

## Three topics in extreme QCD

*Friday 29 July 2022 09:45 (45 minutes)*

I discuss three topics in QCD at nonzero temperature and density. First, how configurations with fractional topological charge  $1/N$  in a  $SU(N)$  gauge theory may contribute at low temperature. Second, how the Polyakov loop, which appears to be an artifact of Euclidean space-time, can be naturally introduced in the Hamiltonian form, by introducing new states with test charges. Lastly, I discuss the solution for the low energy excitations for a  $SU(N_c)$  theory with  $N_f$  light fermions in 1+1 dimensions, which is just a modified free boson for fermion number.

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**Session Classification:** Session