京都大学若手人材海外派遣事業　ジョン万プログラム
研究者派遣プログラム

英文報告書
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研究課題名	**長距離相互作用の制御された極低温気体の量子相** **Quantum phases of ultracold gases with manipulated long-range interactions**		
海外渡航期間	平成２５年　４月２４日～　平成２５年　７月２６日		
渡航先 （英語表記）	国名：United Kingdom 大学等研究機関名：University of Cambridge 研究室名等： Theory of Condensed Matter(TCM) Group, Cavendish Laboratory 受入研究者名： Dr Antonio M. García-García		

２．渡航の報告　（英文）

渡航先の研究環境、研究者との交流、研究発表の状況等、渡航中の滞在経験について英語(500～1000語)で記述して下さい。受入研究者と撮影した写真や研究発表で用いた図等について、可能な範囲で別添として提出して下さい。ページ数については増加してもかまいません。

この報告は、ジョン万プログラムの成果として、京都大学ホームページ（英文）などに掲載されることがあります。

渡航先の研究環境、研究者との交流、研究発表の状況等、渡航中の滞在経験について

Cavendish Laboratory is situated in the West Cambridge Site of the University of Cambridge, about 2 km west of the Cambridge City centre. The Laboratory is surrounded by a few collages comprising the University of Cambridge as well as by agricultural farms. The Theoretical Condensed Matter (TCM) group occupies a large portion of the top floor of Mott building, which is situated close to the southeast corner of the Site. The lower floors of the building is occupied by experimental physics groups.

Interaction among researchers through frank conversations allow constructive criticism. In addition to the six professors and seven other senior staff members, who each has students and/or postdoctoral researchers in the group, there are several senior researchers regularly visiting the TCM group. Several office rooms are shared by students and postdocs who work with different staff members. The common space in the TCM group with a professional standard espresso machine is a core of interaction. Informal discussions often take place there.

Also there are often informal seminars over sandwiches. I gave a talk on my recent paper in May. I have also attended some seminars held at other research groups of Cavendish Laboratory.

My host, Dr Antonio M. García-García (Fig. 1), has students in Cambridge, but as a guest professor he also has a group in Lisbon, Portugal. I had an opportunity to meet one of the members of the Lisbon group at the beginning of my stay. Even while Antonio had to be abroad for a few weeks during my stay, most of the time I was not alone on the lunch table at the Cavendish canteen. Moreover, I have started a new collaboration with one of the postdocs in the TCM group, Dr Stefan Baur, on the dynamics of strongly interacting ultracold atoms when the interaction strength changes as a function of time.

I visited and gave a seminar at University of St Andrews in Fife, Scotland based on the results of the collaboration with Antonio. The seminar, on 11th July, was also attended by researchers in Glasgow and Edinburgh over an Internet teleconference system. I had opportunity to discuss with several researchers at the university over the course of my two-day visit, and have also started a theoretical collaboration with a researcher there and his collaborators.

At low temperatures, thermal fluctuations are reduced and many materials undergo phase transitions to more ordered states. Examples of such ordered phases include magnetism and superconductivity. However, in low dimensions, quantum fluctuations can destroy ordering even at absolute zero temperature. Recent experimental advances have allowed switching the effective dimension of some microscopic systems by introducing long-range interactions, which obeys a power law as a function of the distance (Fig. 2). The main motivation of the visit was to theoretically study the gradual destruction of superconducting order after the dimension of the system is abruptly reduced when the power-law interaction is switched off. We aim to understand such dynamics by combining analytical and numerical methods of quantum mechanics, and will soon submit a new paper to a refereed journal.

During my visit I have also submitted a paper on polarons, which are objects in solids consisting of an electron and oscillation quanta (phonons) of the ions forming the crystal lattice, with researchers in Korea, and resubmitted a manuscript with Antonio and another collaborator on the long-range superconducting order in one-dimensional system with power-law interactions.

I also enjoyed the opportunities to attend formal dinners at one of the collages, Trinity Hall (founded in 1350), and meetings of "Toiro-kai" (Cambridge University Japanese Interdisciplinary Forum), where I became acquainted with other Japanese researchers in various fields of study.

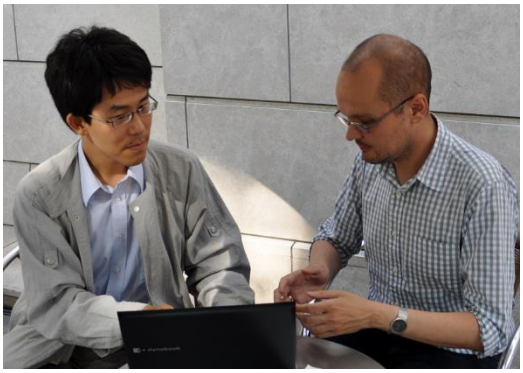

Figure 1: With Dr Antonio M. García-García

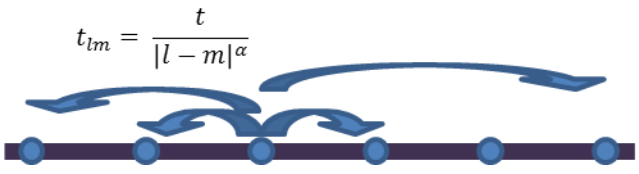

Figure 2: Power-law interaction