DPRK Astronomy research at the Huairou Solar Station, China

Project report

1. Summary of the project

The purpose of project is to train two astronomers to improve the research level in Solar physics at Pyongyang Astronomical Observatory (PAO). To acquire the needed skill for processing and analysis of multi-wavelength observation data from ground-base and space telescopes is our motivation for this visit. During our visit, we obtained wide range of knowledge on data processing from understanding FITS file format to working with difference images. We get general working knowledge on IDL to use powerful tools provided by Solar Software (SSW); We get acquainted with accessing many data service centers to know how to obtain necessary data.

Based upon background knowledge obtained, we have experience to study one topic on estimation of magnetic helicity carried by prominence eruption on 2010 March 30. That event is very famous as "first light of the Solar Dynamical Observatory (SDO)" since the eruption was observed just after SDO opened its window.

By using SSW code and observation data, we calculate magnetic helicity injection through the photosphere and estimated magnetic helicity carried by eruptive prominence to discuss on long-term helicity budget. We obtained that magnetic helicity carried by prominence eruption is estimated to reach 20% of total injected helicity during two passages over solar disc from the birth of the parent active region. We submitted a draft on our result to “Research in Astronomy and Astrophysics”

2. Objectives / deliverables achieved

In that work we use 304A image from Atmospheric Imaging Assembly (AIA) onboard SDO, 195A and 304A images from Solar Terrestrial Relations Observatory (STEREO) and Michelson Doppler Imager (MDI) magnetogram onboard Solar Heliospheric Observatory (SoHO).

Since the prominence eruption took place at the eastern limb from the viewpoint of SDO, we can give a good estimation of twist (turn number) of overall prominence body owing to high spatial resolution and short time cadence of SDO. As the separation angle between STEREO-B and SDO was about 71 degree on the eruption, the region producing the prominence eruption could be observed in the central part of the solar disc from the STEREO viewpoint to locate domains occupied by two footpoints of the erupting prominence. Unfortunately, information on magnetic flux distribution of the eruption-producing subregion is unavailable because of absence of magnetogram on STEREO. Assuming that magnetic configuration will remain unchanged significantly to use MDI data on 03:05 UT April 1, about 33 hours after the eruption. In this way we estimated magnetic helicity. AR NOAA 11045, parent active region of the erupted prominence, emerged on February 5, 2010 and underwent about two rotation to produce the

event just at the north-east solar limb in its decaying phase. We study a long term evolution by calculating radial magnetic flux, magnetic helicity injection rate and total flux of helicity injection during two passage over solar disc using SOHO/MDI 96-min line-of-sight magnetogram and LCT technique. Magnetic helicity carried by the prominence eruption is estimated to reach 20 % of total injected magnetic helicity during two passages over solar disc before the eruption. Our result implies that extensive statistical examination on how many percentage of total prominence eruptions are successful and how much magnetic helicity of whole amount of initial helicity in successful eruptions are shed by CMEs should be conducted from the viewpoint of magnetic helicity budget.

3. Deviations from the original project implementation

Thanks to support of Huairou Solar Observing Station, we attended “Helicity Thinkshop on Solar Physics" held in National Astronomical Observatories of China during October 27-31, 2013.

4. Significant challenges and recommendations for improving the quality, implementation and impact of the project

We are going to transfer data processing technique including working knowledge with FITS file, IDL code and SSW package, to staffs and students in Pyongyang Astronomical Observatory. That will improve background knowledge and research capacity to help them have general idea as to how research works in modern solar physics are performed.

Also observational data and SSW package which we take to our country will be of great use in research work of Astrophysics and Solar physics in our country.

5. Suggestions and recommendations to the OAD for expanding the project both locally and to other parts of the world

It is thought to be essential that our present visit continue to research visit for 6 months next year because we have not yet been acquainted with data processing technique treating high resolution data including SDO/AIA, Hinode. Especially to get updated observational data with large capacity, regular visit is needed.

6. Full financial report detailing the expenses

- Travel fee
    - Pyongyang- Beijing train fee 162 EURO x 2 (persons) = 324 EURO
    - Beijing - Pyongyang train fee 142 EURO x 2 (persons) = 284 EURO

- Monthly payment (including local transportation) : 350 RMB x 2 (persons) x 6 months = 4200 RMB ~ 513 EURO

  Total = 1121 Euros

7. Copies of associated invoices/receipts to support the financial report.

Receipts for travel expenses were submitted to Dr Ziping Zhang, Beijing Planetarium, China.