"Effective Field Theory and Lattice Field Theory" School - Gradient Flow: Assignments

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1 Exercise 1

Consider the gradient flow equation for scalar fields

$$\partial_t \phi(x,t) = \Delta\phi(x,t) \qquad \Delta = D_\mu(t) D_\mu(t)\,. \tag{1}$$

Discretize the equation in an infinite volume lattice with spacing a and calculate the tree-level propagator of flowed scalar fields in momentum space.

2 Exercise 2

Consider a lattice of spacing $a = 0.1$ fm and a box of size L^4 with $L/a = 32$. Imagine flowing a local field. Give your best estimate for the values of t/a^2 where both cutoff effects and finite volume effects should be under control (at least in theory).

3 Exercise 3

Calculate the tree-level in the continuum theory of the expectation value

$$\left\langle \overline{\chi}(0,t) \overset{\leftrightarrow}{\not{D}} \chi(0,t) \right\rangle \tag{2}$$

as a function of the flow time t for a generic mass m. Using the short flow-time expansion justify the result of the calculation.

4 Exercise 4

Consider the gradient flow equation for fermions on the lattice with spacing a

$$\partial_t \chi(x,t) = \nabla^*_\mu \nabla_\mu \chi(x,t)\,. \tag{3}$$

Modify the r.h.s of the equation to classically remove the O(a^2) cutoff effects.