Aspects of Chiral Symmetry Restoration from Two-Flavour Lattice QCD Correlation Functions

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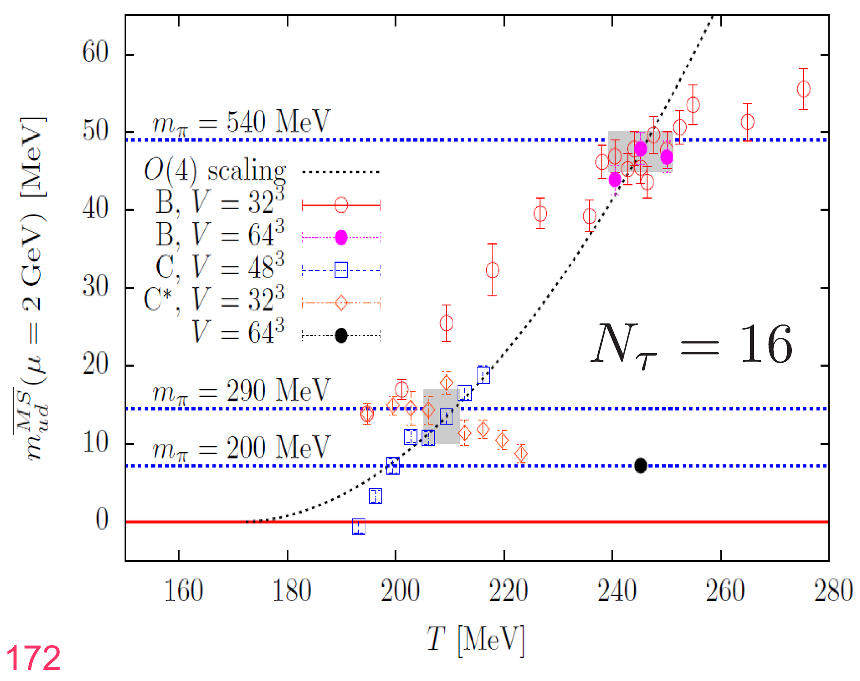
I. Temporal Correlators and the QGP

QCD current-current correlation functions are sensitive to:
- Chiral symmetry breaking/restoration
- Dissociation of particle bound states
- Transport phenomena

$$G_H(\tau,T) = \int dx \langle J_H(\tau,x) J_H(0,0)\rangle e^{ipx}$$
$$= \int d\omega \rho_H(\omega) K(\tau,T) \quad , \quad H = V, A, S, PS$$

II. Lattice Setup and Wilson LCP's

- Two flavours of non-perturbatively improved dynamical Wilson-Clover fermions.
- Extending our previous runs at fixed κ (1), now:
  - → Tune the AWI quark mass to a constant.
  - → Obtain LCP's



1) B.Brandt et al.; PoS LATTICE2010 (2010) 172

III. Finite T Weinberg Sum Rules

At high temperatures, with chiral symmetry restored:
→ finite temperature Weinberg sum rules (2):

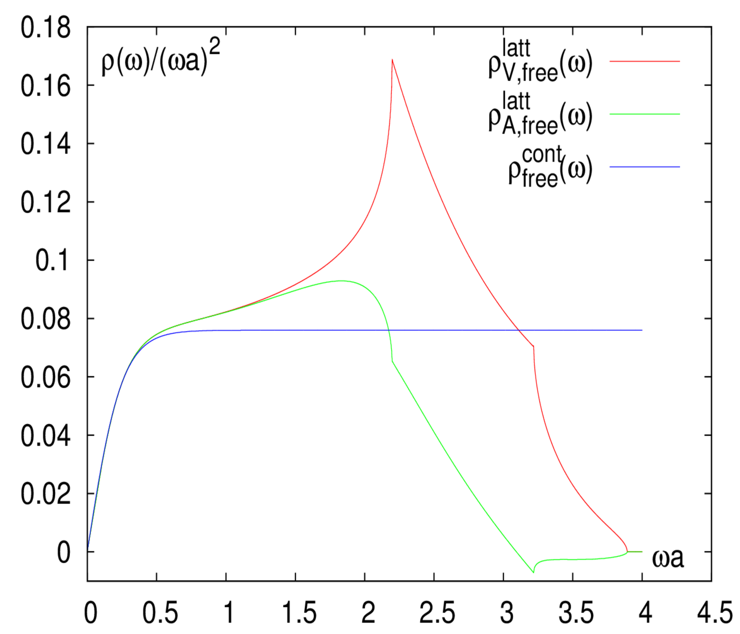
$$W_{SR1} = \int_0^\infty d\omega \; \omega \; (\rho_V(\omega) - \rho_A(\omega)) = 0$$

where $\rho_V(\omega)$ and $\rho_A(\omega)$ are the spectral functions entering the definition of the temporal correlators.

→ The ratio $G_V(\tau)/G_A(\tau)$ is a sensitive measure for studying the Weinberg sum rule and chiral symmetry restoration.

Note:
- Finite lattice spacing without an extrapolation to the continuum
- Lattice cutoff effects enter the (free) spectral functions
- On the lattice the sum rule is not exact:

$W_{SR1} \Rightarrow 1 + \mathcal{O}(a^2)$

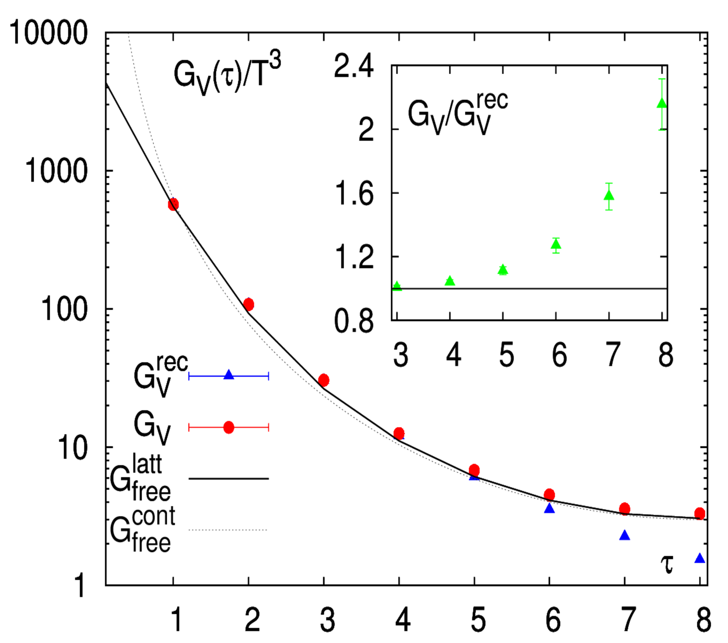


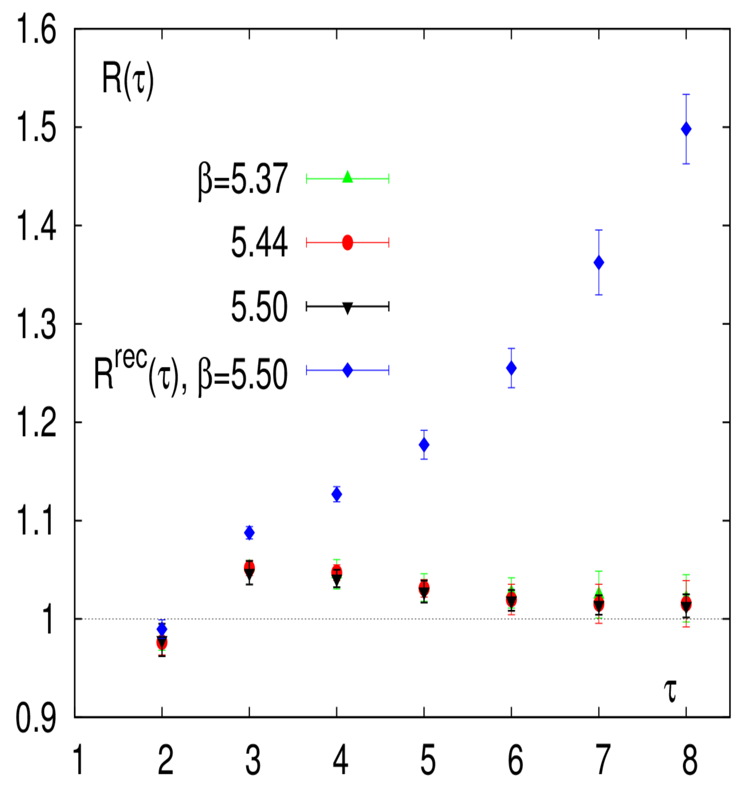
2) J.I.Kapusta, E.V.Shuryak; Phys.Rev. D49 (1994) 4694-4704

IV. Two-Flavour Lattice Results

To study chiral symmetry restoration:
- Choose LCP at $m_\pi = 200 MeV$
- At $\beta = 5.50$ we compute and compare to the reconstructed correlator (3):

$$G_{rec}(\tau,T) = \sum_{\tau'=\tau,\Delta=N_\tau}^{N_{\tau'}-N_\tau-\tau} G(\tau', T=0)$$





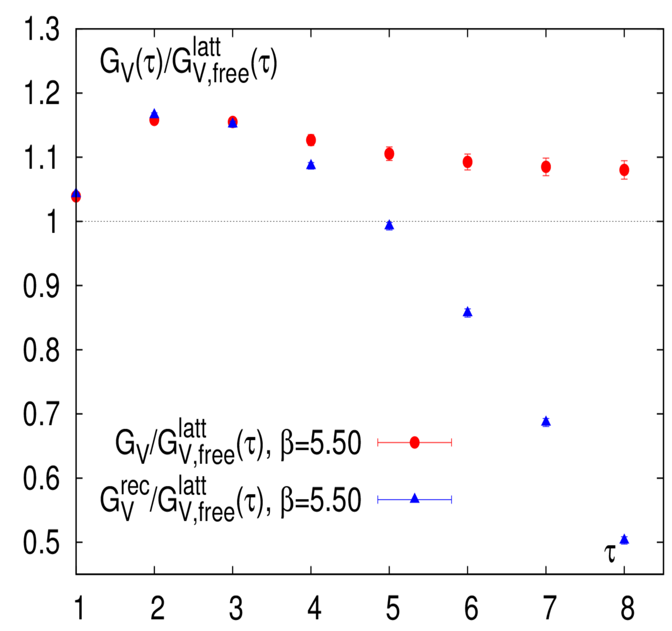
- Visible difference already at correlator level
- Large $G_V(\tau)/G_V^{rec}(\tau)$ at $\tau \simeq N_\tau/2$
  - → Large modification of the bound state structure
- Minimize lattice effects by ratio:

$$R(\tau) = \frac{G_V(\tau)}{G_A(\tau)} \cdot \frac{G^{latt}_{A,free}(\tau)^2}{G^{latt}_{V,free}(\tau)^2}$$

→ Chiral symmetry is restored to within 2% at $\beta \geq 5.37 \;\rightarrow\; T \simeq 200 MeV$.

3) H.T.Ding et al.; arXiv:1204.4945v1

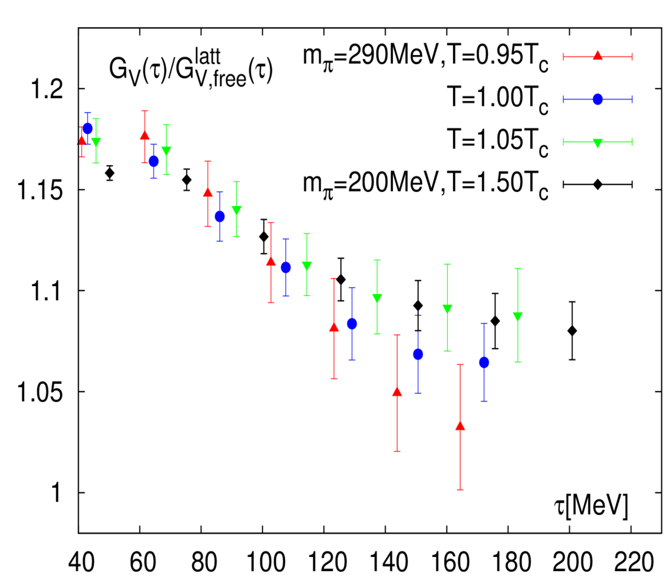
V. Dissociation of the ρ-Particle?



Signs of ρ-dissociation?
- Compare $\frac{G_V^{rec}(\tau)}{G^{latt}_{V,free}(\tau)}$ and $\frac{G_V(\tau)}{G^{latt}_{V,free}(\tau)}$
- Large deviation in $G_V^{rec}(\tau)$
  - → Due to bound state peak
- Almost flat behaviour in $G_V(\tau)$
  - → Dissociation of bound state and emergence of transport?

→ Further analysis required, but the signs are there.

- Choose LCP at $m_\pi = 290 MeV$
  - → Fine temperature resolution
- Lower temperature results
  - → Follow the trend of $\frac{G_V^{rec}(\tau)}{G^{latt}_{V,free}(\tau)}$
- Larger temperature results
  - → Flat at large distances just as $\frac{G_V(\tau)}{G^{latt}_{V,free}(\tau)}$



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