

Referee report:

Ph.D. thesis title: 'The mathematical theory of perturbations in cosmology'.

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Study programme: Physics

Specialization: Theoretical Physics

The thesis is devoted to the investigation of cosmological perturbations. It is split into four main parts. The first two chapters comprise an introductory part. In chapter 1 the brief overview of modern cosmology is presented. In Chapter 2 there is given a review of the algebraic classifications for Weyl tensor in the multidimensional case, the classifications of spinors, the special attention is paid to Kundt class. The results of these chapters are obtained by other authors and do not contain novel results by Mr. Novák, playing the role of literature analysis.

In Chapter 3 the methods of tetrad formalism as well as Geroch-Held-Penrose formalism are applied to the perturbations of the Friedmann-Lemaître-Robertson-Walker metrics, leading to new results for decoupling in different sectors as well as to the estimative expressions for scalar perturbations. The obtained results are novel and require further investigation in order to check their applicability to the Cosmological Inflation theory.

The Chapter 4 is devoted to the study of scalar perturbations within nonlinear $f(R)$ models containing stable deSitter points. The explicit expressions for scalar perturbation potentials are obtained for the three approximate cases, namely, astrophysical approach, large scalaron mass and quasistatic approach. The obtained results are novel, they can be applied within the frameworks of the popular Miranda, Starobinsky and Hu-Sawicky models. The results of this chapters are published as a high standard paper in EPJC. These results are an important step towards the more close understanding of the problem of the Universe acceleration.

Among the minor critique remarks regarding the content of the thesis, I could mention the following one. The narration in the Chapters 1 to 3 is vague to a noticeable extent. In some places, the author makes concise evaluative judgements about various theoretical facts that sometimes seem overly subjective due to the lack of the proper balancing views, examples or the supplementary context from the references. The dissertation is written in understandable English, with some typos and errors. However, the mentioned limitations are of no significance on the scientific results of the work.

The thesis proves Mr. Novák's ability for creative scientific work. The results given in Chapter 3 hint at applications to the Cosmological Inflation theory, while the results presented in Chapter 4 could be used for simulations of galaxy dynamics for the case of mentioned models of $f(R)$ -gravities. These models are a promising way to model the accelerated expansion of the Universe, thus this thesis should contribute to new research in this direction.

Yours Sincerely
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