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Space Solar Physics in China: 2014—2016*

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Abstract The activities of Chinese space solar physics in 2014—2016 were mainly undertaken within the framework of Strategic Priority Program on Space Science, sponsored by CAS, which include: to accomplish the last version for the mid and long-term (2016—2030) plan of Chinese space solar physics; to subsidy a few of pre-study projects of space solar physics; to implement two intensive study projects, ASO-S and SPORT. This paper summarizes these activities briefly.

Key words Space astronomy, Solar physics

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1 Strategic Study for 2016 to 2030

The primary draft of "The Strategic Report of Mid and Long-term (2016—2030) Plan of Chinese Space Solar Physics" was finished in 2014. In the early 2015, National Space Science Center (NSSC), CAS arranged international peer reviews for the report. Taking into account almost all of comments of the referees, we submitted the revised version to NSSC in October 2015. The final report, as an appendix of "Prospect for Space Science in 2016—2030" will be published in 2016.

The current prospect, based on the two prospects previously proposed in 2008 and 2012, is more concise and more extensive and puts more emphases on the actuality and feasibility. The core contents are on the one hand to aim at the vital scientific objectives on the physical formation of solar magnetic fields, solar flares, and Coronal Mass Ejections (CMEs), their mutual interactions and relations; on the other hand, to take the opportunity of the 25th solar activity maximum to make a breakthrough from zero in the approval of a solar satellite proposal. Subsequently, at the early time of the "14th Five-Year Plan", it is targeted to realize the breakthrough from zero in the solar observations made by our own mission. The ultimate goal is to become one of the key members in the international community of space solar physics by 2030.

2 Financing Some Pre-study Projects

During this period, the third batch of pre-study projects was got partially support from Strategic Priority Program on Space Science, sponsored by CAS. Among them 4 projects belong to solar physics:

(i) Key technique studies on a new type Birefraction filter (from January 2015 to December 2016).

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(ii) Further technique studies on space-borne solar full-disc vector magnetograph (from January 2015 to December 2016).

(iii) Key technique studies on detection of solar energetic particles with a high accuracy (from January 2016 to December 2016).

(iv) Key technique studies on inner coronagraph at L5 (from January 2015 to December 2016).

Due to financial problem, these projects were delayed by one or two years to start and the scale of budget were also reduced.

3 Some Mission-level Projects

As described in previous reports[1−6], although there are some mission-level projects, like Deep Space Solar Observatory (DSO, a heritage of Space Solar Observatory), Kuafu (a solar-terrestrial mission), Advanced Space-based Solar Observatory (ASO-S), and Solar Polar Orbit Telescope (SPORT), none of these mission projects has formally been developed into the engineering phase. From 2014 to 2016, both DSO and Kuafu did not seem to have made great progress on the way to the approval of the engineering stage. We therefore describe only ASO-S and SPORT here. Another project, LASGA (Large Area Solar Gamma-ray spectrometer) is also described, since it is a new mission which has be accepted as a payload aboard the future Chinese space station.

(1) ASO-S

ASO-S is a mission proposed for the 25th solar maximum by the Chinese solar community[7]. The scientific objectives are to study the relationships among solar magnetic field, solar flares, and Coronal Mass Ejections (CMEs). ASO-S consists of three payloads: Full-disk Magnetograph (FMG), Lyman-alpha Solar Telescope (LST), and Hard X-ray Imager (HXI), to measure solar magnetic field, to observe CMEs and solar flares, respectively. ASO-S has a solar synchronous orbit at an altitude of 720 km with an inclination angle of around 98.2°. ASO-S is almost finished by now its so-called intensive studies (similar to phase-B). Explicitly, during 2014—2015, following works have been accomplished: the preliminary design of ASO-S satellite system; the requirement analysis on rocket system, launch site system, measurement and control system, and ground support system; the preliminary design of scientific application system; the schematic design and key techniques for scientific payloads of FMG, LST, and HXI; some prototypes (*e.g.*, HXI) or key components of payloads; and so on.

On 30—31 October 2014, ISSI-BJ organized an international forum especially on ASO-S[8]. Twenty-five participants reached an agreement after this two-day meeting: "ASO-S has well-defined scientific objectives and will measure fundamental and important parameters of solar magnetic field, solar flares, and CMEs. The mission is not overloaded and is still ambitious. It has focus and is in good balance between the advanced scientific objectives and resources. Therefore, the mission is very probable to be successful".

ASO-S is now ready for the competition with other proposals for phase-C study.

(2) SPORT

SPORT is intended to be the first mission from a polar orbit around the Sun to measure the solar high-latitude magnetism leading to eruptions and the fast solar wind, and to image the interplanetary propagation of CMEs in the ecliptic. The payload aboard SPORT includes a solar ultraviolet imager (121.6 and 13.1 nm), a solar vector magnetograph, a large-angle coronagraph (white light and 121.6 nm), a heliospheric imager, an energetic neutral atom imager, a solar wind plasma analyzer, a fluxgate magnetometer, a radio and plasma wave instrument, and an energetic particle and composition analyzer.

A Chinese CZ-5E rocket with upper stage is envisioned to be the launch vehicle for SPORT. The spacecraft is designed to first travel along a big elliptic transfer orbit towards Jupiter. Using the gravity assist of Jupiter, the mission will achieve an elliptic polar orbit around the Sun with an inclination an-

gle of 62°, a perihelion at 0.7 AU, and an aphelion at 5 AU. Further multiple gravity assists from Venus will shrink the solar polar orbit within 2 AU and increase the inclination angle to 70°. Imaging observations of the Sun and interplanetary space will be activated, when SPORT is within 2 AU from the Sun. Because of the high-inclination angle, the total mass of the mission has to be no more than 1050 kg.

During the intensive study between 2012—2015, the SPORT team made the following progress: a schematic design of the spacecraft orbit and platform, booms and antennas deployable in space, attitude stability and control, and full-prototypes and key components of some instruments (*e.g.*, the coronagraph, heliospheric imager and ultraviolet imager). The ISSI-BJ SPORT forum held on 24—25 November 2013 concluded that SPORT will be a "great mission" having both imaging and in situ capabilities out of the ecliptic[9]. SPORT will compete for selection and implementation during China's 13th Five-Year Plan period of 2016—2020.

(3) LASGA

It is an accepted proposal for the payload aboard Chinese space station which will be launched in 2020 or in 2022. The scientific goals are: (i) to observe solar high energy radiation with a high sensitivity, for studying the relationship between accelerated electrons and protons, as well as the frequency distributions; (ii) to observe solar gamma-ray spectra with a high energy resolution, for studying the energy spectra of accelerated protons, their acceleration mechanisms, and temporal variations; (iii) to observe inner links between solar energetic radiation and disaster space weather, for studying the forecasting method of disaster space weather; (iv) to observe cosmic gamma-ray bursts, for studying GeV excess near galactic center and burst mechanisms. The energy range is from 10 keV to 2.5 GeV with energy resolution of 2.8% at 662 keV. The effective area is 1600 cm^2. By now LASGA is in the stage of schematic design. If everything goes smoothly, LASGA is expected to work in the orbit for over ten years and cover a whole period of the 25th solar cycle.

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