

Posudek práce

předložené na Matematicko-fyzikální fakultě
Univerzity Karlovy

- posudek vedoucího
 bakalářské práce
- posudek oponenta
 diplomové práce

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Název práce: Dynamical systems in cosmology

Studijní program a obor: Fyzika, Obecná Fyzika

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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 oponenta:

The thesis is quite ambitious for a bachelor level. As a result the thesis as a whole is impressive, but also bares some shortcomings. One of the most striking example of such a shortcoming is that many cosmological models are setup for investigation, but not all of them are analyzed to an adequate depth. This holds, in particular, for models presented in section 5 and 6, e.g., sections 5.2 and 5.3 should be omitted. Another such an issue are the figures, which should have been more polished and carefully handled. They should have on them denoted:

- the letter/symbol of each critical point depicted,
- the sign of the deceleration parameter by appropriately coloring the decelerating part of the phase space.
- the captions should contain more information, especially in Figs. 4.3 and 4.5.

Often the fonts of the figures should be bigger and appear next to the text describing them.

Moreover, more tables could be used. For example, a table with the different stability cases should be used to help to identify the different cases of the plots.

There are concepts missing from the introduction that are later used in the main study. For example:

- Regarding the action described by eq. (1.8), it should be mentioned that it holds for minimally coupled scalar fields.
- Below eq. (1.21) it should be explained how the strong energy condition results into the $3p+\rho < 0$ for a barotropic fluid in the FLRW cosmology.
- On pg. 9, the shear tensor has nor been defined and its evolution equation have not been presented.
- The concept of heteroclinic orbits should have been provided in the introduction.

There are parts of the thesis that are opaque and should have been explained better. For example:

- Throughout the text, the Jacobian matrix should be presented better, so one knows what each of its elements represents and analyzed.
- Pg 18, 5 lns from below. From Fig. 3.1 one cannot see the behavior of w , thus further detailed analysis should be provided in order to guide the reader.
- The last paragraph of section 3.1 should explicitly state that the case when $w_1 < -1/3$ and $w_2 > -1/3$ is discussed.
- It should have been explained how one arrives from eq. (3.18) to eq. (3.23).
- The paragraph below Table 3.3 does not sufficiently describe what happens with the flow in the phase space for the different cases of the model discussed.
- The last phrase in the caption of Figure 4.3 “with the other point being saddle” does not make sense.
- In few tables, like 4.4, 4.6 and 4.8, there are single critical points but with a \pm sign in the corresponding eigenvalues. It is not clear whether this is a typo or an unexplained issue. In Table 4.6 from the discussion about the critical point G in the text it appears that the + sign is the only correct sign. On the other hand, in few tables, like 5.2, 5.3 and 4.2, there are \pm sign in front of an eigenvalue, probably representing two eigenvalues, since otherwise the number of eigenvalues would be less than the dimensionality of the dynamical system.
- The discussion following eq. (6.6) regarding the influences of $w_{1,2}$ is not based on evidences obvious to the reader.

Some typos:

- 5 lns from below on pg 30: instead of “points E and F”, it should read “points E and D”.
- Eq. (4.18) commas indicating partial derivatives are missing in the denominator and numerator.
- Eq. (4.19) the $f(\lambda)$ should be without minus.

A list of further remarks follows:

- Eqs. (4.6)-(4.8) the equality between the quantity with tilde over them and those without does not hold, they should have been written as separate cases.
- On the linguistic side, apart from the fact that the articles the and a are often missing or they are misused, they are few further mistakes throughout the thesis, but in general the text is on a good level.

Despite the above mentioned issues, the bulk and quality of the work is quite impressive for a bachelor thesis. Therefore, the thesis can be considered as excellent and it is recommended to be recognized as a bachelor thesis.

Případné otázky při obhajobě a náměty do diskuze:

- 1) Was it checked that the new set of variables are well defined? Was the Jacobian matrix checked for singularities?
- 2) An invariant submanifold splits the phase space in not communicating parts, as in the case of Fig. 3.3 . Regarding the parts of the phase space that were excluded from the analysis, were the criteria based on dynamical features or physically motivated?
- 3) When describing the point M on pg 28, it is stated that it is saddle like, but the left panel in Fig. 4.3 shows a different behavior. What is going on?
- 4) In section 5.1.1 the new variables are defined in such way that trajectories are entering the phase space in Fig. 5.1 from a “prohibited” region, is such a dynamical system well defined?

Práci

- doporučuji
 nedoporučuji
uznat jako bakalářskou.

Navrhuji hodnocení stupněm:

- výborně velmi dobře dobře neprospěl/a

Místo, datum a podpis oponenta: