Causal fermion systems as an effective collapse theory

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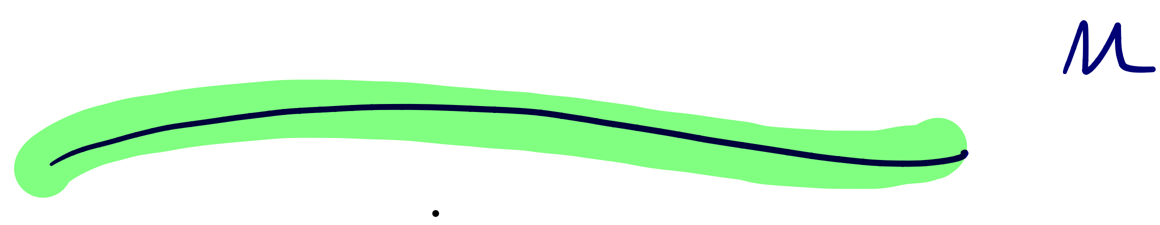
Ingredients

- nonlinear eqns (causal action principle
  EL eqns)
- conservation laws
  current conservation ψ physical wave function
  $\langle \psi | \phi \rangle^t$



  time independent
- linearized field eqns
  analysed in detail in Minkowski space
  homogeneous solutions
  electromagnetic waves

$$(i\partial\!\!\!/ + A\!\!\!/ - m)\psi = 0, \qquad \Box A = 0$$

more generally

in general $\mathcal{B}(x,y)^* \neq \mathcal{B}(y,x)$

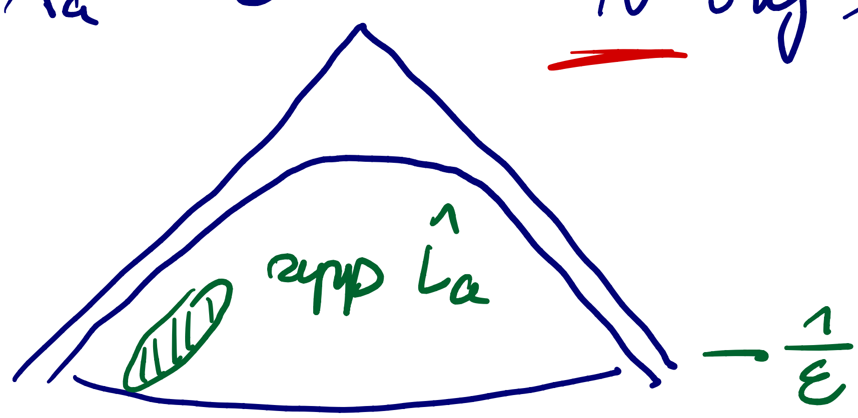
$$(i\partial\!\!\!/ + \mathcal{B} - m)\psi = 0$$

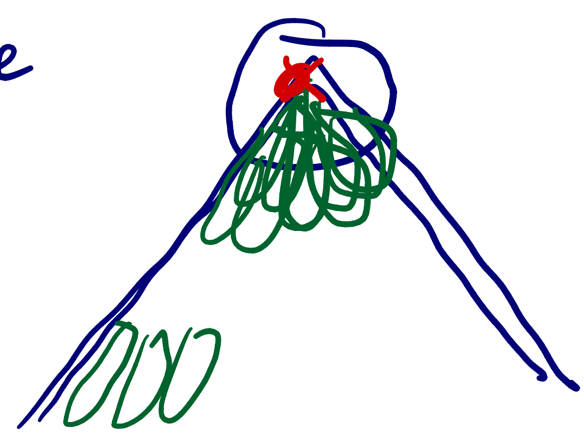
$$(\mathcal{B}\psi)(x) = \int \mathcal{B}(x,y)\,\psi(y)\,d^4y$$

$$\mathcal{B}(x,y) = \sum_{a=1}^{N} A_a\left(\frac{x+y}{2}\right) L_a(y-x)$$

$$\Box A_a = 0$$

N very large





- non-zero homogeneous solutions are all present
describe it stochastically
by a Markovian process (in the nonrelativistic regime)

$$V(x,y) = \sum_a B_a(t)\, L_a(\vec{y}-\vec{x}) \times \delta(t-t')$$

$t = x^0$
$t' = y^0$

- the operators L_a are in general <u>non-symmetric</u>

Thus $i\partial_t \Psi = H\Psi$,

$$H = H_0 + V$$

non-symmetric operator

$$H_0^* = H_0 \,, \qquad V^* \neq V$$

$\Rightarrow$ $U(t) = e^{-itH}$ <u>not</u> unitary

current conservation does <u>not</u> hold for the linear dynamics

But from the general conservation laws we know that current conservation holds if the nonlinear corrections are taken into account.