Effects of partial quenching and staggered fermions on the scalar correlator

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Abstract: The lightest non-singlet scalar $q\bar{q}$ meson is simulated on the lattice with two dynamical Domain Wall quarks. The dynamical correlators give the scalar meson mass 1.58 ± 0.34 GeV. The correlators with $m_{val} \neq m_{sea}$ show striking effect of partial quenching: they are positive for $m_{val} \geq m_{sea}$ and negative for $m_{val} < m_{sea}$. We derive the scalar correlator within the Partially Quenched Chiral Perturbation Theory and find it describes lattice correlators well. The leading unphysical contribution comes from the exchange of the two pseudoscalar fields and is also positive for $m_{val} \geq m_{sea}$ and negative for $m_{val} < m_{sea}$ at large t. After the subtraction of this unphysical contribution, we obtain the scalar meson mass 1.51 ± 0.19 GeV from partially quenched correlators, which is consistent with the dynamical result and has appreciably smaller error-bar.

The effects of staggered fermions on the scalar correlator is also explored. We derive the scalar correlator in the Staggered Chiral Perturbation Theory and in the Chiral Perturbation Theory for Staggered sea and Ginsparg-Willson valence quarks. We point out that the scalar correlator can become negative on some of the currently used dynamical 2+1 MILC configurations due to the taste breaking.