ASO-S Mission and Its Updated Orbit Analyses

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Abstract. ASO-S mission is a space mission aiming at comprehensive observations of the Sun during the 25th solar cycle maximal years. It was launched into space in Oct.,2022 by Chinese launcher CZ-2D. It has been in orbit for more than 2 years. Since its launch, scientists of ASO-S team have witnessed a lot of accomplishments relevant to this mission. In this paper, taking the comprehensive work firstly published in Solar Physics Journal by ASO-S task team for example, authors have analyzed the ASO-S mission and its effects in worldwide solar researches; and the stability of orbit of ASO-S are assessed in detail, which is quite relevant to the lifespan of ASO-S.

Keywords: ASO-S mission; solar physics; orbit evolution; solar activity; solar flares

1 Introduction

Solar activities have great influences on lives on Earth [1,2,3,4]. Most energies which human relies on are from the Sun. The Sun has so important that since the middle of last century some countries have invested many resources in the studies of the Sun both on the ground and from the space. There are several famous missions for the studies of the Sun, for example, the Solar & Heliospheric Observatory (SOHO) is a joint mission by ESA and NASA [5,6], which was launched on December 2,1995;Solar TErrestrial RElations Observatory (STEREO),which was launched on Oct. 26, 2006 by USA[7]; Solar Dynamics Observatory (SDO) is another satellite for the Sun[8],which was launched on Feb.,11,2010 by USA; Parker Solar Probe was launched on Aug.12,2018,which is the nearest spacecraft aiming at observing the Sun[9].Chinese Hα Solar Explorer(CHASE) was sent into space on Oct.14,2021 by Chinese scientists[10].Advanced Space-based Solar Observatory (ASO-S) was successfully deployed in near Earth space on Oct.,9,2022,which are comprehensively equipped with three types of payloads[11].On May 24,2023,the first paper by the ASO-S task team since its successful deployment in space was published in "Solar Physics", titled as The Advanced Space-Based Solar Observatory (ASO-S)[12].In this paper, authors try to focus on the statistics about follow-on researches on the Sun, which have cited the original publication, "The Advanced Space-Based Solar Observatory (ASO-S)".

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2 Statistics of follow-on researches relevant to ASO-S

During the study of this paper, authors have considered the first paper "The Advanced Space-Based Solar Observatory (ASO-S)" by the ASO-S task team published on May 24,2023 in "Solar Physics" as an indicator for study interests in ASO-S relevant researches. From Figure 1, it has shown that there are about 20~30 accesses of the first paper each month from Apr.,2024 to Feb., 2025. It suggests that the enthusiasm relevant to ASO-S researches has continued stably during the past 12 months.

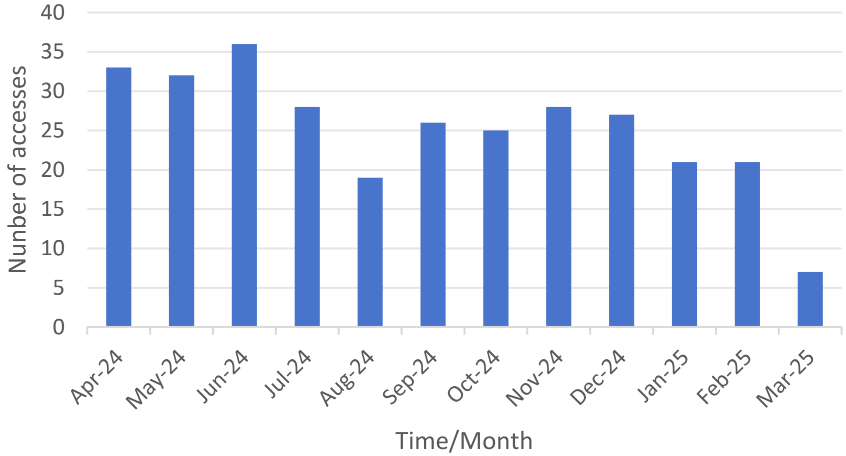

Fig. 1. Accesses of the first paper versus time

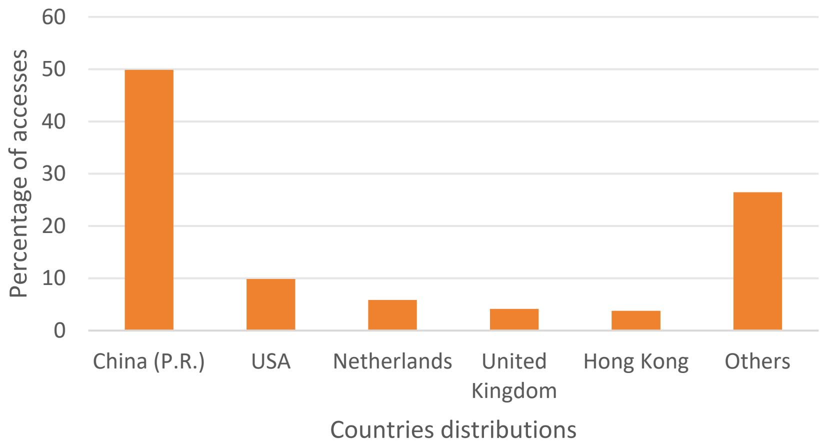

Fig. 2. percentage of accesses of the first paper from different countries or areas

In Figure 2, it has shown that there are about six areas where scientists have carried on solar activities researches relevant to the ASO-S mission. They are China Mainland, USA, Netherlands, United Kingdom, Hong Kong, and other countries. The worldwide geographical distribution of accesses of first ASO-S paper has indicated that ASO-S mission has occupied world leading status in the studies of the Sun. Another mission control paper "A Chinese solar observatory in space" has proved such advantages benefiting from ASO-S mission.

In Figure 3, there are more than 60 citations of the first paper of ASO-S since its publication [12]. It suggests worldwide researches relevant to ASO-S mission are fruitful and highlighted in the recent years [13,14,15,16]. The citations of first paper of ASO-S mission, to some extent, it has indicated there are worldwide social effects made by the ASO-S mission, which was one of the initial purposes of realizing the ASO-S project decades ago.

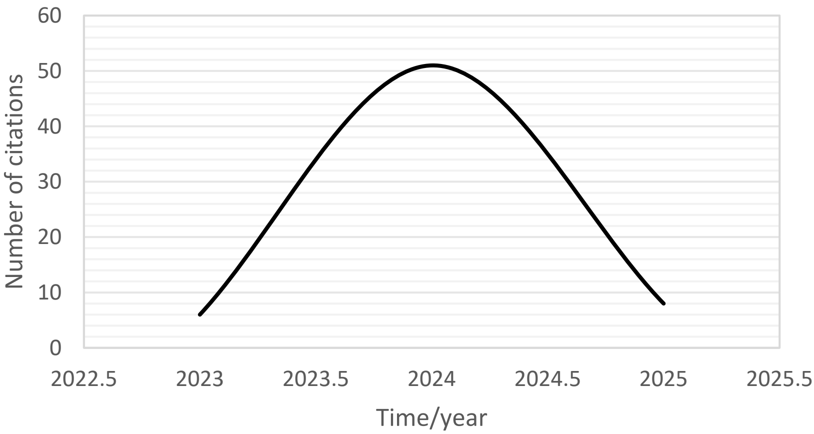

Fig. 3. Number of citations versus the time

The citations of the first paper of ASO-S mission have also demonstrated the significant contributions of ASO-S mission to worldwide solar physics science.

3 Obit evolution of ASO-S

Orbit stability is one of the key factors which will contribute much to the lifespan of a spacecraft. Here, authors have made some simulations about the main orbit elements for ASO-S. They include the altitude, inclination and the eccentricity. These three parameters are related to the orbit characteristics. Based on the orbit data set during the period from Oct.,9,2022 to Mar.,11,2025, authors have made data reductions. The updated orbit analyses results are presented as followings.

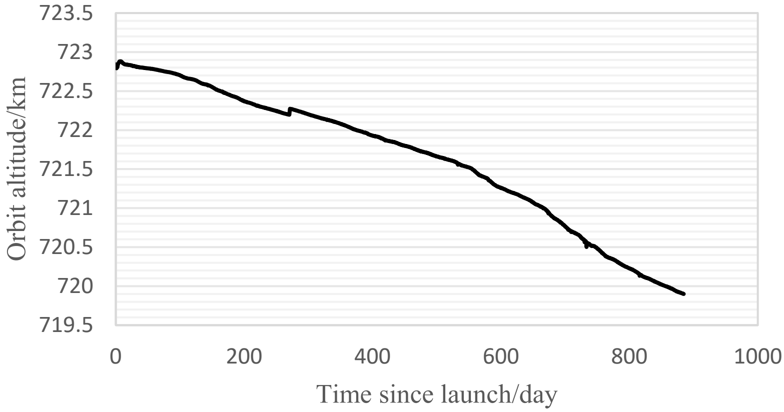

Fig. 4. Altitude change versus time

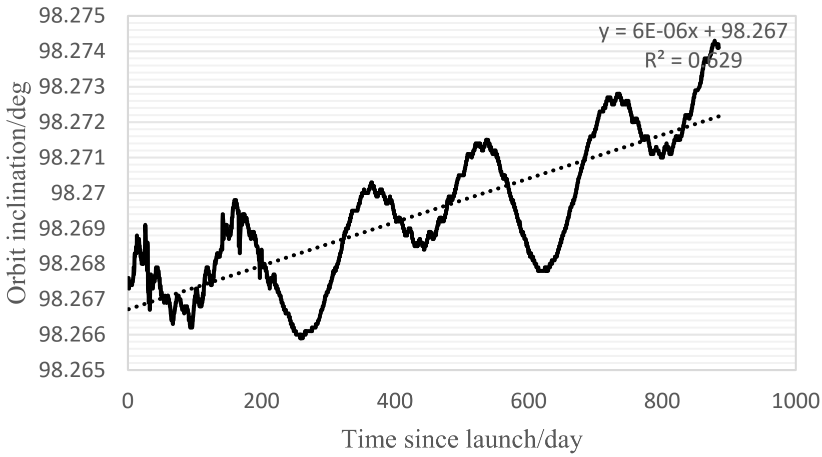

Fig. 5. Inclination change versus time

In Figure 4 and 5, the orbit altitude change and inclination change since ASO-S' launch on Oct.9, 2022 are respectively presented. The orbit altitude has decreased by about 3 km as of Mar.,12, 2025. The inclination has an increasing trend, which can be expressed by the straight line equation: y = 6E-06x + 98.267. The slope of the fitted dotted line is about 6e-06.

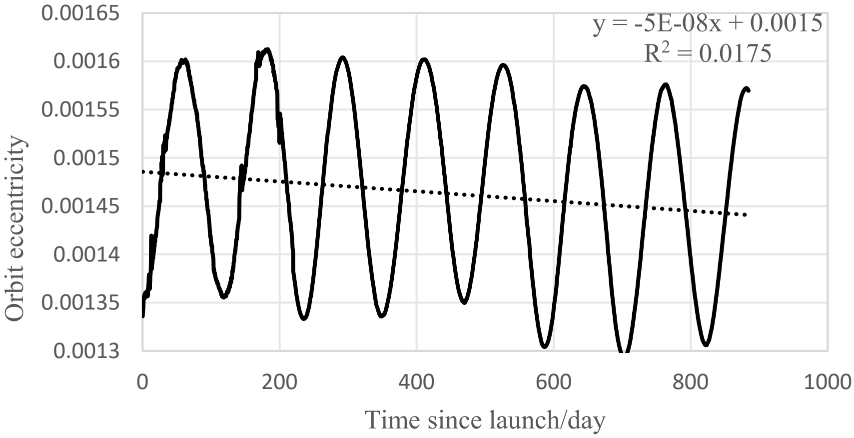

Fig. 6. Eccentricity change versus time

In Figure 6, the orbit eccentricity since ASO-S' launch is presented, which has a secular downhill trend with the slope of -5E-08. The dotted line in Figure 6 is the fitted straight line for the change of eccentricity versus time. Results in Figure 4, Figure 5 and Figure 6 have shown that the orbit for ASO-S is stable enough for scientists to carry out sufficient observations of the Sun.

4 Conclusions

ASO-S satelliate has been in orbit for more than 2years.During this period, some discoveries are found out, such as white light flare; as a rule of thumb, white light flare is believed to be rare. But scientists of ASO-S have found out 49 white light flares out of 205 flares during the period from Oct.,2022 to May,2023;the detected white light flares rate is about 24%;it means that white light flares are no longer rare [15]; ASO-S scientists have successfully constructed the first Lyα Carrington map based on full-disk Lyα images acquired by the Solar Disk Imager (SDI) on board ASO-S[16], which could help model the corona Lyα emission. According to the updated orbit analyses, the orbit of ASO-S is relatively stable, which will continue to support smooth operations of ASO-S in future. Based on massive data set of the Sun observations, more reasonable models about the Sun science are promising to emerge in the future. More new discoveries about our star Sun will be disclosed by ASO-S mission team.

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