

Posudek práce

předložené na Matematicko-fyzikální fakultě
Univerzity Karlovy

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| <input checked="" type="checkbox"/> posudek vedoucího | <input type="checkbox"/> posudek oponenta |
| <input checked="" type="checkbox"/> bakalářské práce | <input type="checkbox"/> diplomové práce |

Autor: Lukáš Knob
Název práce: Dynamical systems in cosmology
Studijní program a obor: Fyzika, obecná fyzika
Rok odevzdání: 2020

Jméno a tituly vedoucího: Giovanni Acquaviva, Ph.D.
Pracoviště: Ústav teoretické 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 student Lukáš Knob addressed the analysis of several cosmological models in the framework of dynamical systems. In such approach, Einstein's equations are recast as an autonomous system of ODEs, whose fixed points represent past and future asymptotic states of the models considered: these include both isotropic and anisotropic models, sourced by standard linear barotropic fluids as well as more exotic equations of state, scalar fields with general potentials and interacting fluid components. The character of the critical points are analysed in detail with the methods of linear stability and centre manifold theory, and the most interesting cases are represented graphically.

I find that the scope of the thesis is quite advanced for a bachelor level. Nevertheless, the student showed curiosity for the topic and the capability of understanding its formal aspects and to use them in effective (and sometimes creative) ways. Here's a highlight of the main strengths of the thesis:

- the choice of dimensionless variables adopted in Section 3.2 is unusual but solid, and it displays a creative approach to the problem;
- the analysis of scalar fields with general potentials in Section 4.2 also represents an advanced topic which has been rarely considered in the literature;
- resorting to the centre manifold theory in order to assess the stability of non-hyperbolic critical points is also not a common task even in the specialized literature on the topic;
- the student also learned how to use numerical aids (Wolfram Mathematica) in order to display the results of the analytical calculations in 2D and 3D plots, hence making the results themselves more accessible to the reader.

On the other hand, the work shows some shortcomings on different aspects:

- the clarity of the presentation is sometimes hampered by the language, which could however be rectified in most part of the manuscript and it can surely improve through experience;
- sometimes the student gave for granted some notions which, in a self-contained work such as a thesis, should be explained in every aspect which could be useful for a first-time reader;
- the visual presentation of the results through „stream plots“ can be improved by refining the Mathematica code in order to, e.g., show the names of the critical points in the plots. This would allow the reader to understand better the results.
- the difficulty of the topic made it hard for the student to complete some parts of the analysis (i.e. Sections 5.2 and 5.3), which end up just setting up the dynamical system without entering in the details of the results.

Overall, as I expressed before, the thesis approaches a topic which requires some advanced concepts in theoretical cosmology: notwithstanding the shortcomings listed above, the thesis presents the topic, the methods and the results in a clear and functional way; at the same time the student showed the ability to learn and use the necessary methods and he is undoubtedly able to expand the reach of the analysis to new and more complicated cases – as he expresses also in the Conclusions of the thesis.

I hence recommend to accept the work as a bachelor thesis.

Případné otázky při obhajobě a náměty do diskuze:

Práci

doporučuji

nedoporučuji

uznat jako bakalářskou.

Navrhuji hodnocení stupněm:

výborně velmi dobře dobře neprospěl/a

Místo, datum a podpis vedoucího:

V Praze dne