Non-perturbative studies of QFT in Minkowski space

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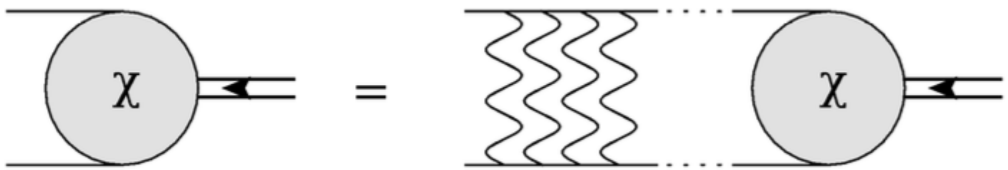
The non-perturbative regime of QFT's has its paradigmatic example in the existence of bound states, that appear as poles of the proper n-point Green's function.

$$\frac{1}{1-x} = 1 + x + x^2 + x^3 + x^4 + \ldots\ldots.$$



Pictorial representation of the Bethe-Salpeter Eq.
analogous to Schroedinger Eq., but in Relativistic QFT

$$S(p) = \frac{i}{A(p^2)} \frac{\not p + M(p^2)}{p^2 - M^2(p^2) + i\epsilon} \, ,$$

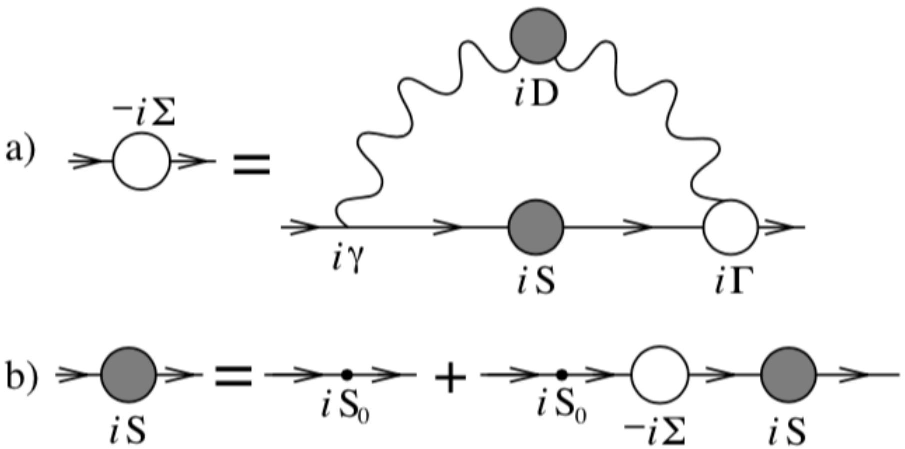
Fermion propagator

$$D^{\mu\nu}(q) = -\frac{i}{q^2 + i\epsilon} \left(D(q^2)\, T_q^{\mu\nu} + \frac{1}{\lambda}\, L_q^{\mu\nu} \right) ,$$

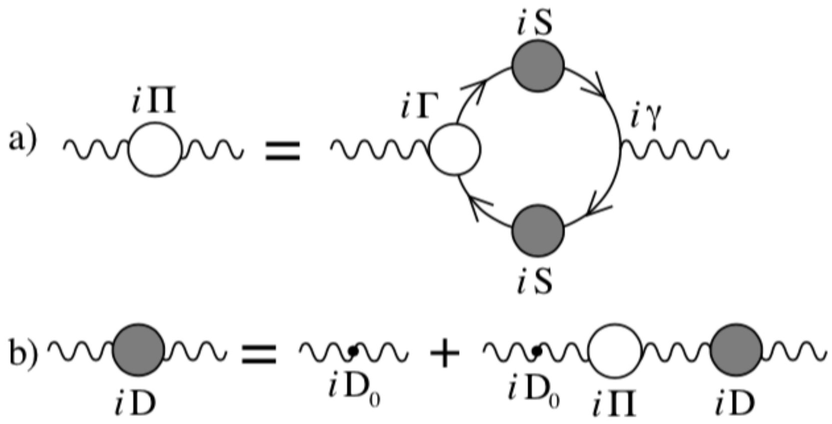
Photon propagator

$$ig\,\Gamma^\mu(p,q) = ig\big(f_1(p^2, q^2, p\cdot q)\,\gamma^\mu + \ldots\big)\, .$$

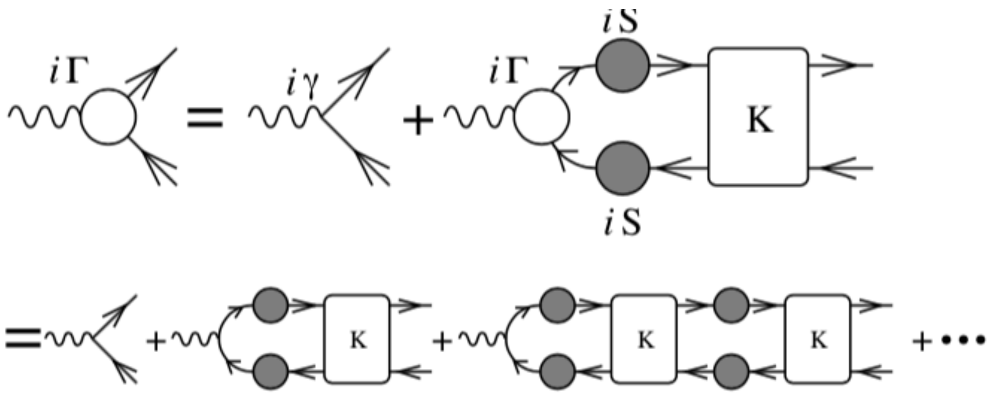
Vertex Function



Dyson-Schwinger Eq. for a fermion —> Self-energy Σ (2 legs) !!



DSE for the photon —> Self-energy Π (2 legs)!



DSE for the vertex function (3 legs) —> K, scattering matrix (4-legs)

Aim

Non perturbative investigation of the dynamics inside a bound system, after properly truncating the DSEs tower. All the general principles of the QFT under scrutiny must be preserved.

Applications (e.g.)

Hadron physics —> 3D Tomography of hadrons, directly in Minkowski space

Condensed matter —> Electron-hole bound system and its dynamical properties

Background

Basic knowledge of QFT, e.g. C. Itzykson and J. B. Zuber, *Quantum Field Theory,* Chaps. 1-3

Syllabus

1) DSEs & BSE in 4D space: an introduction
2) Parametric form of the Feynman diagrams
3) Nakanishi integral representation of n-leg amplitudes
4) Application of the Nakanishi approach for solving DSEs & BSE in Minkowski space, for simple examples

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