Commun. Math. Phys. 174, 93 – 116 (1995)

Communications in
Mathematical
Physics

Local BRST Cohomology in the Antifield Formalism: II. Application to Yang–Mills Theory

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Received: 8 June 1994 / in revised form: 21 February 1995

Abstract: Yang–Mills models with compact gauge group coupled to matter fields are considered. The general tools developed in a companion paper are applied to compute the local cohomology of the BRST differential s modulo the exterior space-time derivative d for all values of the ghost number, in the space of polynomials in the fields, the ghosts, the antifields (=sources for the BRST variations) and their derivatives. New solutions to the consistency conditions $sa + db = 0$ depending non-trivially on the antifields are exhibited. For a semi-simple gauge group, however, these new solutions arise only at ghost number two or higher. Thus at ghost number zero or one, the inclusion of the antifields does not bring in new solutions to the consistency condition $sa + db = 0$ besides the already known ones. The analysis does not use power counting and is purely cohomological. It can be easily extended to more general actions containing higher derivatives of the curvature or Chern–Simons terms.

1. Introduction

In a previous paper [1], referred to as I, we have derived general theorems on the local cohomology of the BRST differential s for a generic gauge theory. We have discussed in particular how it is related to the local cohomology of the Koszul–Tate differential δ and have demonstrated vanishing theorems for the cohomology $H_k(\delta|d)$ under various conditions. In the present paper, we apply the general results of I to Yang–Mills models with compact gauge group and provide the explicit list of all the non-vanishing BRST groups $H^k(s|d)$ for those models.

It has been established on general grounds that the groups $H^k(s)$ and $H^k(s|d)$ are respectively given by

$$H^k(s) \simeq \begin{cases} H^k(\gamma, H_0(\delta)) & k \geqq 0 \\ 0 & k < 0 \end{cases} \tag{1.1}$$

★ Aspirant au Fonds National de la Recherche Scientifique, Belgium.

★★ Supported by Deutsche Forschungsgemeinschaft and by the research council (DOC) of the K.U. Leuven.

★★★ Also at Centro de Estudios Científicos de Santiago, Chile.