

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: Visualization of superfluid helium flows in the proximity of boundaries

Studijní program a obor: Fyzika a Obecná fyzika

Rok odevzdání: 2018

Jméno a tituly vedoucího/opponenta: Dr. Martin James Jackson, MPhys (Hons), PhD, MInstP

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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:

This thesis is a clear and concise report of a high standard, summarizing a novel experiment performed in the Department of Low Temperature Physics.

The body of work covers a series of experiments concerning thermal counterflow in superfluid ^4He , studied using the particle tracking velocimetry technique. The flow-induced motion of small deuterium tracer particles suspended in the liquid was recorded in the vicinity of a heater, which was used to drive the thermal counterflow, and their velocities were calculated. From the obtained velocity distributions, the inter-vortex distance close to the heater was found to be incompatible with that predicted in the bulk by numerical simulations and measured experimentally, proving that there is a significant enhancement of vorticity near the heater.

This result highlights the necessity of boundary and entrance effects to be included in any description of turbulent flows in superfluid helium. In simple terms, this thesis shows that the geometry of any counterflow channel can influence how turbulence forms inside the channel. This observation represents a significant contribution to quantum turbulence research and has been deemed suitable for publication in an impacted, peer-reviewed journal.

It is apparent that the preparation and implementation of the experiment required a great deal of fore-thought and technical skill and that the analysis of the collected data required a significant amount of work. The interpretation of the analysed results demonstrates that the student has a clear understanding of the relevant physics.

Regarding criticism; I have made numerous comments and suggestions throughout the thesis, and an annotated copy has been made available for the student's consideration. Here, I summarize the main criticisms, which do not significantly affect the overall high standard of this work.

I believe that the description of the early history of superfluid research would have been best presented in chronological order to better illustrate how we developed our current models of superfluidity and to highlight some of the apparent paradoxes that had to be addressed.

When the damping of a torsional oscillator in a superfluid is discussed, it is stated that no damping was observed below T_λ . This is not true. As temperature is lowered below the transition temperature, there is a small and gradual decrease in damping, but nothing sudden or dramatic. No damping will be seen at absolute zero, however.

In a couple of instances, the labeling of variables on axes is too sparse and is inconsistent with the main text; specifically, it is not obvious that the line identifying when the flatness of the horizontal velocity distribution becomes Gaussian is actually equal to 3.

Some of the discussions and descriptions are perhaps too brief, however those passages which covered well-established theories or methods appropriately referred to the relevant literature.

In conclusion, I believe that this body of work has great scientific merit and is of a level higher than expected for a bachelor's thesis. In fact, this work has been published in Physical Review B and the student appears as the first author - a notable achievement for someone at this stage of their academic career. The thesis is of a very high standard and adequately represents the research conducted.

It is my recommendation that the student be awarded the degree of bachelor of physics.

Případné otázky při obhajobě a náměty do diskuze:

Differentiating between the intrinsic and extrinsic mechanisms, describe how a quantized vortex can be nucleated, and explain how they may form turbulence and ultimately decay.

By what mechanism does a tracer particle approach and attach to a vortex and how is the vortex affected by the process?

Are the tracer particles affected by the laser sheet?

Do the statistical distributions in the horizontal and vertical directions differ, and if so; why?

Práci

doporučuji

nedoporučuji

uznat jako diplomovou/bakalářskou.

Navrhuji hodnocení stupněm:

výborně velmi dobře dobře neprospěl/a

Místo, datum a podpis oponenta:

A handwritten signature in black ink that reads "M Jackson". The letters are cursive and fluid, with a large initial "M" and a long, sweeping underline for the "J".

Praha 22.01.2019