Propagators of 2d Landau-gauge Yang-Mills theory

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In two-dimensional Yang-Mills theory many quantities can be determined exactly. In particular, no propagating modes exist, and thus the theory is perfectly confining. It is also related to topological field theories [1]. In Landau gauge, this is manifest already in perturbation theory, where one has an explicit version of Kugo-Ojima confinement by the quartet mechanism [2].

On the other hand, the Gribov-Zwanziger confinement scenario is also applicable to this theory [3]. As in higher dimensions it can be used to obtain predictions for the infrared critical behavior of correlation functions, especially the ghost and gluon propagators. If the scenario is correct in two dimensions, this would be very advantageous. On the one hand, it would permit to study the connection between the Gribov-Zwanziger confinement scenario, the Kugo-Ojima confinement scenario, and topological aspects. However, it is not a-priori clear how results will translate to higher dimensions. On the other hand, it will be possible to study finite volume effects with much higher resolution that in higher dimensions [4]. These effects are currently under active debate (see, e.g., [5]), and any possibility to study them quantitatively is valuable.

Unfortunately, it is not (yet) known how to calculate the Landau gauge correlation functions analytically. A possibility to obtain them are lattice calculations.

Results for the gluon propagator and the ghost dressing function are given in figure 1. Clearly, an infrared suppressed gluon propagator (at large volume) is seen as well as a infrared enhanced ghost dressing function. This is in qualitative agreement with the Gribov-Zwanziger scenario. In particular this implies that of the two infrared exponents found in [3], only the non-trivial one is realized.

Hence, this supports the existence of a Gribov-Zwanziger mechanism also in two-dimensional Yang-Mills theory. It will thus be an interesting laboratory to study the aforementioned effects. A quantitative analysis of the infrared effects as well as an extension to other quantities of interest, like vertices and the Faddeev-Popov operator, is straight-forward [4]. This may open up an interesting road to connect various aspects of confinement and to understand more quantitatively finite volume and other lattice artifacts.

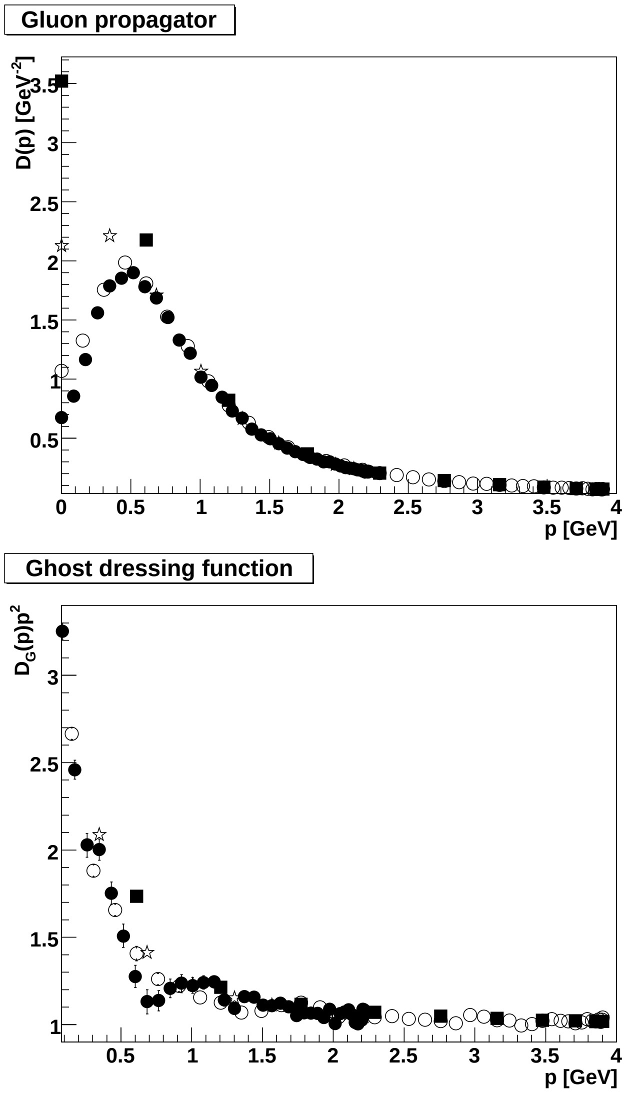

Figure 1: The gluon propagator (top) and ghost dressing function (bottom). Full circles, open circles, open stars, and full squares denote results from a (14.2 fm)^2, (8.08 fm)^2, (3.56 fm)^2, and (2.02 fm)^2 lattice, respectively. Momenta are measured along the x-axis and the scale has been set using the exact continuum result for the string tension [6] set to (440 MeV)^2. More details can be found in [4].

References

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