Contribution ID: **100** Type: **Poster**

Duality and disorder operators in SU(N) Lattice Gauge Theory

Tuesday 4 November 2025 18:00 (1h 30m)

We construct an exact dual formulation of pure SU(N) Hamiltonian lattice gauge theory with local dual dynamics in (2+1) dimensions. The dual model is obtained by making a series of iterative canonical transformations on the electric field operators and their conjugate vector potentials associated with the links around each plaquette. This transformation maps the original gauge degrees of freedom to dual variables defined on plaquettes: SU(N) magnetic scalar fields corresponding to plaquette flux operators, and their conjugate electric scalar potentials. Under SU(N) gauge transformations, both transform like adjoint matter fields. The dual Hamiltonian describes the nonlocal self-interactions of these plaquette flux loops in terms of the electric scalar potentials and with inverted coupling. We show that these nonlocal loop interactions can be made local and converted into minimal couplings by introducing SU(N) auxiliary gauge fields along with
new plaquette constraints. Our construction completely simplifies the magnetic part of the Hamiltonian, which dominates near the continuum ($g^2 \longrightarrow 0$) limit.

Exploiting these exact duality transformations, we construct the most general disorder operator for SU(N) lattice gauge theory. These disorder operators, defined on the plaquettes and characterized by (N-1) angles, are the creation and annihilation or the shift operators for the SU(N) magnetic vortices carrying (N-1) types of magnetic fluxes. They are dual to the SU(N) Wilson loop order operators which, on the other hand, are the creation-annihilation or shift operators for the (N-1) electric fluxes on their loops. We derive a new order-disorder algebra involving SU(N) Wigner-D matrices that reduce to standard Wilson-'t Hooft algebra in a special limit. We also compute the path integral expression for the vortex-free energy, which should be useful for Monte Carlo simulations and to understand the role of magnetic vortices and their condensation, if any, in the colour confinement.
References:
1. Manu Mathur, Atul Rathor , Exact Duality and Local Dynamics in SU(N) Lattice Gauge Theory, Phys. Rev. D 107, 074504 (2023).
2. Manu Mathur, Atul Rathor, Disorder Operators and Magnetic Vortices in SU(N) Lattice Gauge Theory, Phys. Rev. D 108, 114507 (2023).

Parallel Session (for talks only)

Theoretical developments and applications beyond Standard Model

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Session Classification: Poster session