GPPU 進捗報告会

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May 8, 2018

What I am working on

- Nucleon Structure (in PACS Collaboration)

  completed[1]
- Hyperon (Non)standard Beta Decay (with S. Sasaki)

  Now Researching...
- Spectre Reconstruction on Smeared Charmonium (with S. Sasaki and A. Rothkopf)

  Now Researching...

[1] arXiv:1710.10782

charmonium in lattice

construct charmonium operator

$$M(x) = \overline{c}(x)\Gamma c(x) \tag{1}$$

calculate 2pt function

$$C(\tau) = \int d\mathbf{x}\langle M(x)|M(0)\rangle \tag{2}$$

energy eigen state

$$C(\tau) = \sum_n e^{-E_n\tau} \int d\mathbf{x}\langle M(\mathbf{x},0)|n\rangle\langle n|M(0)\rangle \tag{3}$$

Smearing

smeared quark

$$M_i(x) = \int d\mathbf{y}\phi_i(\mathbf{x} - \mathbf{y})\overline{c}(\mathbf{y}, \tau)\Gamma c(\mathbf{y}, \tau) \tag{4}$$

Smearing

smeared quark

$$M_i(x) = \int d\mathbf{y}\phi_i(\mathbf{x}-\mathbf{y})\bar{c}(\mathbf{y},\tau)\Gamma c(\mathbf{y},\tau) \tag{4}$$

like spreading on a toast!

Smearing 2

matrix of correlators

$$\mathrm{C}_{ij}(\tau) = \int d\mathbf{x} \langle M_i(x) | M_j(0) \rangle \quad (5)$$

diagonalize...and obtain

- eigenvalues $\rightarrow$the energy(mass) of the state
- eigenvectors $\rightarrow$wave function overlaps

optimal operator

optimal state

A linear combination of the eigenvector and smeared operators

$$|m_{opt_k}\rangle = v_i^{(k)}|\Psi_i\rangle \tag{6}$$

is ideally a pure state.

This method is called "variational method".

spectral reconstruction

$$C(\tau) = \sum_n e^{-E_n \tau} \langle 0|\Psi^\dagger(0)|n\rangle\langle n|\Psi(0)|0\rangle \tag{7}$$

One can estimate the spectral function as a function of E_n using Bayesian Reconstruction method[2], however a priori information of the spectral function ρ is required.

[2] PRL 111, 182003 (2013)

spectral reconstruction

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in a temporal preriodic system

$$C(\tau) = \int dm n(m) e^{-m\tau} \rho(m) \tag{8}$$

[2] PRL 111, 182003 (2013)

a priori information

- asymptotic behavior $\rho(m) = const. \times m^2$ in large m
- sum rule $\int dmn(m)\rho(m) = C(0)$

a priori information

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- sum rule $\int dmn(m)\rho(m) = C(0)$

problems

- how to determine the coefficient of m^2 (theoretically estimated in the case of the local source)
- the Bose-Einsten distribution function diverges at $m = 0$.

Spectral reconstruction method is not always successful in the case of the smeared source.

improved sum rule

midpoint subtraction[3]

$$\overline{C}(\tau) = C(\tau) - C(\beta/2) \tag{9}$$

where β is a temporal lattice size.
This method can eliminate the singularity
$\int dmn(m)e^{-m\beta/2}\left(e^{-m(\tau-\beta/2)} - 1\right)\rho(m) = \overline{C}(0)$
Using this method, we found improved sum rule

$$\int dmn(m)e^{-m\beta/2}\left(e^{-m(\tau-\beta/2)} - 1\right) m^2 \sim \begin{cases} \frac{1}{3}m^2 + \mathrm{const.} & \beta m \gg 1 \\ \mathrm{const.} & \beta m \ll -1 \end{cases} \tag{10}$$

[3]PRD, 75, 094502 (2007)

preliminary result

We tested the improve sum rule in the analysis on smeared charmonium spectral reconstruction.

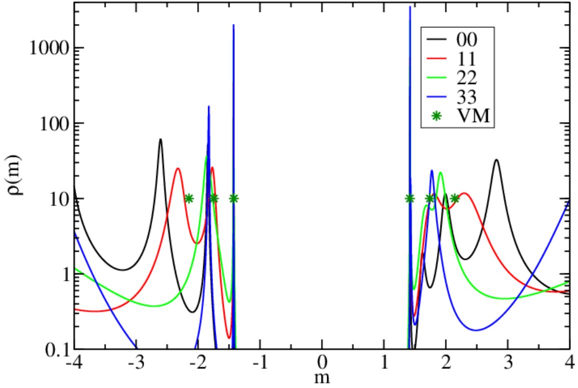

Figure: vector channel (J/Ψ)

Consistent with the variational method ?

task & outlook

task

- symmerize correlator $C(\tau) \to \frac{C(\tau)+C(\beta-\tau)}{2}$
- error analysis (plot w the error band)

  numerical problem...

outlook

- analysis on the optimal state
- expand the local operator with optimal operators

$$|M_0\rangle \sim \sum_k \langle m_{opt_k}|M_0\rangle |m_{opt_k}\rangle \tag{11}$$