

## 変革を駆動する先端物理・数学プログラム (FoPM)

## 国外連携機関長期研修 報告書

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I visited the university of Nevada, Las Vegas (UNLV) to discuss the application of radiation process of charged particles in relativistic magnetohydrodynamic (MHD) waves to high energy astrophysical phenomena with Prof. Bing Zhang. Prof. Bing Zhang's laboratory is in Robert L. Bigelow PHYSICS BUILDING (right photo).

Firstly, I presented my research on radiation in relativistic Alfven waves to Prof. Bing Zhang. Through discussions, we decided to apply my research to the emission from persistent radio source near the source of Fast Radio Burst (FRB) 121102. I read previous papers about the persistent radio source. We discussed radiation of electrons in relativistic Alfven waves driven by FRB absorbed via synchrotron absorption.

Finally, we came to the conclusion that the conversion efficiency of synchrotron absorbed FRB to Alfven waves should be studied because the radiation properties such as typical frequency and radiation power depends on amplitude of Alfven waves.

After we discussed the application of radiation process in relativistic MHD Alfven waves to FRB, we considered the application of radiation process in relativistic MHD waves to Gamma Ray Burst (GRB).

Firstly, I presented my research on numerical calculation of radiation spectrum emitted by electrons in relativistic magnetosonic waves using special relativistic MHD simulation with test particle to Prof. Bing Zhang. I explained that radiation power of an electron is suppressed compared to synchrotron radiation in relativistic MHD waves with strong electric field.

Finally, we considered the application of the suppression effect to the GRB fast cooling problem and discussed how the interpretation which invokes highly magnetized radiation regions in the GRB jets may be changed.

In Prof. Bing Zhang's laboratory, I participated in many seminars. In Journal Club, I presented my research about GRB prompt emission and relativistic Alfven waves. In astro-coffee, the seminar for introduction of articles published in arXiv, we discussed high energy astrophysical phenomena and planets. I presented the paper about magnetar giant flare identified in the galaxy M82. In Multi-Messenger Astronomy meeting, I listened to presentations about reviews of neutrino, gravitational wave and so on.

During my stay, I participated in the Nevada Center for astrophysical (NCFA) symposium. In NCFA symposium, I was able to listen to presentations and panel discussions about multi-messenger astronomy using neutrino, gravitational wave and multi-wavelength electromagnetic wave. In poster sessions, I asked the presenters about their research and enjoyed discussion with them. In Frank Astronomy Public Lecture. I was blessed with an opportunity to listen to the lecture by the discoverer of FRB, Duncan Lorimer. In the final panel discussion session, we listened to future prospects for experiments related to multi-messenger astronomy.

On the first day, I arrived at the airport in Las Vegas in the evening. At the airport, I got on Uber to go to the university of Nevada, Las Vegas. Once I arrived at the university, I went to the front desk of the dormitory. At the



front desk, I signed a contract and was given a guest card. I was able to enter a dorm room at night.

In Robert L. Bigelow PHYSICS BUILDING, I enjoyed discussions about physics and astronomy with graduate students and researchers in UNLV. During the NCFA symposium, I went to Caesars Palace for dinner with participants of the symposium and enjoyed conversations about multi-messenger astronomy.

I ate meals in a buffet cafeteria in UNLV, Dining Commons for breakfast and dinner. I ate cereal with milk and orange juice for breakfast. I ate hamburger, french fry and pizza for dinner. In addition, I was able to eat a wide variety of foods such as vegetables, fruits, sweets, ice cream, American foods and so on in Dining Commons.

I had lunch in Student Union in UNLV. I ate chicken in Panda Express, sushi in SOHO Sushi Burritos, sandwich in Subway and hamburger in Steak n Shake. I enjoyed order of meals in English in Student Union.

I enjoyed eating together with Bing Zhang's group members. In a hamburger restaurant, I ate hamburger and french fry. In a Japanese restaurant, I ate tuna, eel, udon and so on. In a Thai food restaurant, I ate spicy curry and sweet mango and drank Thai tea.

The climate was warm in Las Vegas in winter. It was so comfortable for me. During my stay, I heard stories from people who went to National parks near Las Vegas. I would like to go to the National parks in the future.

I think my first stay in America was so successful. I enjoyed my life in UNLV thanks to many people who helped me. I promised to conduct joint research on the application of radiation process in relativistic MHD waves to GRB with Prof. Bing Zhang.

I would like to understand diverse high energy astrophysical phenomena and share a fun of understanding the universe with many people all over the world in a new era of multi-messenger astronomy.