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New era of Chinese solar instruments

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As China's first comprehensive satellite dedicated for solar physics, the Advanced Space-based Solar Observatory (ASO-S) [1,2] was successfully lifted off from Jiuquan Satellite Launch Center at 7:43 on 9 October, 2022 (China Standard Time, CST). ASO-S, dubbed "Kuafu-1" (Kuafu was a giant in Chinese mythology who never stopped chasing the Sun), is now keeping its eyes on the solar activities from a Sun-synchronous orbit 720 km above the Earth's surface. Along with the Chinese Hα Solar Explorer (CHASE) [3] launched on 14 October, 2021, the X-ray Extreme Ultraviolet Imager (X-EUVI) onboard the Fengyun-3E meteorological satellite (FY-3E) [4] launched in July 2021, and the Solar Upper Transition Region Imager (SUTRI, https://sun10.bao.ac.cn/SUTRI) onboard the Space Advanced Technology demonstration satellite (SATech-01) launched in July 2022, ASO-S marks a milestone for Chinese solar instruments to step into the new era of space age.

It is the magnetic field that controls solar cycles and produces solar eruptions, e.g., the two most violent phenomena – flares and coronal mass ejections (CMEs). ASO-S aims to reveal the connections among solar magnetic field, flares, and CMEs, and to improve forecasts of damaging space weather. To fulfil the science objectives, three instruments are designed: a Full-disk vector MagnetoGraph (FMG), a Hard X-ray Imager (HXI), and a Lyman-α Solar Telescope (LST). ASO-S can acquire simultaneous observations of photospheric magnetic field with a sensitivity of 5 Guass for longitudinal field, nonthermal emission of solar flares from 30 to 200 keV, and dynamics of CMEs up to 2.5 solar radii in both Lyman-α and white light.

The ASO-S mission will last for at least four years, covering the peak of solar cycle 25. After a commissioning phase of 4 to 6 months, the science data will be released to the community and public through the website at Purple Mountain Observatory (http://aso-s.pmo.ac.cn). Combining the CHASE data at Solar Science Data Center of Nanjing University (https://ssdc.nju.edu.cn), the Chinese space missions will substantially advance our knowledge of solar activities and space weather.

Up to now, the Chinese solar community has built several ground-based solar observatories, including the Huairou Solar Observing Station [5], Fuxian Solar Observatory [6], and Mingantu Observing Station [7]. A new 1-m telescope called Accurate Infrared Magnetic field Measurements of the Sun (AIMS) is near the end of its construction at Lenghu and expected to obtain the first light in 2023 [8]. A 2.5-m Wide-fiEld and High-resOlution Solar Telescope (WeHoST) is under construction and scheduled to see its first light in 2026 [9].

In terms of space-borne telescopes, as shown in Figure 1, the X-EUVI acquires X-ray and extreme ultraviolet images

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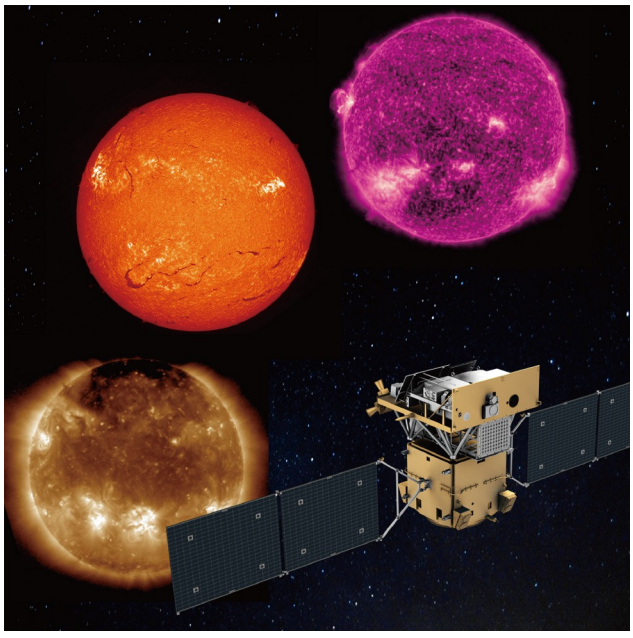

Figure 1 (Color online) Illustration of the ASO-S satellite and three solar images taken respectively by CHASE, FY-3E/X-EUVI, and SATech01/SUTRI.

of the solar corona, the SUTRI takes narrow-band images of the solar transition region with the Ne VII 46.5 nm line, the CHASE mission provides seeing-free Hα spectroscopic observations of both the photosphere and chromosphere, and the ASO-S mission opens a new era of comprehensive solar observations with multi scientific payloads. Looking into the future, the Chinese solar community has proposed more prospective space missions to shed light on the mysteries of the Star.

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