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Solar physics research in Taiwan

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Abstract. Taiwan has a small but growing solar physics community. The current research interests are mainly in the following three fields: helioseismology, solar atmosphere dynamics, and Sun–Earth connection/space plasma. Here, we give an overview of the solar research in Taiwan.

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1. Overview

The solar physics research in Taiwan is mainly focused in the following fields: helioseismology (NTHU and NCU), solar atmosphere dynamics (NCU and PSSC/NCKU), Sun–Earth connection and space plasma (NCU and PSSC/NCKU). The following is a compilation of the research projects in each field.

2. Helioseismology

There are currently two groups working on helioseismology in Taiwan: one at National Tsing Hua University (NTHU), led by Dean-Yi Chou, another at National Central University (NCU), led by Chia-Hsien Lin. The NTHU group has been working on helioseismology since early 90's. The group currently has one postdoctor, two PhD students, and one Master student. The NTHU group built a ground-based global observing network (Taiwan Oscillation Network, TON) in 90's to observe high-degree solar p-mode oscillations. The TON consists of four telescopes at Teide Observatory (Spain), Huairou Solar Observing Station (China), Big Bear Solar Observatory (USA), and Ulugh Beg Observatory (Uzbekistan). Beside the TON data, the NTHU group also uses the MDI/SOHO and HMI/SDO data to study helioseismology. The scientific topics currently carried out in the NTHU group include:

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- solar-cycle variations of subsurface meridional flows
- absorption, emission and suppression of solar acoustic waves in magnetic regions
- acoustic waves scattered by sunspots
- lifetime of high-degree solar p modes
- signature of solar-cycle variations near the base of the convection zone

C-H Lin's group, started in 2010, currently has only one Master student, but is expecting to have more students and one to two postdoctors in the coming year. The research interests of the group include subsurface magnetic structures of solar active regions, solar chemical compositions and equations of state.

3. Solar atmosphere dynamics

In addition to helioseismology, CHL group is also interested in solar atmosphere dynamics. The current research project is to study the physical mechanisms that would trigger and drive coronal mass ejections and also to examine possible connections between the subsurface magnetic structures and the eruptive events in the atmosphere.

Ya-Hui Yang and C. Z. Frank Cheng at the National Cheng-Kung University (NCKU) have worked on various topics associated with solar flares, including numerical modelling, hard X-ray emissions, and reconnection currents.

4. Sun–Earth connection and space plasma

The research in this field is currently carried out at NCU and NCKU. NCU is also planning to develop an international collaboration with scientists at the Center for Space Plasma and Aeronomy, University of Alabama Huntsville (CSPAR/UAH); Max-Planck Institute for Solar System Research (MPS); and Stanford University.

The following is a compilation of the on-going research projects from several NCU researchers.

- Heliospheric plasma and magnetic fields:

  The main scientist working on this topic is Alexei Dmitriev. The latest work of Dmitriev and his colleague is titled "Statistical characteristics of the heliospheric plasma and magnetic field at the Earth's orbit during four solar cycles 20-23"

In this study, they analyzed the variability of key heliospheric parameters measured at the Earth's orbit during four solar cycles from 1964 to 2007. Specifically, they studied statistical characteristics of solar wind proton number density, temperature, bulk velocity, interplanetary magnetic field vector and components as well as dimensionless parameters in connection with variation of sunspot number. From harmonic analysis, they found basic periods which correspond to the rotational harmonics of Sun and Earth as well as to specific solar periodicities, including solar cycle. They also found that the heliospheric parameters are transitional and characterized by log-normal distributions.

- High-speed streamers and coronal holes:

  Keh-Wei Pi and J.-H. Shu are studying the relation between coronal holes and high-speed streamers. The following is a brief description about their latest work:

  High Speed Streamers (HSS) can affect the dynamics of the magnetosphere when it reaches the earth. There are two types of HSS: fast-solar-wind related and coronal-mass-ejection related. Fast solar wind has been thought to be originated from coronal hole regions and the wind speed can be influenced by the ambient magnetic field structure. The objective of Pi and Shu is to understand the characteristics of a HSS generated by a coronal hole. They use solar ultraviolet images from the SOHO and STEREO satellites and in-situ plasma data from the ACE and STEREO satellites. They also apply an image processing technique, phase-based optimal image thresholding, for automatically classifying coronal holes. By using these data, they are able to investigate how the coronal holes change the characteristics of HSS.

- Magnetohydrodynamics (MHD) simulations:
  Hsiou-Shan Yu and Ling-Hsiao Lyu have worked on this subject. Their recent studies include the following:

  - The causes of plasma acceleration and changes of magnetic flux in a resistive MHD plasma;

  - Dynamical evolution of "X" and "O" point in the Harris Field-Reversal layer

  Besides the MHD simulations, Yu and Lyu had also worked on helioseismology in the past. One example of their work is "Solar latitudinal differential rotational pattern deduced from traces of supergranulations or plages observed by Taiwan Oscillation Network"

At NCKU, Plasma and Space Science Center (PSSC) was established in 2006, and has been headed by C. Z. Frank Cheng. The research projects of the center include basic plasma sciences, plasma diagnostics, controlled thermonuclear fusion, space sciences, and satellite scientific payload development.

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