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Non-perturbative renormalization of the flavour-singlet local vector current with $O(a)$-improved Wilson fermions

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We determine non-perturbatively the renormalization constant of the flavour-singlet local vector current with $O(a)$-improved Wilson fermions in a moving reference frame. The renormalization constant is fixed by comparing the expectation values (one-point function) of the local vector current and of the conserved one in thermal QCD with a non-zero imaginary chemical potential and in the chiral limit. We implement the method in QCD with $N_f = 3$ flavours discretized by the standard Wilson action for gluons and the non-perturbatively $O(a)$-improved Wilson fermions. By carrying out extensive numerical simulations, the renormalization constant is determined with a precision of a few permille for values of the bare coupling constant in the range $0.52 \leq g_0^2 \leq 1.13$.

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