平成２９年度国立天文台滞在型共同研究報告書
Activity Report for NAOJ Visiting Joint Research in FY 2017

<div align="right">2017年7月20日</div>

申請者 Applicant	氏　名 Name	しも じょう　ます み 下　条　　圭　美
	所属・職 Division・position	チリ観測所・助教
研究課題名 Research Title	Investigating microflares using ALMA and EUV/X-ray data	
研究場所 Place	三鷹キャンパス・ALMA棟3階305/306号室	
共同研究者 氏名・所属・職名 Joint researcher's Name ・Institution・Position/ Graduate Student year	Le Minh Tan Tay Nguyen University, Vietnam Lecturer	

１．研究概要（Summary of research）

Coronal/Chromospheric heating and particle acceleration processes in a solar flare are still the big questions in solar physics and understanding of energy release process is an important key to solve them. Therefore, it is necessary to investigate the transfer of magnetic energy to various energies (e. g. thermal, high-energy particles, waves). However, investigating of particle acceleration is not progress, because the resolution (~15") of X-ray/gamma-ray/radio observations that indicate accelerated particles is significantly worse than that (1"~0.1") of observation with other spectral ranges. In order to solve this problem, we have been working on the high-resolution ALMA data with band 3 recorded on 17 December 2015 in the 6th solar commissioning campaign.

The purpose of our joint research is to start to examine the non-thermal emission from microflares using the solar ALMA data. We also compared the ALMA data with EUV/X-ray data to understand the nature of microflares and the emission mechanism responsible for mm-wave emission in microflares. We estimated the contribution of mm-wave thermal emission of high temperature plasma (0.1~10 MK) from the multi-wavelength data, and try to separate non-thermal emission from mm-wave data.

２.研究成果(Research achievements)

Calibration of the ALMA data

The target is near the preceding sunspot of the active region AR12470. This preceding sunspot is the biggest sunspot in the solar disk on the observing day, and it has the negative magnetic polarity. We considered the ALMA data with spectral window ID number 5, 7 (Spw5-7, 94 GHz), 9 and 11 (Spw9-11, 106 GHz) recorded from 18:42:33 – 18:52:48 UT. After regular calibration, we used imaging scripts which are developed by NAOJ solar group to create the single dish image, the interferometric images, and the combined image and then we also self-calibrated the ALMA data.
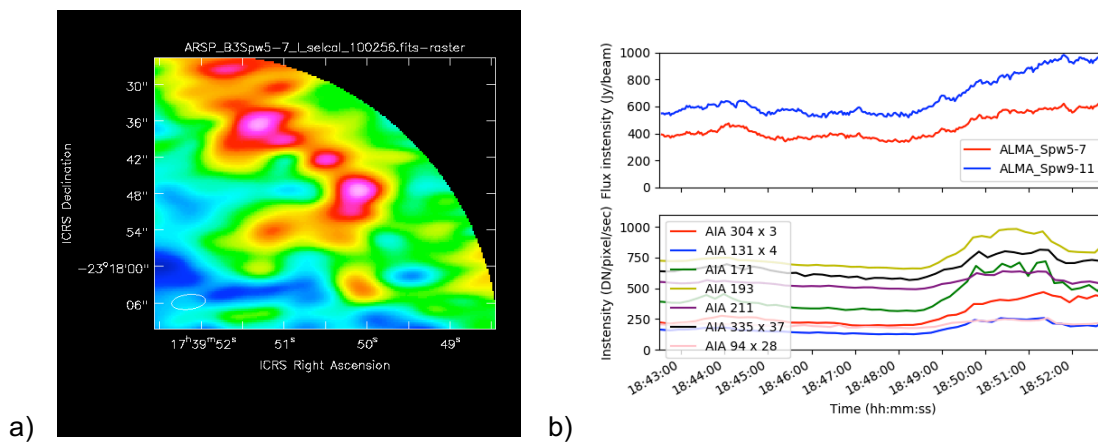

Figure 1. Selected region showed by a box on image of ALMA data (a) and flux intensity profiles of multi-wavelength data (b).

Developing scripts to analyze the ALMA and AIA data

Using Casa and SunPy, we wrote scripts to estimate the physical parameters (e. g. flux intensity, spectral index, noise level) from completely different spectrum data.

We compared location and timing of 94 and 106 GHz emissions with emissions at EUV wavelengths to deduce the thermal or non-thermal nature of the 94/106 GHz sources. We plotted the flux intensity time profiles of AIA/ALMA data and estimated the spectral index of the millimeter emissions. Figure 1 shows an example of flux intensity time profiles from ALMA and AIA data. Results reveal that the flux intensity from ALMA at 106 GHz is higher than that at 94 GHz and the peaks of the intensities of AIA data occurred before those of ALMA data.

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We synthesized images using XX- and YY-cross correlations for each spectral window and then plotted histograms to show the pixel distributions of brightness and the pixel distribution function of the difference image (See Figure 2). Using the width of the Gaussion function fitted to the distribution of the differential, the noise level of Spw5-7 and Spw9-11 data are 3.2 K and 3.6 K, respectively. The estimated errors of the analysis method for Spw5-7 and Spw9-11 data are 3.8 % and 6.0 %, respectively.

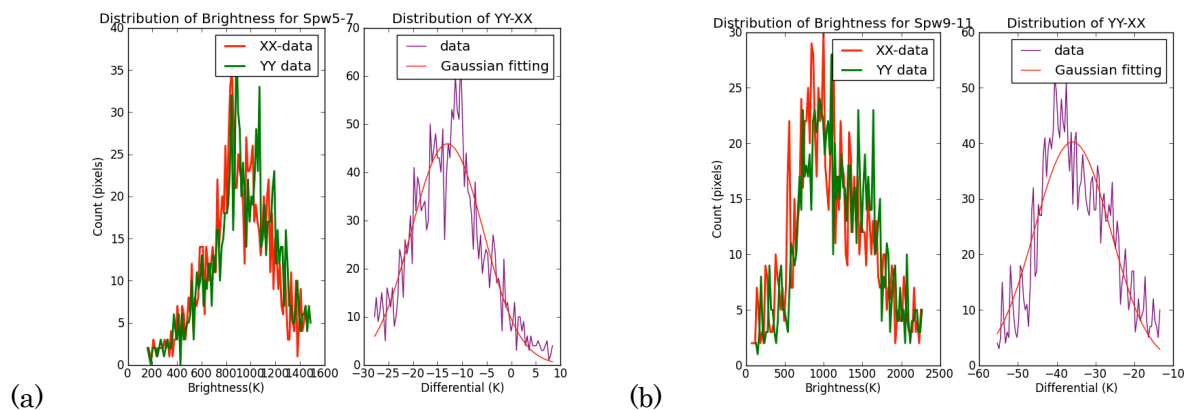(a)   (b)

Figure 2. The pixel distributions of brightness (left panel) and pixel distributions function of the difference image (right panel) of Spw5-7 (a) and Spw9-11 (b).

Additional activities

Attending some seminars which topics are as follows,

- Topic "All CMEs originating near the disk center of the Sun do not arrive at Earth: Why?" presented by Dr. Sachiko Akiyama (NASA Goddard Space Flight Center)

- Topic "Solar flare prediction model with three machine-learning algorithms using chromospheric brightening and vector magnetogram" presented by Naoto Nishizuka (NICT)

Plan in future

We will continue to discuss the physical processes of microflare events. A paper is expected to be seen in December 2017

３．本制度に対する意見、要望など【申請者記載欄】
　（Any comments on this program【For applicant】）

　申請者にとって、今回が初の海外研究者招聘であった。招聘前にいくつかVISA関係でトラブルがあったが、事務部のサポートのおかげで申請者から見るとかなりスムーズに物事が進んだ。特に研究推進課・国際学術係の高田さんにはさまざまな面で助けていただいた。この場を借りて御礼を申し上げる。今回の経験で、国立天文台における海外研究者の受け入れ態勢が整っていることを実感できたのも、個人的には今回のプログラムでの大きな収穫であった。
　滞在期間が１ヵ月の本プログラムで、Tan氏にALMA太陽観測データ解析のノウハウを教え、科学研究の入り口までたどり着くことができた。今後メール等のやり取りで科学研究を推進するが、１ヵ月の滞在ではやはり短い。審査を厳しくしていいので２〜３ヵ月の台内滞在期間を作り出せるような制度の方が、今回のような途上国での研究のスタートアップを目的としたプログラムには良いだろう。

４.本制度に対する意見、要望など【本事業で来訪した共同研究者記載欄】
(Any comments on this program【For joint researcher】)

We think that NAOJ Visiting Joint Research program brings the chances for young researchers to achieve the good kills of analysis of the ALMA data. It is also important for researchers in the developing country to develop their career and have opportunities of collaborative research in Astronomy.

５.共同研究者の滞在日程(Joint research period)

氏名・所属 （Name・Institution）	Le Minh Tan・Tay Nguyen University, Vietnam	
滞在日程（Period of stay）		日数(days)
2017年　6月　8日　　〜　2017年　7月　4日		27日間(days)
合　計（Total）		27日間(days)