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Researches on solar eruptive phenomena and solar activities using chromospheric imaging data with the CHAIN

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In 2010, Kyoto University moved the Flare Monitoring Telescope (FMT) from Japan to Peru, and currently we are technically supporting two projects of building new solar telescopes in Saudi Arabia and Algeria under the Continuous H-Alpha Imaging Network (CHAIN) project. We also held international data analysis workshops three times during this four years to train foreign and domestic young researchers to analyze the data obtained by the FMT and Solar Magnetic Research Telescope (SMART) at Hida Observatory in Japan.

Current main scientific themes of the CHAIN project are

(1) 3D velocity field measurement of eruptive phenomena on the solar surface:
By applying "cloud model fitting" to multi-wavelength H-alpha chromospheric images, we can calculate physical parameters of moving features on the chromosphere. We especially focus on the 3D velocity field of erupting filaments to understand the process of growth and propagation of CMEs. Morimoto & Kurokawa (2003) statistically investigated time evolution of 3D velocity field of disappearing phenomena of chromospheric H-alpha filaments, and they observationally showed that if H-alpha filaments actually erupted, then CMEs necessary appears. On the other hand, however, when filaments are disappeared without eruption, sometimes CMEs occur. We have to know how to CMEs are generated in such a case, comparing with other observational data or MHD simulations. Moreover, we will statistically investigate relationship between characteristics of filament eruptions and geo-effectiveness of the CMEs .

(2) Detection of shock waves (Moreton wave) generated by solar explosive phenomena:
The FMT is quite effective to detect Moreton wave that was explained as the intersection of coronal shock wave on the solar chromosphere. Narukage et al. (2002) and Asai et al. (2012) observationally showed that Moreton waves detected in H-alpha chromospheric images actually correspond to foot-point of coronal shock waves observed with X-ray telescope or EUV telescope on satellites. On the other hand, even if flares that has almost the same intensity, sometimes they are accompanied by Moreton waves and sometimes they are not accompanied by them. We are investigating what are differences between flares "with" and "without" Moreton waves. According to our preliminary statistical study, the angle of filament eruption from the solar surface seems to be the most important parameter. We promote more investigation for more cases more accurately by combining with other satellite data or MHD simulations. Moreover, after that, we want to compare with characteristics of radio bursts and to investigate time evolution of various shock waves from solar surface to interstellar space.

(3) Estimation of solar UV radiation and comparison with ionospheric variation:
Solar radiation is also one of very important element for understanding the change of space weather. Especially solar UV around from 50 to 140 nm has strong influence for the ionosphere of the earth. One of good index of the change of ionosphere is the "geomagnetic solar daily quiet variation (Sq)". It basically changes well obeying the variation of solar UV radiation. When we investigate long-term variation of solar component and terrestrial component of Sq, currently we usually use F10.7 flux, sunspot number etc. as indexes of solar activity, because actual UV observations started just after around 1995. However, the indexes such as F10.7 do not accurately express variation of UV radiation and we cannot know accurate variation of terrestrial component of Sq. Therefore, we are currently trying to reproduce UV intensity from chromospheric images that have been obtained during longer-term than UV data. After this, by using estimated variation of solar UV radiation, we want to investigate relationship between solar activities and other physical parameters of ionosphere, too.

In this talk, we introduce our recent results and plans in VarSITI period on these themes.

Keywords: CHAIN, solar flare, filament eruption, Moreton wave, chromosphere, solar UV radiation