

**The Global COE Program**  
**“The Next Generation of Physics, Spun from Universality and Emergence”**  
**Bilateral International Exchange Program (BIEP, invite) report**

Send report to: Your responsible Professor in Kyoto University

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(Year/Month/Day) 2012/12/31

**Invited Student**

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**Responsible Researcher in Kyoto University**

Name	Prof. Yoshiro Takahashi
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Position	Professor
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**Research Project**

Title	<b>Optical Feshbach resonances in ytterbium</b>
Duration	<b>5 weeks</b>

**Please summarize your activities and results during your stay in Kyoto University. Also please describe how your stay has been beneficial to the graduate students in the host institute. You can add a sheet, if you need more space. You can also write any comments and requests to the GCOE program.**

There have been two main tasks I took part in during my stay:

1. I joined the experimental group working on two color photoassociation spectroscopy in ultracold ytterbium gases, and
2. I have given seminars on numerical methods used to calculate the bound states and collisional properties in the Yb<sub>2</sub> system

**Photoassociation spectroscopy.** I have worked together with student Kikuchi Yuu measuring two-color photoassociation spectra in a variety of systems: bosonic ytterbium and unpolarized and polarized fermionic ytterbium atoms. Aside from usual laboratory work including the operation and optimization of the experimental setup (ie. fiber coupling, AOMs, etc.) I have also provided theoretical predictions for the positions of yet unobserved photoassociation resonances that should help find them.

**Numerical methods.** I have given several seminars on the numerical methods I use to solve the Schrodinger equation that describes the interactions between ytterbium atoms. Some of these methods I have developed myself, including a method for efficient computation of bound state energies very close to the dissociation limit using a nonlinear coordinate transformation. During those seminars we have produced MATLAB code (from scratch) that uses these methods. These programs can now be used by prof. Takahashi's group for their research. I strongly believe they will prove useful.

The result from my stay is that we now have two prospective papers to write on the photoassociation spectroscopy in ytterbium, which we can write almost immediately and are scheduled for production this month. We have also extensively discussed another direction of research: the boson-fermion excited state of ytterbium, for which there already is some experimental data produced by prof. Takahashi's group that awaits theoretical description. After we are done with the two papers that need to be written immediately, we will start working on the boson-fermion data.

To sum up, during my stay, we have strongly tightened the collaboration between my group in Poland and prof. Takahashi's group, we have produced useful software that can be now used by the Group and we have prospects for at least three good theoretical and experimental papers.