

Posudek práce

předložené na Matematicko-fyzikální fakultě
Univerzity Karlovy v Praze

- posudek vedoucího posudek oponenta
 bakalářské práce diplomové práce

Autor: Roman Derco

Název práce: Instantons and unitarily inequivalent quantum vacua

Studijní program a obor: Fyzika, jaderná a subjaderná fyzika

Rok odevzdání: 2011

Jméno a tituly oponenta: RNDr. Jiří Novotný, CSc.

Pracoviště: ÚČJF MFF UK

Kontaktní e-mail: Jiri.Novotny@mff.cuni.cz

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 oponenta:

Because the submitted thesis is the second corrected version of the originally unsuccessful one, I will not repeat the general outline of the thesis in detail (this can be found in the report on the previous version) and rather I will concentrate to the differences.

In the previous version, the review part has been "equation for equation" copied from single sources which could be easily traced back to be the chapters of the textbooks or monographs or separate sections of the original papers. The new version has improved a little bit. Namely, more than one source is used for each topic and these sources are more carefully quoted in the text. Also the language of this part has been somewhat improved. Though this substantial improvements, this part of the thesis is still rather sketchy, sometimes the sentences are not ended properly or some part of them is evidently missing (e.g. the sentence before eq. (3.11)), the various paragraphs are not much logically interconnected and sometimes it seems as if some of the paragraphs in fact should belong rather to the different sections (e.g. the third paragraph on page 19 (section 3.3), where the notation has been changed without any reason and from the context it seems that it should be rather part of the section 4.3). Sometimes also some incorrect statements appear (e.g. in the first paragraph of section 3.1, where the soliton is defined as a finite action solution of the equations of motions instead of the finite energy one). I am also still missing some sort of "added value" in the sense of little bit more unified point of view to the related topics taken from different sources. On the other hand I appreciate, that the author has responded to the suggestion from my previous report and added several additional relevant topics like the path integral quantization of the particle on the circle, the interpretation of the instantons as the classical trajectories connecting the topologically inequivalent classical vacua and the θ -vacua.

The part containing original work of the author also has been changed. The controversial parts has been removed and a new material has been added. This can be found in the introduction to the section 4. (page 21), to the last paragraph of section 4.1 (page 26), to the section 4.2 (pages 27-31) and to the appendix A (pages 40-44, where a detailed derivation of the eq. (2.54) is presented). With the exception of the last calculation (this should be rather taken as a part of the review, because it represents a re-derivation of the known result) which is mathematically rigorous and consistent, the other parts contain rather conjectures than formal results. However, even though there might be some rationale for these conjectures, the form of their presentation is vague and confusing and also inconsistencies are present (e.g. the matrix elements of a dimensionful observables x and y are obtained dimensionless (cf. eq. (4.60)-(4.62), the Hilbert space of states and operators on it are not properly specified and last but not least, the origin of fig. 4.7 is not explained at all).

On the other hand I have to admit, that the problem of the interrelation of the topological aspects of the quantum field theory and the unitarily inequivalent representations of the canonical commutation relations is very difficult so that I did not expect that it can be solved completely within the diploma thesis.

Therefore in spite of the above reservations about the form of the thesis I suggest (provided the oral presentation will be satisfactory) to accept the work as a diploma thesis and to evaluate it as good.

Případné otázky při obhajobě a náměty do diskuze:

- 1) On page 11 after eq. (2.56) you make the following statement: "It means that time evolution leads out of the original Hilbert space. Despite the fact that the number of degrees of freedom is finite, time evolution of the vacuum give us IQV which breaks the SvNT. This breaking could come from non-trivial topology at finite degree of freedom but we have not investigated this." Could you specify here the inequivalent vacua and corresponding unitarily inequivalent representations of the canonical commutation relations which break the Stone-von Neuman theorem in this case?
- 2) Starting with eq.s (4.50), (4.51) you introduce the system of two independent linear harmonic oscillators with which you manipulate rather vaguely in what follows. Could you specify the Hilbert space of states

and the operators on it more closely? Do the operators x and y commute, and if it is the case, why do you introduce the operator $xy+yx$?

3) Could you explain the shape of the potential in fig. 4.7?

Práci

doporučuji

nedoporučuji

uznat jako diplomovou/bakalářskou.

Navrhuji hodnocení stupněm:

výborně velmi dobře dobře neprospěl/a

Místo, datum a podpis oponenta:

V Praze 24.1.2012

Jiří Novotný