Determination of r_0/a

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Methodology I

- Advantages of using r_0/a to set the scale:
  - good to have as many quantitites as possible
  - it's a purely gluonic quantity
  - allows a fair comparison with results from other actions
  - can be determined rather precisely
- Disadvantage:
  - the value of r_0 in physical units is not well known

Methodology II

- Calculate the static potential from smeared Wilson loops:
  - static action uses HYP-smeared temporal gauge links with

$$\alpha = (1.0, 1.0, 0.5)$$

  - operator basis consists of 5 operators at different levels of spatial APE-smearing,

$$n_{\text{smear}} = \{0, 8, 8, 8, 8\}, \quad \alpha = (1.0, 0.5)$$

    leading to

$$C_{\alpha\beta}(t; r) = \langle 0 | \mathcal{O}_\alpha(t; r) \mathcal{O}^\dagger_\beta(0; r) | 0 \rangle,$$

  - only on-axis Wilson loops are used.
- For each r we use a generalised eigenvalue system

$$C(t_1)v = e^{-E(t_1 - t_0)} C(t_0)v$$

to project the correlator matrix down to one operator, for which the fitting plateaus are identified,

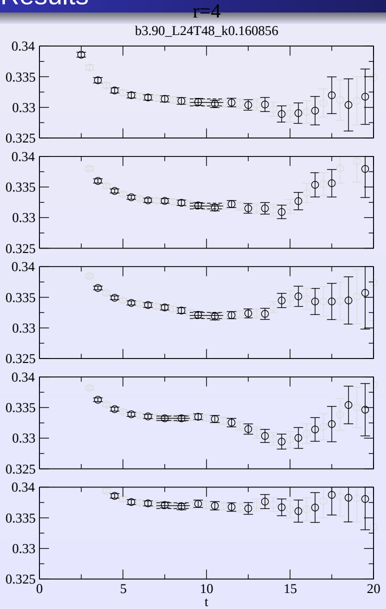
Methodology III

- the static potential is then directly fitted to the correlator using the interpolating ansatz

$$C(t;r) = Ae^{-(V0+\alpha/r+\sigma r)t}$$

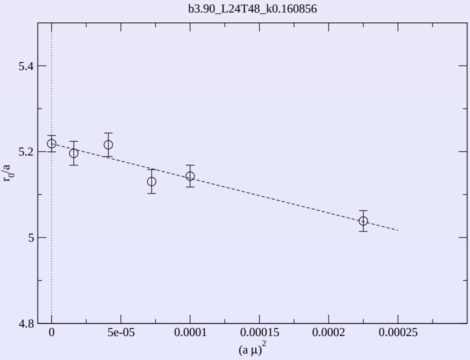
  over the previously determined plateaus in t and over a small range in r,
- the fit takes into account all the correlations in t and r using an appropriate covariance matrix,
- errors are from a bootstrap procedure (and crosschecked with jackknife) using binning.

Results



- Effective masses for $\mu = 0.004$ (top) to 0.015 (bottom) at $r = 4$:
  - systematic errors from the interpolation in r and from excited states,
  - estimated by varying the fit ranges in t and r,
  - always within $1 - 2\sigma$,
  - overlap could still be improved.
- Fits in r, t yield $\chi^2/\text{dof} \sim 0.5 - 1.5$,
- Errors on r_0/a are $0.5 - 1.0\%$.

Results



- Dependence on quark mass $\propto (a\mu)^2$ leading to

  $$r_0/a = 5.219(19) - 8.07(157)(10a\mu)^2$$

  with $\chi^2/\mathrm{dof} = 0.85$ and dof $= 3$.

- Using only 4 lowest μ-values

  $$r_0/a = 5.222(29) - 8.77(430)(10a\mu)^2$$

  with $\chi^2/\mathrm{dof} = 1.26$ and dof $= 3$.

Outlook

- Excited states can also be estimated, with accuracy of a few percent.
- Analysis at $\beta = 4.05$ is ongoing,
- Preliminary result from 196 (very correlated) measurements at $\beta = 3.80, \mu = 0.006$,

$$r_0/a = 4.396(40)$$