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Color Confinement and Topology in Lattice Gauge Theories

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Color confinement is still an open and challenging problem in modern physics, being the non-perturbative regime of $SU(N_c)$ Yang-Mills theory the primarily responsible for such difficulty. Among the various ideas proposed to understand the confinement mechanism, the center-vortex configurations seem to play a crucial role when reproducing the desired phenomenology.In this picture, the Yang-Mills vacuum consists of an ensemble of percolating magnetic flux lines, the center vortices (a "spaghetti" like vacuum), in what is known as center dominance. These vortex carry charges proportional to the weights of the gauge group, and can be oriented or not. The random fluctuation in the vortices degrees of freedom is (believed to be) the origin of area law of the Wilson loops. Yet, the study of these degrees of freedom is a complicated analytical task. At the same time, Monte Carlo simulations on the lattice provide us a very useful way to study these degrees of freedom, and nowadays a great deal of numerical evidence to the center-vortex scenario is available in the literature. However, the detection of these vortices is not so simple on the lattice. In the continuum, they can be identified by their guiding center while, on the lattice, the same cannot be done and one can only see plaquettes pierced by projected vortices on a dual lattice. In this work, we aim to present the techniques utilized to study the center-vortex picture on the lattice, discussing some difficulties that appear, and show some results obtained by our research group at IFSC/USP.

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