Posudek práce

předložené na Matematicko-fyzikální fakultě
Univerzity Karlovy

☐ posudek vedoucího **× posudek oponenta**
× bakalářské práce ☐ diplomové práce

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Název práce:	**Motion of a large cylinder in superfluid helium**
Studijní program a obor:	**Fyzika**
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Jméno a tituly oponenta:	**RNDr. Patrik Švančara, 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/oponenta:

In his bachelor thesis, the author investigates the dynamics of a starting vortex shed by an elliptical obstacle (called ‚airfoil') moving in superfluid helium-4. The employed experimental technique relies on the use of small particles (in this case made of solidified deuterium), whose flow-induced motions are captured by a high speed camera, allowing to directly visualise the flow in question.

The thesis explains in great detail how one can obtain, starting from raw camera frames, the time-dependent position and velocity of the starting vortex. Specifically, the vortex is made visible thanks to maps of Lagrangian pseudovorticity, a parameter that was sucessfully introduced by the Prague flow visualisation laboratory to study large vortices in superfluid helium-4. Based on my own experience with this parameter, I appreciate that the author carefully studies (sec. 4.7) what is the influence of free parameters entering the pseudovorticity calculation on the obtained pseudovorticity maps, showing that the obtained results are robust and the final choice of parameters is far from arbitrary.

The motion of a starting vortex is investigated under very specific experimental conditions (single temperature of the helium bath and two speeds of the airfoil). The presented results indicate the vortex has a similar size and moves along a similar trajectory in both cases, but its velocity and strength are likely linked to the speed of the airfoil. It is, however, difficult to draw more general conclusions and future experimental runs are required to fully understand this physical problem.

The thesis, written in English, is easy to follow and it is structured in a logical manner. However, I have found several inconsistencies in the text:

- Eq. (1.18), defining the ensemble average, misses a denominator.
- Sec 2.2.3 – ‚Calibration' of an accelerometer and a force sensor is mentioned, but no explanation of what this means is given. Since these devices are not discussed in the thesis, I find such details irrelevant.
- Sec 3.1.1 – The fact that the airfoil is visible in some images is presented as an issue (which is then successfully resolved by a masking algorithm), but the reasons why this is an issue are unclear from the text.
- Sec. 3.2.2 – Symbols α, β are used first as fitting parameters in (3.3), but then again as unrelated coefficients in (3.9) and (3.11). Similarly, symbols p, ϕ and ψ are used in the text for denoting mutiple quantities without warning the reader.
- Sec. 4 – In (3.12), the author defines non-dimensional time to describe the motion of the airfoil. The parameter is consistently used in the following discussion, except for a number of occasions, where the author uses camera frames (Fig. 4.4) or milliseconds (p. 35, Fig. 4.11 and p. 37).

Other errors or misprints are present in the text, but they have a negligible impact on the scientific quality of the presented work.

In conclusion, the thesis clearly shows that the author is capable of analysing highly non-trivial data in an organised and convincing manner. Impact of the work is supported by the attached abstract, submitted to the 14th European Fluid Mechanics Conference. Therefore, I am happy to report this work meets all the standards for a decent bachelor thesis.

Případné otázky při obhajobě a náměty do diskuze:

1. For the investigated temperature (1.95 K), the ratio between the normal and the superfluid component density is practically 1. Do you expect the motion of the starting vortex to qualitatively change at a different temperature of the superfluid helium bath?

2. A global estimate of the mean intervortex distance is given in Sec. 4.6. Can you provide another estimate of the mean intervortex distance inside the starting vortex, based on its experimentally measured size and strength?

3. Density of solid deuterium is larger than that of superfluid helium. Therefore, deuterium particles are permanently settling in the fluid, introducing a parasitic effect. Is this a relevant factor for the investigated flow?

Práci
× doporučuji
☐ nedoporučuji
uznat jako bakalářskou.

Navrhuji hodnocení stupněm:
× výborně ☐ velmi dobře ☐ dobře ☐ neprospěl/a

Místo, datum a podpis oponenta:

Nottingham 26.05.2022 RNDr. Patrik Švančara, Ph.D.