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| **Session:** | **[B3A-1] S1 : Solar System and Sun-Earth Interactions** |
| **Date:** | August 20, 2014 (Wednesday) |
| **Time:** | 11:00~12:35 |
| **Room:** | Room A (Room 101~102) |
| **Chair:** | Young-deuk Park (Korea Astronomy and Space Acience Institute) |

**[B3A-1-1]** **11:00~11:20**

### [Invited] Superflares of Sun-Like Stars

Kazunari Shibata (Kyoto University, Japan)

Using Kepler data, Maehara et al. (2012) have discovered 365 superflares (1034-1036 erg) on 148 solar type stars (G type dwarfs). They revealed that the occurrence frequency of superflares of 1034 erg is once in 800 years, and that of 1035 erg is once in 5000 years on Sun-like stars whose surface temperature and rotation are similar to those of the Sun. It was also found that these superflare stars show quasi-periodic brightness variation, which can be interpreted as a result of rotation of stars with large star spots (Notsu Y. et al. 2013). This interpretation is consistent with standard theory of solar flares and dynamo (Shibata et al. 2013), and has partly been confirmed by spectroscopic observations of some of these stars using Subaru telescope (Notsu S. et al., 2013; Nogami et al. 2014). Furthermore, there were no evidence of hot Jupiters around these superflare stars, suggesting the possibility that superflares may occur on the Sun (Nogami et al. 2014). Shibayama et al. (2013) extended Maehara et al.'s work to find 1547 superflares on 279 solar type stars from 500 days Kepler data. They basically confirmed the results of Maehara et al., but found that in some Sun-like stars the occurrence rate of superflares was very high, 5 superflares in 500 days (i.e., once in 100 days). We shall discuss what would happen on the civilization and environment of the Earth if such superflares would occur on the Sun.

**[B3A-1-2]** **11:20~11:40**

### [Invited] Heating of Solar Active Region

Durgesh Tripathi (Inter-University Centre for Astronomy and Astrophysics, India)

One of the most challenging problems in astrophysics is that of solar coronal heating. Despite of major advancement in observational capabilities as well as theoretical modeling, the solution to this problem remains illusive. Active Region, due to its enhanced heating and brightness, provides excellent target of opportunity to address this problem. The modern solar telescopes have shed new lights towards the understanding of this long-standing problem. Observations suggest that there are different kinds of loop structures present in active regions as well as a significant amount of diffuse emission. Therefore, it is important to study the characteristics of all kind of structures to put good constraints on the theories attempting to explain this problem. Here we review some of the new measurements to study the heating mechanisms in different kind of loop structures and diffuse emission in active regions using the observations recorded by Solar Ultraviolet Measurements of Emitted Radiation (SUMER) onboard SoHO and the Extreme-ultraviolet Imaging Spectrometer (EIS) aboard Hinode. These results show that the properties of warm loops, hot core loops and diffuse emission are consistent with impulsive heating – low frequency nanoflare - scenario. However, the evidences are not strong enough to rule out steady heating completely, in particular for hot core loops. Further measurement using better spectral resolution and temperature coverage is required, which will be provided by Solar-C in near future.

**[B3A-1-3]** **11:40~12:00**

### [Invited] Study on the Triggering Mechanism and Predictability of Solar Eruptions

Kanya Kusano (Nagoya University, Japan), Yumi Bamba, Daiko Shiota, Shinsuke Imada, and Shin Toriumi

Solar eruptions, which are observed as solar flares and coronal mass ejections, are the most catastrophic events in our solar system, and the primary cause of severe space weather. Since, however, the triggering mechanism of solar eruptions is still not sufficiently understood, it is crucially important to determine the magnetic field structure characterizing the pre-eruption state both from the scientific point of view and the prediction of solar weather. Here, we study this problem by systematically surveying the nonlinear dynamics caused by a wide variety of magnetic structures in terms of three-dimensional magnetohydrodynamic simulations and the analyses of data provided by the Hinode and the Solar Dynamics Observatory (SDO) satellites. As a result, we found that there are at least two different types of solar eruptions, which are initiated through the different processes called the eruption-induced reconnection and the reconnection-induced eruption. The comparison of simulations and observations suggests that two different configurations of magnetic field on the polarity inversion line favor the onsets of those two types of eruptions, respectively. Both the two configurations consist of the sheared magnetic arcade and the small magnetic bi-polar fields, which are reversed to the potential component or the non-potential component of the sheared magnetic arcade, respectively. These results imply that not only the large-scale sheared magnetic field but also the small-scale magnetic disturbance may determine when and where the solar eruptions can occur. Therefore, we conclude that the sophisticated observation of a solar magnetic field vector is necessary for forecasting solar eruptions. Finally, we will discuss about a new methodology to improve the predictability of onset of solar eruptions based on our study.

**[B3A-1-4]** **12:00~12:20**

### [Invited] Spectral Variations of Cosmic Rays

David Ruffolo (Mahidol University, Thailand), Alejandro Sáiz, Pierre-Simon Mangeard, Warit Mitthumsiri, Achara Seripienlert, and Usanee Tortermpun

Galactic cosmic rays at Earth exhibit variations in intensity and spectrum, which are due to solar and heliospheric effects. These include 11-year variations with the solar activity cycle, 22-year variations with the solar magnetic cycle, 27-day variations with solar rotation, and temporary Forbush decreases due to solar storms. Neutron monitors have provided precise information on intensity variations, but precise tracking of spectral variations has proven more challenging. Here we report on work in Thailand, with collaborators in other countries, to observe spectral variations of cosmic rays. In addition to providing information about energetic particle transport in magnetic turbulence, and solar and heliospheric effects, this will allow us to develop a proxy for time-dependent ionization in Earth's atmosphere with which to test ideas concerning a connection between solar activity and Earth's climate that is mediated by the cosmic ray flux and cloud formation.

**[B3A-1-5]** **12:20~12:35**

### Latitude Survey Investigation of Galactic Cosmic Ray Solar Modulation during 1994-2007

Paul Evenson (University of Delaware, USA), Waraporn Nuntiyakul, David Ruffolo, Alejandro Saiz, John Bieber, John Clem, Roger Pyle, Marcus Duldig, and John Humble

The Galactic cosmic ray spectrum exhibits subtle variations over the 22-year solar magnetic cycle in addition to the more dramatic variations over the 11-year sunspot cycle. Neutron monitors are large ground-based detectors that provide accurate measurements of variations in the cosmic ray flux at the top of the atmosphere above the detector. At any given location the magnetic field of the Earth excludes particles below a well-defined rigidity (momentum per unit charge) known as the cutoff rigidity, which can be accurately calculated using detailed models of the geomagnetic field. By carrying a neutron monitor to different locations, e.g., on a ship, the Earth itself serves as a magnet spectrometer. By repeating such latitude surveys with identical equipment a sensitive measurement of changes in the spectrum can be made. In this work, we analyze data from the 1994 through 2007 series of latitude surveys conducted by the Bartol Research Institute, the University of Tasmania, and the Australian Antarctic Division. We show that the curious "crossover" in spectra measured near solar minima during epochs of opposite solar magnetic polarity is related directly to a sudden change in the behavior of solar modulation at the time of the polarity reversal. We suggest that the crossover itself results from the interaction of effects due to gradient/curvature drifts with a systematic change in the interplanetary diffusion coefficient caused by turbulent magnetic helicity.