connections between quark - and meson-properties. For example, the spontaneous breakdown of chiral symmetry generates a dynamical quark mass M which becomes related to the vector and axial-vector masses via

$$m_{A_1}^2 - m_\rho^2 = 6M^2 .$$

From this one finds

$$M \approx 312 \text{ MeV}$$

The scalar mass is predicted:

$$m_\sigma = 2M \approx 624 \text{ MeV.}$$

The pseudoscalar masses vanish due to their Goldstone nature. If they are to have their proper physical values, bare quark masses $-\bar{\Psi} m \Psi$ have to be added to the Lagrangian with $m \approx \begin{pmatrix} 15 & & \\ & 15 & \\ & & 435 \end{pmatrix}$.

This splits the dynamically generated mass M which now becomes a matrix

$$M \approx \begin{pmatrix} 312 & & \\ & 312 & \\ & & 432 \end{pmatrix} .$$

The masses M determine the vacuum expectations of scalar densities

$$\langle 0 | \bar{\Psi} \frac{\lambda^a}{2} \Psi | 0 \rangle = f_\pi^2 \, tr(\lambda^a M)$$

from which one finds an SU(3) violation in the vacuum of -16%.

I thank Dr.D.P.Mavlo for an interesting discussion.

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