二国間交流事業 共同研究報告書

令和4年4月25日

独立行政法人日本学術振興会理事長 殿

[代表者所属機関・部局] 東京大学・カブリ数物連携宇宙研究機構 [職・氏名] 准教授・マルテンス カイ [課題番号] JPJSBP1 20193508

1. 事業名相手国: ドイツ (振興会対応機関: DAAD)との共同研究

- 2. 研究課題名
 - (和文) 暗黒物質探索、ニュートリノ実験、および生体イメージングに用いられる絶縁液体の純化

(英文) Purification of Insulating Liquids Used in Dark Matter Searches, Neutrino Physics, and Biomedical Imaging

- 3. 共同研究全実施期間 <u>2019 年 4月 1日 ~ 2022 年 3月31日</u>(3年<u>0</u>ヶ月)
- 相手国代表者(所属機関・職・氏名【全て英文】)
 Universitaet Muenster · Professor · Weinheimer Christian

5. 委託費総額(返還額を除く)

本事業により執行した委託費総額		1,715,203	円
内訳	1年度目執行経費	1,303,502	円
	2年度目執行経費	411, 701	円
	3年度目執行経費		円

6. 共同研究全実施期間を通じた参加者数(代表者を含む)

日本側参加者等	3名	
相手国側参加者等	8名	

^{*} 参加者リスト(様式 B1(1))に表示される合計数を転記してください(途中で不参加となった方も含め、 全ての期間で参加した通算の参加者数となります)。

7. 派遣·受入実績

	派遣			
	相手国	第三国	安八	
1年度目	2	0	3(0)	
2年度目	0	0	0(0)	
3年度目	1	0	0(0)	
4年度目	-	-	-(-)	

*派遣・受入実績(様式 B1(3))に表示される合計数を転記してください。

派遣:本委託費を使用した日本側参加者等の相手国及び相手国以外への渡航実績(延べ人数)。 受入:相手国側参加者等の来日実績(延べ人数)。カッコ内は本委託費で滞在費等を負担した内数。

8. 研究交流実績の概要・成果等

(1)研究交流実績概要(全期間を通じた研究交流の目的・研究交流計画の実施状況等)

- The main result of our ongoing joint research was to identify a group that can produce field emission arrays (FEAs) that cover large areas and we expect can be tailored to achieve the desired emission characteristics: long term stability and uniform emission over their large area. We are continuing this work with our partners at the University of Münster and our colleagues at the OTH Regensburg to characterize the emission of the FEAs fabricated at OTH Regensburg. Münster prepared the ²²⁰Rn injection system that fills their LXe chamber uniformly.
- Researchers from the OTH Regensburg will be visiting us at the Kamioka Observatory May 16 20 on their own funding to join our tests of their FEAs in LXe and to discuss further improvements of their FEA design for our particular application.
- Given previous COVID-19 related travel restictions such exchange has only now become possible again; COVID-19 has delayed our progress but not stopped our research program. We are working very closely now with OTH Regensburg to develop FEAs with the required characteristics to proceed with our tests at Münster on Rn removal.

(2)学術的価値(本研究交流により得られた新たな知見や概念の展開等、学術的成果)

Given the slow progress under recent COVID-19 related travel restrictions there have not been any relevant publications or talks on results from our research effort yet, but the project is being continued with vigor and has picked up momentum again now that foreign researchers can enter Japan again since a few weeks: Prof. Rupert Schreiner and his PhD student Matthias Hausladen will come and visit Kamioka to discuss liquid xenon specific FEA layouts and their production with us, with Münster joining remotely.

(3)相手国との交流(両国の研究者が協力して学術交流することによって得られた成果)

The milestones mentioned above were both achieved during or right after our exchanges under this Bilateral Research Grant: uniform radon injection at Münster was demonstrated there after Hiraide-san's visit there, and our breakthrough in obtaining access to FEA technology based on radio isotope free silicon wafers was achieved during Prof. Martens' visit to Münster in March of 2020, just before COVID-19 travel restrictions prevented further international travel until now.

(4)社会的貢献(社会の基盤となる文化の継承と発展、社会生活の質の改善、現代的諸問題の克服と解決に資 する等の社会的貢献はどのようにあったか)

Identifying dark matter particles is a scientific effort that - when accomplished - will greatly enhance humankind's knowledge and understanding of the Universe we live in. Preparing for the 3rd generation liquid xenon dark matter search experiment by supplying new methods to maintain radiopurity in its liquid xenon target volume is an important aspect of this effort.

Improving medical positron emission tomography with trimethyl bismuth based advanced detectors for the 511 keV positron annihilation photons clearly serves society; this aspect of our program at Münster unfortunately has seen setbacks unrelated to COVID-19 when an explosion at a laboratory in France forced our Münster colleagues to upgrade their equipment to prevent a similar catastrophe in their own lab - this research too is being continued.

While admittedly not related directly to this important research project, the success of our two younger researchers and their progress in their carreers can clearly be seen also as an endorsement of their choice to join it: Within the XENON collaboration Kazama Shingo-san is entrusted with being one of the collaboration's analysis coordinators, and in this function is now leading the ongoing analysis effort on our XENONnT science data. And from FY2021 Hiraide Katsuki-san was awarded an Excellent Researcher position for Hyper-Kamiokande at the Kamioka Observatory, which unfortunately removed him from our dark matter and medical device oriented bilateral research project.

(6)将来発展可能性(本研究交流事業を実施したことにより、今後どの様な発展の可能性が認められるか)

Here fortunately we are not talking about possibility, but about reality: Our Bilateral Research Grant proposal was a truly international proposal of grand ambition and with excellent prospects for success, and is continued vigorously in Germany at both Münster and now also Regensburg, and at Kamioka in Japan. As a truly international project we unfortunately were greatly affected by the international travel restictions imposed to prevent the spread of COVID-19 in 2020 and 2021, but at the same time our new alliance with Regensburg has significantly strengthened our project and given it new momentum:

Prof. Schreiner and his PhD student will visit Kamioka in May of this year and spend a week there in our laboratory with us to see how we can improve and further adopt their vacuum FEA design for use in liquid xenon. Prof. Weinheimer has applied to the European Research Council for a major grant to further develop our technology for use in a future, 3rd generation liquid xenon experiment under which we hope to continue this effort into the future. He also continues the trimethyl bismuth development in his lab and we plan on using the Regensburg FEAs in this research field too.

(7)その他(上記(2)~(6)以外に得られた成果があれば記述してください) 例:大学間協定の締結、他事業への展開、受賞、産業財産権の出願・取得など N/A