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Asymptotic symmetries in the BV-BFV formalism. (English) Zbl 1470.81051

A classical field theory on a manifold with boundary phrased in the BV-BFV formalism is described by two sets of data, one assigned to the bulk manifold and one to the boundary, together with an appropriate map between the two [A. S. Cattaneo et al., Commun. Math. Phys. 332, No. 2, 535–603 (2014; Zbl 1302.81141)]. To the bulk manifold $M$ one associates BV data composed of a $(-1)$-symplectic graded manifold $(\mathcal{F}, \Omega)$, a degree 0 action functional $S$ and an odd vector field $Q$ on $\mathcal{F}$ of degree 1 with the cohomological property $[Q, Q] = 0$. To the boundary $\partial M$ one assigns BFV data composed of an exact $(0)$-symplectic graded manifold $(\mathcal{F}^0, \Omega^0 = \delta \alpha^0)$, where $\delta$ denotes the de Rham differential on the space of local forms, a degree 1 local action functional $S^0$ on $\mathcal{F}^0$ and an odd vector field $Q^0$ on $\mathcal{F}^0$ of degree 1 with the property: $[Q^0, Q^0] = 0$. The BV-BFV construction connects the BV data associated with the bulk to the BFV data associated with the boundary by means of a map $\pi : \mathcal{F} \rightarrow \mathcal{F}^0$ together with the following relations

\begin{align*}
\iota_Q \Omega &= \delta S + \pi^* \alpha^0, \\
\iota_{Q^0} \Omega^0 &= \delta S^0,
\end{align*}

\begin{align*}
\frac{1}{2} \iota_Q \iota_Q \Omega &= \pi^* S^0, \\
\iota_{Q^0} \iota_{Q^0} \Omega^0 &= 0.
\end{align*}

In this paper, the authors show how one recovers the standard Noether analysis of surface charges from the BV-BFV picture, in field theories of BRST type such as electrodynamics (ED) whose symmetries are closed off-shell. The authors prove that $S^0[\Lambda] = Q_N[\Lambda] + \text{higher antifield number}$, where $Q_N[\Lambda]$ denotes the Noether charge associated to a (local) symmetry generated by a gauge parameter $\Lambda$. The authors also discuss the extension of the BV-BFV formalism to corners, i.e., boundaries of the boundary, and higher codimension strata.

The authors study the asymptotic symmetries of ED considered as an abelian Yang-Mills theory [P. Mnev et al., Ann. Henri Poincaré 21, No. 3, 993–1044 (2020; Zbl 1433.81120)]. After introducing appropriate falloff conditions on fields, the authors compute the asymptotic charges. They also study the behavior of the symplectic structure of ED under large gauge transformations (LGT), i.e., transformations of the fields whose parameters have nonvanishing asymptotics. The authors argue that the failure of invariance of the canonical structure under LGT does not mean that LGT’s are not symmetries of the asymptotic structure [A. Herdegen, Lett. Math. Phys. 107, No. 8, 1439–1470 (2017; Zbl 1409.70015)] because from the viewpoint of BV-BFV the failure of invariance of $\Omega^0$ is “expected” and fully consistent with the structure, if one appropriately takes into account the corner data.

The authors also study the free two-form model, which is dual to a free scalar field on-shell, and recover asymptotic charges for scalar field theory. While in the case of ED, the on-shell vanishing of the boundary action leads to the existence of a conserved quantity, the conservation of asymptotic charges for the scalar field is deduced from the vanishing of the boundary action for the dual theory. The authors also propose a modified duality between a scalar and a two-form model in order to compute asymptotic charges for scalar fields when sources are added. Finally, the authors argue that constant shifts and (dually) symmetries generated by closed but not exact forms do not yield a BV structure.

Reviewer: Farhang Loran (Isfahan)
MSC:
81T20 Quantum field theory on curved space or space-time backgrounds
81T32 Matrix models and tensor models for quantum field theory
53D05 Symplectic manifolds (general theory)
58A50 Supermanifolds and graded manifolds
81R05 Finite-dimensional groups and algebras motivated by physics and their representations

Keywords:
asymptotic symmetries; large gauge transformation; BV-BFV formalism; generalized Noether’s procedure

Full Text: DOI arXiv

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