

The background of the slide is a 3D visualization of a lattice structure. It consists of numerous vertical and diagonal columns of spheres. Each sphere is rendered with a gradient of colors, including shades of pink, purple, blue, green, and yellow, giving it a glowing, translucent appearance. The spheres are arranged in a regular, repeating pattern, creating a sense of depth and perspective.

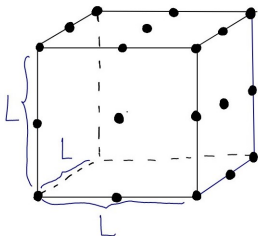
Twisted Boundary Conditions in Lattice QCD

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Boundary Conditions



4D LATTICE

$L \times L \times L \times T$
SPATIAL \hookleftarrow TIME
3D

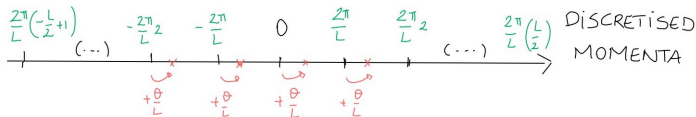
Periodic Boundary Conditions

$$\psi(t, x_i=0) = \psi(t, x_i=L)$$

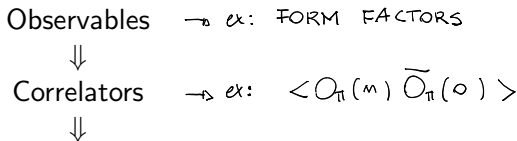


Twisted Boundary Conditions

$$\psi(t, x_i=0) = e^{i\theta} \psi(t, x_i=L)$$



Observables on a Lattice



Propagators G

$$D G = S \Rightarrow G = D^{-1} S$$

DIRAC OPERATOR \leftarrow \leftarrow PROPAGATOR \leftarrow SOURCE

$$D^{-1} \equiv (D^{-1})_{n \times n}$$

$$n > 10^6$$

$$L^3 T \times 12$$



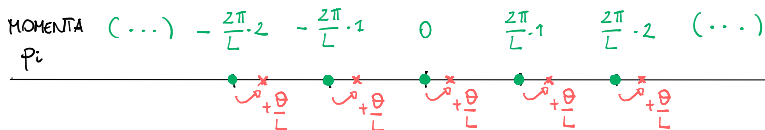
High computational costs



Idea of the Project and Possible Approaches

Assumption

D_0^{-1} is known with **high precision** (\equiv high computational effort)



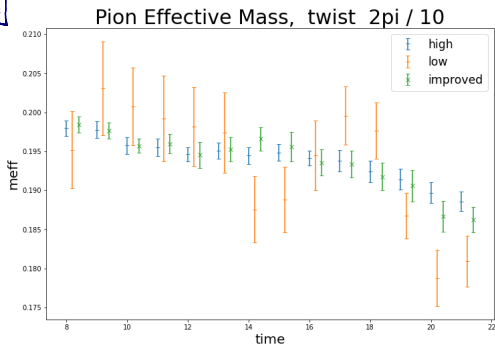
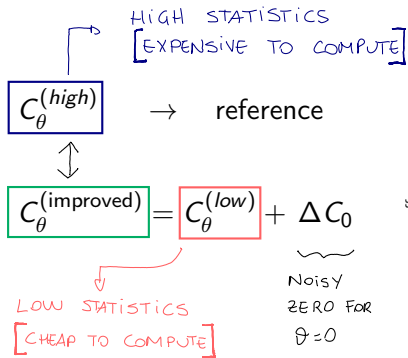
Goal

To calculate D_θ^{-1} with **high precision** in a **cheap** way using D_0^{-1}

3 APPROACHES:

- ~~❌~~ ① matrix relations for $D_\theta^{-1} = (D_0 + B)^{-1}$
- ? ② algorithmic improvement (domain decomposition)
- ✓ ③ variance reduction technique

Variance Reduction Technique



Observations and next steps:

- the method works well at the correlators level
- check for more general quantities (e.g. form factors)
- theoretical understanding and prediction of the improvement