

Posudek práce

předložené na Matematicko-fyzikální fakultě
Univerzity Karlovy

- posudek vedoucího posudek oponenta
 bakalářské práce diplomové práce

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Název práce: **Weylova a konformní symetrie**

Studijní program a obor: **Obecná fyzika**

Rok odevzdání: **2019**

Jméno a tituly vedoucího: **Doc. Alfredo Iorio**

Pracoviště: **Ústav částicové a jaderné fyziky**

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Odborná úroveň práce:

- vynikající velmi dobrá průměrná podprůměrná nevyhovující

Věcné chyby:

- téměř žádné vzhledem k rozsahu přiměřený počet méně podstatné četné závažné

Výsledky:

- originální původní i převzaté netriviální kompilace citované z literatury opsané

Rozsah práce:

- veliký standardní dostatečný nedostatečný

Grafická, jazyková a formální úroveň:

- vynikající velmi dobrá průměrná podprůměrná nevyhovující

Tiskové chyby:

- téměř žádné vzhledem k rozsahu a tématu přiměřený počet četné

Celková úroveň práce:

- vynikající velmi dobrá průměrná podprůměrná nevyhovující

Slovní vyjádření, komentáře a připomínky vedoucího:

In this thesis the Candidate studied conformal and Weyl symmetries, for classical field theories, and investigated the fascinating possibility, for Liouville field theory, of classical instances either of Weyl or of gravitational anomalies.

The Candidate first builded-up the necessary advanced knowledge of conformal and Weyl symmetries, by mastering the results of the work [1]. There the necessary and sufficient conditions, for flat space scale invariant theories to be fully conformally invariant, were established. Such conditions rely on the possibility to “lift” Lorentz and scale invariant actions to their diffeomorphic and Weyl invariant counterparts, for fields of any spin and spacetimes of any dimension.

Jackiw in [2] elaborates on the results of [1], focusing on the two-dimensional Liouville scalar field theory. He considers the fact that the procedures described in [1] find an obstruction, due to the central term of the conformal symmetry algebra for this theory, that is the Virasoro algebra. While this behavior is not surprising, when seen as a “classical trace anomaly” (see, e.g., [3] and also [1]), Jackiw rises the question whether this “classically anomalous” behavior could be transferred to the diffeomorphic invariance, retaining Weyl invariance instead.

In this thesis, the Candidate became fully familiar with all the subtleties involved in the elaboration exposed in [2], and, more importantly, explicitly computed all the relevant quantities necessary to prove Jackiw’s conjecture. More specifically, on the one hand, he computed the improvement terms of the energy momentum tensor, necessary to re-establish tracelessness, hence to cancel the anomalous behavior on the Weyl-symmetry-side. On the other hand, he provided an explicit proof of the statement of [2] about the fact that W^μ is not a vector under diffeomorphisms. This way he proved the conjecture that indeed the “classical anomaly” swaps to the diffeomorphic-invariance-side. Finally, he performed the computation of the covariant divergence of the energy-momentum tensor, $\nabla_\mu T^{\mu\nu}$, to have an explicit expression for the gravitational anomaly. Although the outcome is not conclusive in this respect, the result is a solid starting point for later investigations.

The calculations just described are lengthy and non-trivial, and were performed by the Candidate by developing his own computational tools and notations. Furthermore, the logic of the various procedures is quite involved and subtle, and the Candidate showed to master them fully. Both these facts show sharpness of mind, commitment and rigorous discipline. These qualities led the Candidate to successfully complete the assigned task, and to actually produce a work that went beyond my expectations.

[1] A. Iorio, L. O’Raifeartaigh, I. Sachs, and C. Wiesendanger, Weyl gauging and conformal invariance. Nucl. Phys. B **495** (1997) 433.

[2] R. Jackiw, Weyl symmetry and the Liouville theory, Theor. Math. Phys. **148** (2006) 941.

[3] F. Toppan, On anomalies in classical dynamical systems, J. Nonlin. Math. Phys. **8** (2001) 518.

Případné otázky při obhajobě a náměty do diskuze:

Q1. Is this statement true: “The presence of any macroscopic scale in the theory, like, e.g., a mass m , necessarily impedes any kind of scale and conformal symmetry”? Elaborate your answer.

Q2. The expression $\nabla_\mu T^{\mu\nu}$ you computed is quite involved. At this stage of the analysis, it is not easy to see how to reduce it to a more intelligible form, and this is not necessary, anyway, to establish your conclusions. Nonetheless, do you have any educated guess that can help figuring out what to expect there?

Práci

doporučuji
 nedoporučuji
uznat jako bakalářskou.

Navrhuji hodnocení stupněm:

výborně velmi dobře dobře neprospěl/a

Místo, datum a podpis vedoucího:

Praha, 4.6.2019

Alfredo Iorio
