Referee Report

SCIPOST Submission 202001_00038$v2$ - revision

The quasilocal degrees of freedom of Yang-Mills theory

Overview

The revised manuscript has been significantly improved in clarity and mathematical rigor. I would like to thank the authors for having carefully read and implemented the requested/suggested changes in my previous (admittedly very long) report. I do have just a few minor comments that the authors may or may not decide to implement. At any rate, as I do not have other obstructive comments or remarks, I do suggest this manuscript for publication in Scipost.

Minor comments

1. In the introduction "we in this article limit ourselves" may be rephrased.

2. A general comment on the differential geometry on field space used here, although I understand this is not a strictly mathematical paper: It is probably good to reiterate that most things are done within the setting of "local" calculus, and not as general differential geometry on Frechet manifolds, for which much more detail would unfortunately be needed: the dual of a Frechet space is not Frechet, so one needs to define what cotangent bundles mean. Except from the connection form, everything seems to be "local" to me, in the sense of pullback from the (infinite) jet bundle. The "cotangent bundle" considered here is the fiberwise dualisation of the vector bundle whose sections are the fields. This could be a decent way to clarify in what sense all of these quantities are understood.

3. After (1): the normal components of A naturally do not show up on a "time slice" Σ. I do not think this is a "gauge". Rather, the "quasilocal YM configuration space" is a subspace of the space of initial data (over R), in the sense of a Cauchy problem (naturally, one would specify A, E at Σ, on shell of Gauss' constraint). I guess the authors might be after a slightly different perspective here, but I am still not sure this should be considered as a gauge, since the restriction map ι^* for $\iota\colon \Sigma \to \Sigma \times \mathbb{R}$ "kills" the transversal part of a connection $A_t dt$.

4. Similarly, the authors consider $\mathcal{A}/\mathcal{G}$ as the "true" configuration space of the theory. I guess this makes sense, although it seems to me that the more relevant space to look at would be the symplectic reduction of C inside the phase space, where C denotes configurations that satisfy Gauss' law. I would call that the reduced phase space (i.e. what the authors use in 3.4).

5. After (9): typo "tcovariance"

6. After Def 2.3. The authors define forms $\lambda \in \Omega^k(\mathcal{A}) \otimes \Gamma(\Sigma, W)$. Do they really want to consider forms on the space of fields with values in sections of a vector bundle on which there is an action of G? I found this confusing for I do not see an obvious application for such a general object, so perhaps a couple words might be useful for the reader?

7. In section 3: what is a "canonical completion" of a symplectic structure?

8. The ideas relating to a modification of the symplectic reduction picture, presented in section 3.4 are interesting. It is a little confusing though that a general theorem is invoked according to which the reduced form on $\Phi//\mathcal{G}$ IS symplectic, but then it is said not to be. I would fix this by making it clear that the authors are taking inspiration from standard symplectic reduction techniques, and provide a similar construction which shows a behaviour sensitive of boundaries. This is implied by the title, but it remains slightly unclear to the reader whether a general theorem is invoked (and in my understanding, it isn't).