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Peer Review

Review of: "Dynamical Edge Modes in Yang-Mills Theory"

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This paper studies the symplectic structure of Yang-Mills theory with boundaries. The main focus is on the splitting of the symplectic structure into “bulk” and “edge” modes, and a discussion of how these degrees of freedom interact. A suitable set of bulk and edge variables is identified, and the symplectic form is shown to split into a direct product form, both for spacetimes formed by a causal diamond and for static spacetimes with a timelike boundary. The Poisson brackets between all fields are obtained by inverting the symplectic form, and it is demonstrated that brackets of the form {bulk, edge} vanish.

In the latter sections of the paper, it is shown that the splitting is not preserved under dynamical evolution, as the Hamiltonian generating time translations contains a cross term that mixes bulk and edge parts. Such a feature is argued to be due to the non-abelian nature of the gauge group, as abelian Maxwell theory remains split. Finally, several perturbative examples are given to highlight aspects of the construction, both in the weak field and near horizon limits. It is shown that the Hamiltonian for the weak expansion preserves the splitting, although the horizon limit appears to have no further effect on separating the bulk-edge mixing in the Hamiltonian.

This paper is of a high technical level, and the analysis is presented in a clean and concise manner, with a suitable introduction given for non-experts. In addition to the comments raised by the other reviewers, I have several minor points that I feel should be addressed.

- Is the requirement of a static spacetime in (4.1) important? Can one relax this condition, e.g., to study YM on stationary spacetimes (or those with even less symmetry)?
- Is (4.5) a unique choice for a DEM boundary condition? Would general well-posed boundary conditions (which admit edge modes) lead to a bulk/edge split?

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- Is it possible to perform the analysis of section 5.2 away from the weak field limit? It is not entirely clear to me if the conclusions for the horizon limit hold away from the weak field limit (where the cross term is already suppressed).
- It would be interesting to provide some discussion as to what classes of non-abelian theories would be expected to split at the level of the Hamiltonian (e.g., in the final paragraph of Section 6). Is this likely to be as simple as gravity vs. all other non-abelian theories?

Declarations

Potential competing interests: No potential competing interests to declare.