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Imprint of chiral symmetry restoration on the Polyakov loop and the heavy quark free energy

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The Polyakov loop expectation value $\langle P \rangle$ is an order parameter of the deconfinement transition in the heavy quark mass regime, whereas its sensitivity to the deconfinement of light, dynamical quarks is not apparent. From the perspective of an effective Lagrangian in the vicinity of the chiral transition, the Polyakov loop, P, is an energy-like observable, and $\langle P \rangle$ should hence scale like the energy density. Using $N_f = 2 + 1$ HISQ configurations at finite lattice spacing, we show that near the chiral transition temperature, the scaling behavior of $\langle P \rangle$ and the heavy quark free energy F_q is consistent with energy-like observables in the $3d$, $O(N)$ universality class. We extend this analysis to other energy-like observables, including the response of F_q to the baryon chemical potential, which is expected to scale like a specific heat.

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