Roles of Ground-based Solar Observations of Hida Observatory toward the Solar-C Era

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Abstract. For the realization of the Solar-C satellite, discussions about scientific themes and preliminary observations are internationally carried out now. At Hida Observatory of Kyoto University, we will play the following roles toward the Solar-C era by utilizing the Domeless Solar Telescope (DST) and the international solar chromospheric full-disk observation network (CHAIN project) that includes the Solar Magnetic Activity Research Telescope (SMART) with international collaborations, for example, such as the development of image-analysis software by UNINOVA (Portugal) and so on.

1. Roles Before the Solar-C Launch

1.1. As the place for development and test of new detectors and optical instruments

The following instruments that can be mounted on the Solar-C have been already developed by using the focal plane of Domeless Solar Telescope (DST; Fig. 1, left panel) at Hida Observatory.

- New-type Lyot filters using liquid-crystal retarders (Hagino et al. 2014): Development and test observations of simultaneously imaging at two wavelengths and imaging-polarimeter combined with a rotating waveplate are being performed at the focal plane of the DST.

- Development of 2-D spectroscopes using Micro Lens Arrays or Optical fibers (Suematsu et al. 1999): Improvement of 2-D spectrograph using MLA and experimental observations at around H-alpha line have been performed by using the spectroscope of the DST.

- Application of correlation imaging sensors (Ando & Kimachi 2003) to solar polarimetric observations: Experimental observations for real-time measurement of Stokes profiles of the solar spectrum with this imaging sensors have been performed by using the spectroscope of the DST.
1.2. Revealing Unclear Points in the Solar Chromospheric Physics

At Hida Observatory, we are focusing on unsolved problems in the elucidation of the mechanism of chromospheric jets and their roles and in the establishment of the inversion method for chromospheric magnetic fields.

- Estimation of released energy by chromospheric activities like jets (Morita et al. 2010): It was confirmed that the "magnetic energy release rate" by magnetic cancellation around the jet is comparable to the total energy loss of the jet estimated from the radiative loss in the Ca II K line observed with the spectrograph of the DST.

- Mechanism and 3-D structures of chromospheric phenomena: We are estimating atmospheric models of chromospheric jets by using spectroscopic data with the DST and MULTI-code (Carlsson 1986) so that we can observationally confirm the mechanism of jets expected by MHD simulation.

- Inversion method of chromospheric magnetic fields: Young researchers of Hida Observatory are currently trying to establish the inversion method of chromospheric magnetic fields by applying Zeeman effect and Hanle effect to various chromospheric lines (Anan et al. 2014).

2. Roles after the Solar-C Launch

2.1. Cooperative Observations with Solar-C

- We will positively promote complimentary observations with satellite’s high-spatial-resolution observations that are limited in the spatial FOV and continuous observable time due to the data capacity. For example, the DST of Hida Obs can cover 300 arcsec FOV and obtain solar data of several TB per 1 day, and the SMART (Fig. 1, right panel) of Hida Obs can cover 2300 arcsec FOV and obtain a few TB data per 1 day at present.

- We will also promote complimentary observations with satellite’s spectroscopic observations that are limited in the amount of information along the wavelength direction. Spectroscopie of Hida/DST can cover whole range of visible light and near IR. Therefor, many kinds of chromospheric lines can be observed for investigating physical parameters of chromospheric gas.

2.2. Expanding and Applying New Knowledge Provided by Solar-C to the Whole of the Sun

- For the purpose of prediction of the influence of solar active phenomena on variations of space weather environment and climate of the Earth, we are trying to monitor the 3-D velocity field of all erupted filaments on the solar disk by ground-based global network observation under the CHAIN project (UeNo et al. 2007, 2014). New knowledge obtained from future detailed observations of filament eruptions by Solar-C may improve the accuracy of predictions utilizing CHAIN’s data.
For the purpose of estimating solar UV variation that affects ionospheric and stratospheric environment, we are calculating Hα Plage Index as a candidate proxy of the solar UV radiation by using H-alpha imaging data for 21 years. It is defined as the percentage of the area covered by plages & active network in the solar disk observed at Hα line center. The accuracy of UV-reproduction may be improved by using the information derived from UV-spectral data of the Solar-C.

Regarding the detection of solar global gas-motions and global distributions of physical parameters that are related with Dynamo theory, in order to add accurate information of the solar differential rotation to the information of global solar gas-motions, the hybrid Particle Swarm Optimization (PSO) algorithm and Active Contour model developed by UNINOVA (Portugal) (Dorotovič et al. 2014) will be applied to full-disks solar images obtained with the SMART (Hida Obs.). Moreover, the information of temperature distribution of the photosphere is also important for the Dynamo theory. We detected the latitudinal dependency of the photospheric temperature by measuring line-depths of two different photospheric absorption lines with high resolution spectroscope of the Hida/DST. This result should be confirmed by being compared with Solar-C’s spectral data.
These roles will mediate between the Solar-C and studies of variations of space weather and space climate.

3. Regular Roles

- At Hida Observatory, we have held many educational observations of the Sun and training of the instruments, data-analysis for students of universities, high schools and general citizen every year. Participants can gain experiences that they operate instruments by their own hands while watching the Sun in real time. This role is needed to be continued after the Solar-C launch also.

- Moreover, we have provided the place that can enforce not only scientific advanced themes, but also other themes that are hard to be accepted in the case of satellites or hard to be carried out by satellites physically, for example, experimental themes, classical scientific themes, themes that need long duration (more than 10 years) or large data capacity, and educational themes etc. This role will also be continued after the Solar-C launch.

Full poster can be downloaded from the address http://www.science-media.org/posterPage.php?v=47.

Acknowledgments. These works were supported by many kinds of Japanese grants from Ministry of Education, Culture, Sports, Science and Technology (MEXT), Kyoto University, Nagoya University, National Astronomical Observatory of Japan and JAXA, through Portuguese research grants from FCT, Lisbon SFRH/BPD/44018/2008 (I.D.) and SFRH/BD/62249/2009 (E.S.), and partially by FCT Strategic Program UID/EEA/00066/203 of UNINOVA, CTS.

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