

Posudek práce

předložené na Matematicko-fyzikální fakultě
Univerzity Karlovy v Praze

- posudek vedoucího posudek oponenta
 bakalářské práce diplomové práce

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Název práce: Determination of parameters of dark energy and modified gravity in the LSST project

Studijní program a obor: Fyzika, Teoretická fyzika

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Jméno a tituly vedoucího: RNDr. Michael Prouza, Ph.D.

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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:

The Large Synoptic Survey Telescope (LSST) is one of the most important astronomical projects currently under construction. After the start of its scientific operation in early 2020s, it will be not only the experiment transforming our approach to astronomy (due to the huge amount of data gathered and their immediate availability), but also likely a first experiment able to really measure the parameters of a dark energy of the universe. The LSST data will thus provide a highly important opportunity to confirm or refute the validity of current standard cosmological model (Λ CDM cosmology).

The Institute of Physics of the Czech Academy of Sciences (CAS) is one of the few international members in the largely U. S.-based LSST collaboration. Until recently, we were involved mostly in the technical aspects of the project, for example in the CCD characterization and CCD testing automation. Together with Michal Vraštil I have entered one of the scientific groups that are associated with the LSST project – the Dark Energy Survey Collaboration (DESC). This is possibly the most important group dedicated to scientific aspects of this experiment, currently composed of about 150 scientists.

Michal's participation in the DESC was very active and very successful. Michal was able to quickly grasp the discussed problematic, and within several months he was able to define a niche for himself. In cooperation especially with the scientists from the Argonne National Laboratory (ANL), he started to work on the cosmological simulations, exploring alternatives with respect to the standard cosmological model. His work is much appreciated across the whole DESC collaboration and dedicated mostly to a specific model of the chameleon gravity. Results of this Michal's contribution to the whole DESC collaboration and to the LSST project are also the core of the presented thesis.

The thesis structure reflects the steps that were taken by Michal in the course of his research. After the introduction there follows the chapter about experimental tests of dark energy, which summarizes the properties and scientific goals of two major experiments under construction – ground-based LSST and future satellite mission Euclid. This chapter contains also a useful overview of other experimental efforts in this area, starting from on-going projects, through under construction up to future ones. The understanding of the LSST experiment and of other projects within this field was crucial for Michal, and the overview in the second chapter might be used as a useful primer of the state of this field.

The third chapter then briefly reviews many alternatives to the standard cosmology of the dark energy. Also this chapter is based on the compilation from many sources, but the understanding of alternatives is essential for specific work on particular theories from this set. I personally appreciate this chapter very much, as for me it was very inspiring to have all this information organized so nicely and concisely.

The fourth chapter then contains Michal's original results from the simulations of chameleon field. In comparison with some other theses, Michal was in more difficult position, as his work within the DESC was initially not precisely defined and the precise topic of his original research within the thesis was defined during the course of the work, based on the needs of the collaboration. Therefore there were also present some blind ends and un-successful attempts to solve the problem, which are very well described in the fourth chapter. However, this very well illustrates the course of work of any scientist, and therefore I think that it was useful also for Michal Vraštil

to deal with this aspect of scientific work already in his diploma thesis. Even though the successfully achieved results are presently only for several simplified cases, these are still very important results for the whole DESC collaboration, that are truly original and were not computed before and that will be used in further cosmological simulations for the LSST.

The thesis is the completed with summary, and with two appendices – the first is summarizing the stepping stone of this whole research – the brief description of the standard Λ CDM cosmology, and the second one contains several excerpts from the computer code with explanatory remarks and some reasoning behind this programming work.

In general, I truly admire Michal's approach and results. I believe that in his thesis he mastered the all the essentials of the scientific work in our field. In comparison with other students that I have already led, my supervision was much less pronounced, as Michal was able to work truly independently. Michal is also do not shy of any mathematical work and of programming, he also possesses very good writing and English skills. In combination with his reliability and carefulness he is almost an ideal candidate for any thesis supervisor.

I believe that in the thesis Michal did not waste these expectations. He was able to achieve the original research results and to establish very good position in the large international collaboration.

Případné otázky při obhajobě a náměty do diskuze:

As the supervisor of the presented thesis, I have discussed my questions with Michal Vraštil already during the writing and the preparation of this presented work. Therefore, I have no further question for the thesis' author at this moment.

Concerning the possible topics for discussion, it might be interesting, if Michal can present us in more detail his plans for next steps in his research during coming months. It will be useful to explain, why he thinks that using multi-grid method in N-body simulations might be more promising than failed attempts to use FFT for the same problems. Also, I am interested, if Michal has already thought about the use of a gravitational hydrodynamic code, as the reviewer has suggested.

Práci

doporučuji
 nedoporučuji
uznat jako diplomovou.

Navrhuji hodnocení stupněm:

výborně velmi dobře dobře neprospěl/a

Místo, datum a podpis vedoucího:

V Praze dne 9. 9. 2015



Michael Prouza