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Advancing Solar Observations with DST and SMART, Hida Observatory, Kyoto University

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In recent years, solar observations from space have made significant progress. Meanwhile, ground-based solar observations offer several advantages, such as flexibility in observation planning, rapid response to solar phenomena, and high-precision plasma diagnostics. At Hida Observatory, Kyoto University, two solar telescopes operate: Domeless Solar Telescope (DST[1]) and Solar Magnetic Activity Research Telescope (SMART[2]).

Figure 1: Pictures of DST (*left*) and SMART (*right*).

DST is a ϕ60-cm vacuum telescope, and is equipped with and Horizontal and Vertical Spectrographs (HS and VS). DST enables high spatial resolution imaging and high-dispersion spectroscopy. Simultaneous multi-wavelength observations allow detailed plasma diagnostics, such as deriving temperature and non-thermal (turbulent) velocity distributions in prominences using appropriate line combinations[3, 4]. Magnetic field structures of/supporting quiescent filaments have also been studied with Spectro-Polarimeter (SP) in the HeI 1083nm line, revealing predominantly reverse-shaped configurations[5]. In addition, high-cadence and high-spatial resolution observations of chromospheric fibrils using Hα ± 0.5 Å by Universal Tunable Filter (UTF) have revealed complex velocity structures[6] (Figure 2).

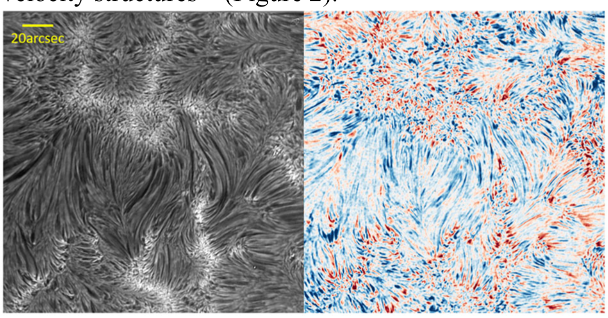

Figure 2: Intensity at Hα center (left) and velocity field of fibrils taken simultaneously at Hα±0.5 Å (right) [6].

SMART, particularly with Solar Dynamics Doppler Imager (SDDI [7]), enables imaging spectroscopy in the Hα line, allowing us to analyze the velocity fields of chromospheric plasma associated with flares and filament eruptions, and other activities. The full 3D kinematics of filament eruptions have been tracked and analyzed by using the cloud model[8]. Recent findings also report persistent transverse oscillations in prominences, likely induced by Alfvénic waves propagating in the corona[9], with periods of ~4 minutes and phase speeds of ~140 km/s, visible only in the Doppler velocity field. Moreover, active studies have been aiming at collaborative research with stellar physics based on studies such as flares by using the Sun-as-a-star technique[10].

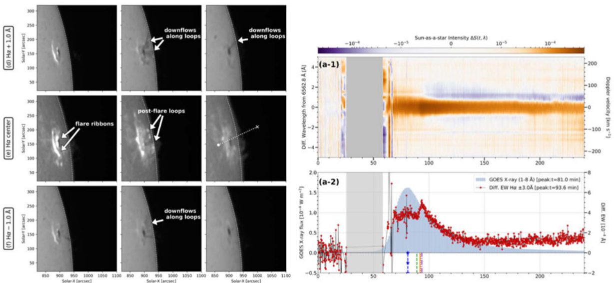

Figure 3: Temporal evolution of the 2023 August 5 X1.6 flare in Hα taken with SMART (*left*) and the result of the Sun-as-a-star analysis[10].

In this presentation, I will introduce recent scientific results obtained with DST and SMART and discuss future directions, including our plans for the next-generation instrument Near InfraRed Tunable Filter (NIRTF[11]). NITRF aims to conduct near-infrared spectro-polarimetric observations with a large field of view and high temporal cadence by being equipped with a 4-m class telescope.

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