

# Report on MERIT Overseas Dispatch Program

Department of Advanced Materials Science 1<sup>st</sup> year Ph.D

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## Abstract

I stayed at the group of Prof. Felix Casanova, CIC Nanogune, San-Sebastian (Donostia), Spain for 3 months. I studied on Spin Hall Effect of ferromagnetic metals. The report of this dispatch including the research and my life is shown below.

## Background

Prof. Felix Casanova's group works in spintronic field. They report a lot of issues recently. Lateral Spin Valve (LSV) is a well-known method in spintronic field, which has a structure of ferromagnetic metals bridged by non-magnetic metal. Spin Absorption technique is an advanced method using LSV. In this technique, we put a metal, which we want to study, on the LSV. It allows us to inject pure spin current to that metal.

Spin Hall Effect (SHE) is one of the most important phenomena in spintronic field which converts spin and charge currents to each other. SHE can appear with several mechanisms; extrinsic and intrinsic. Recently they reported that the mechanisms of SHE can be separated experimentally by measuring temperature dependence with Spin Absorption technique. Thanks to this paper, we started to do collaboration and it gave me chance to do this dispatch.

## Research

I worked mainly on SHE on ferromagnetic metals. Studies on SHE are mostly performed on non-magnetic materials for example Pt. Recently some groups reported that SHE in ferromagnetic metals were observed. In these 3 months we tried to reveal the mechanisms of SHE in ferromagnetic metals by using Spin Absorption technique and measure SHE under a lot of conditions. Also we tried to measure Anomalous Hall Effect (AHE) under same conditions because AHE is considered sharing common mechanism with SHE.

The devices should be composed of nanostructures in this case so that some conditions were too difficult to fabricate and we could not measure the AHE.

However, from the conditions we could measure, understanding proceeds somehow. We will continue this measurement.

On the other hand, about the collaboration which we started before this dispatch, we discussed many times and obtained enough interpretation of the results and analysis. It is now being prepared as a paper.



(Beach of San-Sebastian)

## **Life**

San-Sebastian is near to the boundary to France. It is placed in Basque country which extends over Spain and France. They speak Basque language which only one million people speak. They also speak Spanish. In the institute, Nanogune, English is the official language so that there is no problem but almost all people whom I met on street, in shops, or in restaurant cannot speak English, which made me feel “wall of language.” San-Sebastian has great beach (see the picture) and is well known as a city of gastronomy. Many people from Europe come there for vacation. You will see how safe and comfortable to live if you come.

On weekends I spent much time to visit bars or museums. I really enjoyed foods and culture. I heard that people in Basque are known as honest people. That’s true. For example, I was surprised by the system to pay in bars that we declare what we ordered when we finish and pay. It can work only if almost all people are honest.

In general Spanish people have lunch around 2 p.m. and dinner around 21 p.m. Also they have refreshment around 11 a.m. and 5 p.m. They love eating. These habits are really different from Japan. I felt strange at first but finally I became to love it. Their life style makes us happy.

On Monday we had seminars where people in Nanogune or from other institute talked. Also on Monday we had group meetings and individual meetings so that I could not perform so many experiments on that day. I felt it is annoying at first but it helped me to have good idea and plans, and finally we could do research time efficiently. I found that people in Nanogune take long time for lunch and coffee breaks. They take much time to talk trivial things to each other but I feel they have the habit of working efficiently in limited time. That is maybe different from ours.

## **Acknowledgement**

I would like to express my sincere gratitude to Prof. Felix Casanova, who accepted me to come, helped me to have stay and had many discussions during this dispatch. Also, I would like to say sincerely thanks to my supervisor Prof. Yoshichika Otani for his kind cooperation for this dispatch. Moreover, Ms. Edurne Sagasta helped me a lot for instrument training and things on life. We performed many experiments together and discuss a lot. Ms. Miren Isasa gave me many advice on our experiments. Finally I would like to say special thanks to MERIT program and my assistant supervisor Prof. Oshiyama for letting me have this great chance.