PROCEEDINGS OF SCIENCE

Matrix elements of heavy-light mesons from a fine lattice

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We performed a calculation of matrix elements of heavy mesons on a quenched lattice, generated with Wilson gauge fields at $\beta = 6.6$ with a lattice size of $40^3 \times 80$ and a lattice spacing $a^{-1} \simeq 5$ GeV determined from the Sommer parameter $r_0 = 0.5$ fm. We use a non-perturbatively $O(a)$ improved Wilson fermion action and improved currents.
We have calculated the charmonium spectrum as well as form factors of semileptonic decays of pseudoscalar heavy-light mesons containing a c or a b quark to pseudoscalar light mesons through a vector current:

$$\langle P(p)|V^\mu|H(p_H)\rangle = \frac{m_H^2 - m_P^2}{q^2} q^\mu f_0(q^2) + \left(p_H^\mu + p^\mu - \frac{m_H^2 - m_P^2}{q^2} q^\mu \right) f_+(q^2)\,,$$

where p and m_P are the momentum and the mass of the light meson respectively, and p_H and m_H the momentum and the mass of the heavy meson respectively. $q = p_H - p$ is the momentum transfer. V^μ denotes a local vector current. A comparison with other lattice calculations for the decay $B \to \pi l \nu$ is shown in Figure 1.
For the decay constant of the J/ψ meson we find a preliminary value of $f_V = 341(10)$ MeV, using the definition

$$\langle 0|V_j|J/\psi\rangle = f_V m_{J\psi} \varepsilon_j(\lambda),$$

where $\varepsilon_j(\lambda)$ is the polarization vector of the J/ψ. We obtain the following values for mass splittings of charmonium states: $\Delta M(J/\psi - \eta_c) = 74(2)$ MeV and $\Delta M(\chi_{c1} - J/\psi) = 394(15)$ MeV, where the errors are only statistical.

8th Conference Quark Confinement and the Hadron Spectrum
September 1-6 2008
Mainz, Germany

*Speaker.

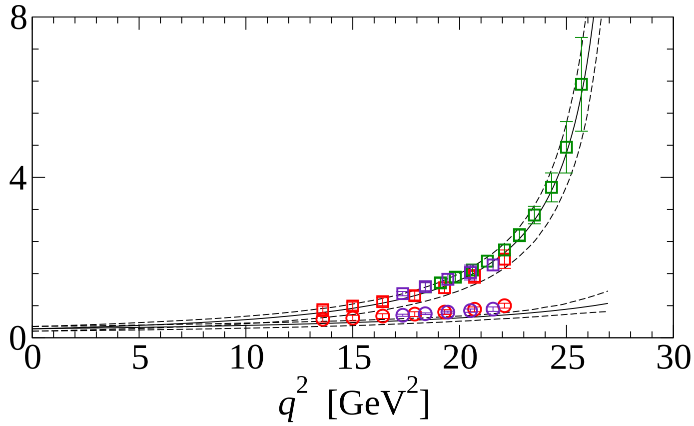

Figure 1: The solid lines denote our results for the form factors (f_+: upper line, f_0: lower line) of the decay $B \to \pi l \nu$. The dashed lines denote our error bounds. The squares denote f_+, circles denote f_0 from other recent lattice calculations (red: quenched, [2], green: $N_f = 2+1$, [3], magenta: $N_f = 2+1$, [4])
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The details of our calculation of the matrix elements and the results for the form factors at $q^2 = 0$ are given in Ref. [1]. We observe a relatively good agreement of our form factors with other lattice calculations.

Our results for the charmonium spectrum are in very good agreement with a previous quenched calculation at the same lattice spacing [5] and in agreement with a recent calculation with two heavy flavors [6]. Since we work on fine lattices where discretization effects are under good control for charmonia it is also of interest to calculate the charmonium decay constants. Our result for the decay constant of the J/ψ is lower than the result of 399(4) MeV from quenched anisotropic lattices of [7] and of 413(40) MeV from lattices with $N_f = 2$ of [8]. The experimental value is 411(7) MeV.

Acknowledgement: We thank J. Simone for useful discussions.

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