Calculation of masses and amplitudes of pseudoscalar mesons.

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Abstracts

We study the Schwinger-Dyson equations (SDE) formalism for a strongly coupled QED-like interaction. The SDEs are an infinite set of integral equations for the n-point Green's functions of a quantum field theory. The SDE are coupled to each other, and a truncation scheme is needed to solve them. The Bethe-Salpeter-SDE formalism allows calculating the wave function of a bound state of two particles. We solve the SDE for several values of the QED coupling strength. It is possible to build QED-Like low energy effective theories of the QCD, which are useful to obtain the spectrum of pseudoscalar mesons $J^{pc} = 0^{+}$ decay constants.

1.Schwinger-Dyson equations

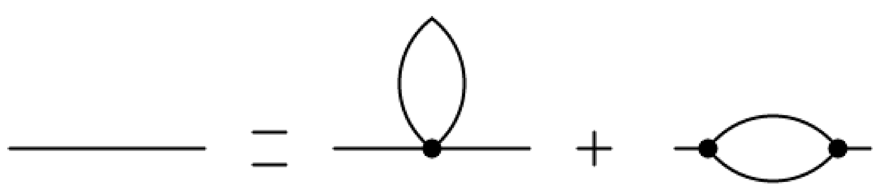
In general the Green functions for a given number n of points, there are correlation functions of type

$$G(x_1 \cdots x_n) = \langle 0 | \, T(\phi(x_1) \cdots \phi(x_n)) \, | 0 \rangle$$

Which are related to Feynmann diagrams, for $n = 2$, it is related to the propagator; it is likely that at n=3 (tree level) a-loops may appear, and this would generate an anomaly.

2. Self-energy

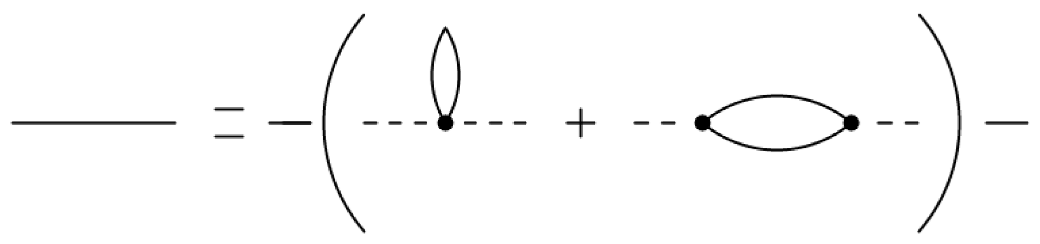
In QFT, the energy that a particle has as a result of changes that it causes in its environment defines self-energy Σ , and represents the contribution to the particle's energy, or effective mass, due to interactions between the particle and its environment.



The term of interaction will be

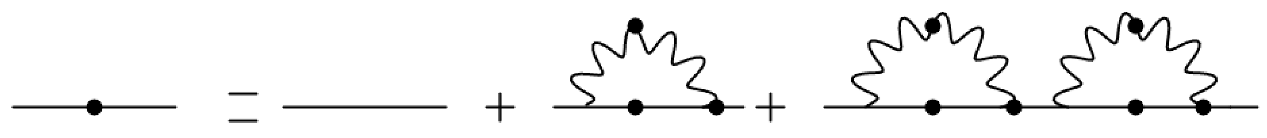
$$\mathcal{L}_I = \frac{\lambda}{4!}\phi^4 + \frac{\mu}{3!}\phi^3$$

If we extract the external legs, amputating each of these, we obtain the diagrams



3. Dynamical mass generation

Using the definition of self-energy, the full fermion propagator is given by the summation; wheresum of all diagrams 1PI . The solid dots indicate the Green's functions are fully dressed.



This can equally well be written as

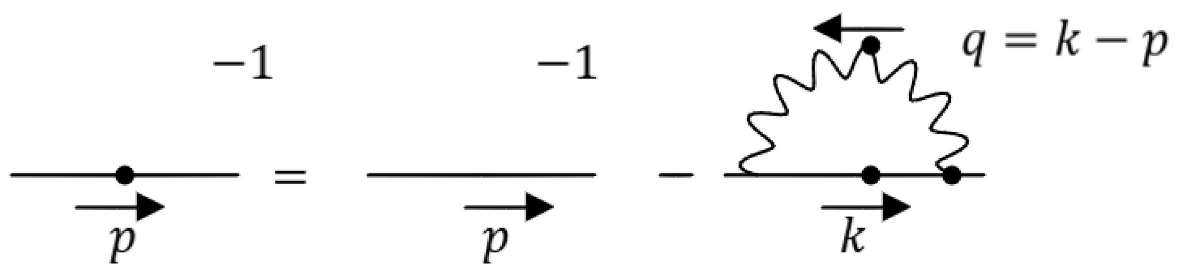
$$S_F(p) = S_F^0(p) + S_F^0(p)\Sigma S_F^0(p) + S_F^0(p)\Sigma S_F^0(p)\Sigma S_F^0(p) + \cdots$$

or also

$$S_F(p) = S_F^0(p) + S_F^0(p)\Sigma S_F(p)$$

So finally, we obtain the field equation for the inverse fermion propagator

$$S_F(p)^{-1} = S_F^0(p)^{-1} - \Sigma$$



whose integral equation has the form

$$S_F(p)^{-1} = S_F^0(p)^{-1} - \frac{\alpha}{4\pi}(3+\xi)\int \mathrm{d}^4k\gamma_\mu S_F(k)\Gamma_\nu(k,p)\Delta(q)$$

Where $S_F^0(p)^{-1} = \not p - m_0$ is the inverse bare propagator; the photon propagator in a covariant gauge $\Delta^{\mu\nu}(q) = \frac{1}{q^2}\left\{\mathcal{G}(q)\left(g^{\mu\nu} - \frac{q^\mu q^\nu}{q^2}\right) + \xi\frac{q^\mu q^\nu}{q^2}\right\}$ the complete structure of the fermion-boson interaction vertex $\Gamma_\nu(k,p)$ so that

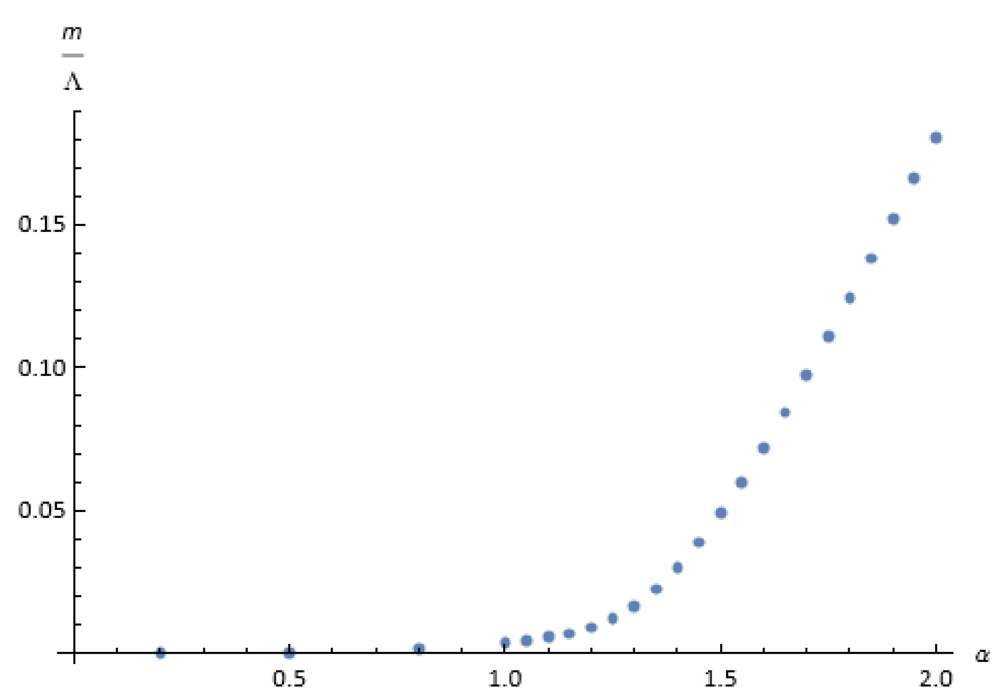
$$S_F(p) = \frac{\mathcal{F}(p)}{\not p - \mathcal{M}(p)}$$

The special case where de bare propagator is $\mathcal{M}(p) = m_0$ y $\mathcal{F}(p) = 1$, we deduce one coupled fermion equations on tracing with the unit matrix $\not p$

$$\frac{\mathcal{M}(p)}{\mathcal{F}(p)} = m_0 + \frac{\alpha}{4\pi}(3+\xi)\int_0^{k^2} \mathrm{d}k^2 \frac{\mathcal{F}(k)\mathcal{M}(k)}{k^2 + \mathcal{M}(k)^2}\left[\theta_+ \frac{k^2}{p^2} + \theta_-\right]$$

4. Graphs

We initiate a change of variable $k^2 = \Lambda^2 x$, so $\mathrm{d}k^2 = \Lambda^2 \mathrm{d}x$. We will use the program *Wolfram Mathematica: Modern Technical computing* considering the conditions $\xi = 0$ and a $\alpha \gg m_0$ and $m_0 \to 0$ doing a quadrature Gaussinian weights and taking different values for $0.5 < \alpha < 2$.



$$\mathcal{M}(p) = m_0 + \frac{\alpha}{4\pi}(3)\int_0^{\Lambda^2 x} \mathrm{d}x \frac{\mathcal{M}(k)}{x + \left(\frac{\mathcal{M}(k)}{\Lambda}\right)^2}\left[\theta_+ \frac{k^2}{p^2} + \theta_-\right]$$

5. References

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