

## Postprint: A Study on the Current Status and Regional Disparities of Astronomy Popularization in China Based on the WWT Platform

**Authors:** Lin Hongzhi, PAN Wenbin, Deng Rongbiao, Wang Hongguang

**Date:** 2018-11-08T00:00:00+00:00

### Abstract

The WorldWide Telescope (WWT) is a powerful tool for astronomy popularization education. This article conducts a detailed investigation and data analysis of WWT's development trajectory in China and related practical activities, revealing that while astronomy popularization based on the WWT platform has progressed rapidly over the past decade, significant regional disparities persist. These disparities are primarily manifested in the concentration of practical activities—such as WWT talent training and tour creation—in a few provinces including Beijing, Hubei, Guangdong, and Chongqing, indicating that substantial efforts are still required to achieve universal public accessibility. Building upon a summary of challenges in utilizing the WWT platform for astronomy popularization education in China, this study proposes a series of targeted promotion measures and recommendations across three key dimensions: “enhancing and implementing awareness of science data-based popularization education,” “strengthening talent cultivation,” and “encouraging the creation and promotion of WWT-based astronomy popularization works.” These proposals aim to provide valuable reference and guidance for astronomy popularization education initiatives in China, particularly those conducted in primary and secondary schools.

### Full Text

#### Preamble

#### A Research on the Development and Regional Differences of Astronomical Science Popularization Based on the WWT Platform Across China

Lin Hongzhi<sup>1,2</sup>, Pan Wenbin<sup>1</sup>, Deng Rongbiao<sup>3</sup>, Wang Hongguang<sup>3</sup>

<sup>1</sup>School of Geographical Sciences, Guangzhou University, Guangzhou, Guang-

dong 510006, China

<sup>2</sup>School of Geographical Sciences, Fujian Normal University, Fuzhou, Fujian 350007, China

<sup>3</sup>School of Physics and Electronic Engineering, Guangzhou University, Guangzhou, Guangdong 510006, China

## Abstract

The WorldWide Telescope (WWT) is a powerful tool for astronomical science education. Through investigation and data analysis of WWT's development trajectory and related practical activities in China, this study finds that while astronomy popularization based on the WWT platform has progressed rapidly over the past decade, significant regional development disparities exist. Specifically, practical activities such as WWT talent training and "Tour" (interactive guided experience) creation have been concentrated in only a few provinces, including Beijing, Hubei, Guangdong, and Chongqing, indicating a long road ahead before the benefits reach the general public nationwide. Building upon an analysis of the challenges in developing astronomy popularization through the WWT platform in China, this paper proposes a series of targeted promotion measures and recommendations across three major dimensions: "enhancing and implementing science popularization education consciousness based on scientific data," "strengthening talent cultivation," and "encouraging the creation and promotion of astronomy popularization works based on WWT." These suggestions aim to provide references for astronomy popularization education activities in China, particularly for primary and secondary schools.

**Keywords:** WorldWide Telescope; Astronomical popularization; Regional differences

Astronomy is one of the six fundamental disciplines and holds an important position in human social development. The Popularization Committee of the Chinese Astronomical Society notes that for middle school students, astronomy is particularly suitable for cultivating scientific interest, fostering innovative qualities, and establishing a scientific worldview. However, astronomy education has long remained in a disadvantaged position within China's education system—astronomy is the only one of the six fundamental disciplines not included in the primary and secondary school curriculum. Consequently, extracurricular astronomy popularization has become a crucial pathway for students to acquire astronomical knowledge.

Since its inception in 2008, the WorldWide Telescope (WWT) has been warmly welcomed by astronomy enthusiasts and science educators both domestically and internationally. As a powerful virtual observatory and astronomical science database, WWT possesses excellent educational functions. Development of astronomy popularization based on this platform can create favorable learning environments and provide novel educational resources, making it a valuable and powerful component of astronomy science education.

Currently, research on astronomy popularization education in China is limited, primarily focusing on curriculum teaching, with even fewer studies addressing regional comparative analysis. This research aims to summarize the application status and regional development differences of WWT in China's astronomy popularization, reveal existing problems and deficiencies, and propose relevant measures and recommendations to promote WWT-based astronomy popularization. The goal is to provide references for astronomy popularization activities in primary and secondary schools and to advance the cause of astronomy science education in China.

### 1.1 WWT Introduction and Development Overview in China

The development of WWT in China has closely followed global trends. In 2001, big data computer scientist Dr. Jim Gray first published the “WWT” concept in *Science* magazine, and was invited to visit the National Astronomical Observatories of China (NAOC) the following year to introduce the “WorldWide Telescope” concept to Chinese colleagues. In May 2008, Worldwide Telescope was officially released as software, and the following month, China's renowned astronomy popularization magazine *Amateur Astronomer* introduced it to domestic readers through a news brief. The July issue featured an article by Dr. Cui Chenzhou from NAOC titled “The GS-WWT Era of Astronomy,” providing a detailed introduction to WWT for Chinese readers.

The year 2009 marked a crucial period for WWT promotion in China. Against the backdrop of the International Year of Astronomy 2009 and the total solar eclipse along the Yangtze River, a wave of astronomy enthusiasm swept the nation, and WWT gained prominence as a new technology and highlight. *Amateur Astronomer* published an article titled “WWT: Assisting You in IYA2009,” co-authored by Dr. Xu Yan from Microsoft Research and Dr. Cui Chenzhou from NAOC, in its special issue for the International Year of Astronomy, while featuring a large WWT promotional poster on the back cover, pushing domestic WWT promotion to a new climax. A science popularization project jointly applied for by NAOC and Microsoft Research, “Astronomy Popularization Exhibition and e-Science Concept Education Based on the WWT Platform,” received funding from the National Natural Science Foundation of China, signifying official recognition and support for information-based astronomy popularization education activities represented by WWT. In November of the same year, the “WWT Beijing Community (WWT Community Beijing),” completed through collaboration between the China Virtual Observatory (China-VO) initiative and Microsoft Research, was officially launched as WWT's official Chinese portal, providing various information and resources for Chinese users. Excellent Tour works created by domestic users could also be shared with the global WWT community through this website.

Since 2010, practical education activities centered on WWT have gradually developed in China, with the most representative being the “WWT Astronomy Teacher Training” and “Universe Tour Creation Competition.” National WWT

teacher training activities, primarily organized by NAOC, Microsoft Research Asia, Central China Normal University, and other institutions, represent the highest-level national WWT talent training events in China and are among the few specialized astronomy popularization education training activities nationwide. Between 2010 and 2017, seven national teacher training events were held across five provinces and municipalities (a Xinjiang-specific training in 2012 falls outside this study's statistical scope), attracting participants from teachers, science educators, and senior astronomy enthusiasts nationwide.

Led by NAOC, three national WWT Tour creation competitions have been held in China as of 2017. These represent the highest-level WWT Tour creation contests in China, providing a platform for astronomy enthusiasts to showcase and share their Tour works while promoting resource development and dissemination of universe Tour works domestically. Meanwhile, under the organization of the Guangdong Astronomical Society, Guangdong Province held university student WWT universe Tour creation competitions for two consecutive years in 2015 and 2016.

## 1.2 The Rise of WWT-Related Supporting Resources in China

Interactive digital planetariums specifically designed for WWT have gradually been established in China. Currently, seven interactive digital planetariums have been completed in mainland China, with details shown in Table 1. These dedicated venues and implementation pathways for WWT-based astronomy popularization education have significantly enhanced WWT's application and promotion in science education in China.

**Table 1** A list of interactive digital planetariums in mainland China

Date	Institution	Significance
October 2013	Shixin Road Primary School, Jiulongpo District, Chongqing	China's first interactive digital planetarium
	Beijing Normal University	First interactive digital planetarium in Chinese universities
	Affiliated High School of South China Normal University	First interactive digital planetarium in Chinese middle schools
January 2017	Shahe Station, National Astronomical Observatories Hebei Normal University Museum	
December 2017	Zhangjiawan Primary School, Hongshan District, Wuhan	

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Date	Institution	Significance
September 2018	China West Normal University	

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Furthermore, through the efforts of NAOC and related institutions and staff, the *Interactive Astronomy Teaching Guidance Series* for primary schools, titled *Astronomy Teaching in Primary Schools: Teacher's Book* [6], edited by Dr. Cui Chenzhou, Director of the Information and Computing Center at NAOC, was officially published in November 2017. In February 2018, the accompanying Tour courseware for *Astronomy Teaching in Primary Schools: Teacher's Book* was released for open sharing. Also in February 2018, the China Virtual Observatory WWT (Personal Edition) was officially launched (Figure 1 [Figure 1: see original paper]). These valuable achievements signify that WWT-based astronomy popularization education in China has begun to receive systematic and standardized guidance, ushering in a new era of astronomy popularization education tailored to China's national conditions.

## 2 Current Status and Existing Problems of Domestic Astronomy Popularization Based on the WWT Platform

The development of astronomy popularization relies on human resources and requires rich multimedia resources for support. Through a decade of collaboration between NAOC, Central China Normal University, and Microsoft Research, this section analyzes the current status and existing problems of domestic astronomy popularization based on the WWT platform through three representative practical activities: WWT talent training, WWT Tour creation competitions, and the inaugural National College Student Astronomy Innovation Works Competition.

### 2.1 Development Status and Regional Disparities from Domestic WWT Teacher Training

Between 2010 and 2017, eight national WWT teacher training events were held across five provinces and municipalities, totaling approximately 223 participants. The highest single-year attendance was 39 in 2010 and 2011, while the lowest was 28 in 2015 and 2016. As shown in Figure 2 [Figure 2: see original paper], the scale of national WWT talent training activities has remained modest but stable over the years. From a regional perspective, Beijing has the highest cumulative participation with 49 attendees (approximately 22.0% of the total), followed by Hubei with 42 participants (18.8%). However, ten regions (Gansu, Hainan, Hunan, Ningxia, Qinghai, Shanxi, Taiwan, Tibet, Macau, and Hong Kong) have zero total participation. Except for Chongqing, Guangdong, Hebei, Inner Mongolia, and Zhejiang, all other regions have single-digit total participation (Figure 3 [Figure 3: see original paper]). Notably, only Beijing, Hebei, and Wuhan have consistently sent participants annually, while other regions show weak continuity or have never participated.

These findings indicate that while domestic WWT-based astronomy popularization has steadily and continuously developed in terms of talent cultivation and reserves, providing valuable human resources for China's astronomy popularization development, significant regional disparities exist. Participants primarily come from more developed regions, with heavy concentration in Beijing and Hubei—closely related to the locations of the event organizers, a point this paper does not elaborate on. For less developed regions, minimal or nonexistent participation creates unfavorable conditions for astronomy popularization education development due to insufficient talent reserves.

## 2.2 Development Status and Regional Disparities from WWT Tour Creation Competitions

Between 2010 and 2017, three national WWT Tour creation competitions were held in China, with a total of 330 submitted Tour works. The first competition had the most entries (175, accounting for 53% of the total), followed by the third (89 entries, 27%), and the second had the fewest (66 entries, 20%) (Figure 4 [Figure 4: see original paper]).

Notably, in the first WWT Tour creation competition, 152 entries came from Hubei, representing 86.9% of that competition's total entries—a dominant position relative to other provinces. This reflects a unique historical circumstance: after WWT's formal introduction to China, Central China Normal University in Wuhan, Hubei, pioneered three-tiered astronomy teaching based on the WWT platform. Students enrolled in these courses used WWT to complete assignments, accumulating a large number of Tour works. When the inaugural national competition launched, these works became the most important source of entries through competition promotion and teacher recommendations.

Across the three WWT Tour creation competitions, the 330 entries originated from 15 provinces. Hubei leads with 167 works, followed by Beijing (46) and Guangdong (35). Liaoning, Heilongjiang, Chongqing, Jiangxi, and Hebei constitute the third tier. Jilin, Jiangsu, Shandong, Shaanxi, Sichuan, Yunnan, and Zhejiang each contributed 1-3 works, while 19 provinces and regions had zero entries (Figure 5 [Figure 5: see original paper]).

Since WWT's introduction to China, Tour creation has steadily progressed quantitatively, providing good resource support for domestic astronomy popularization education. However, the geographic distribution of competition entries reveals significant regional development disparities in WWT-based astronomy popularization in China. Only 15 regions have contributed works, primarily concentrated in six provinces: Beijing, Chongqing, Guangdong, Hubei, Liaoning, and Heilongjiang, with 19 regions showing no Tour works at all. This indicates that WWT's popular science application remains limited to a small active area in China, with substantial regional disparities.

### 2.3 Development Status and Regional Disparities from the Inaugural National College Student Astronomy Innovation Works Competition

From September to December 2017, the inaugural National College Student Astronomy Innovation Works Competition (CAIC) was successfully held, organized by the Chinese Astronomical Society and hosted by its Popularization and Education Working Committees. As China's first national astronomy-themed innovation competition for college students (including associate and undergraduate students), it comprised two categories: astronomy technology innovation and astronomy popularization innovation.

The competition collected 56 preliminary entries, with 45 (80%) falling under astronomy popularization innovation. These popularization innovation works were further categorized into ten subtypes, among which WWT Tour works numbered 9, accounting for 20% of popularization innovation entries (Figure 6 [Figure 6: see original paper]). This demonstrates that Chinese university students possess broad creative thinking in astronomy popularization, with diverse creation forms, and WWT-based astronomy popularization creation holds a relatively important position. However, both WWT Tours and other astronomy popularization works show significant regional disparities: the 45 works came from only 15 provinces, with 19 regions showing zero participation. The distribution of WWT Tour works was even narrower, with 9 works distributed across just 6 provinces, led by Guangdong (3) followed by Shandong (2). This indicates that, except for a very few provinces, an enthusiastic atmosphere for WWT popularization creation has not yet formed in Chinese universities.

### 2.4 Existing Problems and Deficiencies

Despite continuous development of WWT-based astronomy popularization in China, several problems cannot be ignored. First, regarding regional development disparities, practical activities around WWT and its popularization applications have been concentrated in a few provinces such as Beijing, Hubei, Guangdong, and Chongqing, far from achieving nationwide promotion, with significant regional differences in WWT-based astronomy popularization development. The lack of specialized talent and WWT popularization education resources substantially constrains astronomy popularization development in these regions.

Second, concerning WWT promotion activities, China currently relies primarily on the annual national astronomy teacher training organized by NAOC, with limited scale each time that cannot meet the massive demand for digital astronomy popularization education talent. Additionally, WWT Tour creation competitions have been held too infrequently—only three national competitions in ten years—failing to maintain continuous attraction and stimulation for WWT Tour creation, limiting their impact and diminishing WWT's promotional effectiveness.

Finally, regarding popularization resources, the healthy and sustainable develop-

ment of astronomy popularization requires rich materials and resources for support. Apart from the *Astronomy Teaching in Primary Schools (Teacher's Book)* and its accompanying Tour courseware released in February 2018, China currently lacks systematic and large-scale WWT-based astronomy popularization materials and resources. Meanwhile, competition-produced works vary significantly in quality and have disorganized themes, hindering large-scale promotion and application of WWT-based astronomy popularization education. These issues warrant attention and reflection as we seek appropriate countermeasures and approaches to actively promote the development of astronomy popularization education in China.

### 3 Recommendations and Measures

#### 3.1 Enhancing Science Popularization Education Consciousness Based on Scientific Data in the Big Data Era

As society and science and technology develop, the volume of data obtained by humans grows geometrically, ushering in the big data era. The U.S. National Science Board and National Academy of Sciences have noted that the accumulation of large amounts of real data has brought unprecedented promotion to science education. In response, Chinese education and popularization workers must increase their emphasis on scientific data, enhance consciousness of science popularization education based on scientific data, actively explore effective ways to utilize scientific data, and transform these approaches into educational and popularization activities. This will help deepen educational reforms and adapt to new goals and requirements of national informatization development.

Astronomy, primarily an observation-based discipline, has become a data-intensive and data-driven science. Astronomy popularization education cannot be conducted without effective utilization of astronomical scientific data. As the embodiment of a virtual observatory, WWT provides educators and learners with a powerful educational environment based on scientific data. Relevant departments and organizations should further promote the concept of science popularization education based on scientific data, provide astronomy popularization educators nationwide with more opportunities and pathways to understand WWT, and conduct astronomy popularization activities more efficiently based on new concepts and technologies, gradually narrowing regional disparities in astronomy popularization development across China.

#### 3.2 Strengthening Talent Cultivation to Keep Pace with the Era of Data-Driven Astronomy Popularization Education

“Talent is the primary resource,” and astronomy popularization education activities cannot succeed without human resources. The era of data-driven astronomy popularization education has arrived. In 2017, the International Astronomical Union (IAU) established the inter-commission working group “Data Driven Astronomy Education and Public Outreach (DAEPO),” the only IAU working

group among more than fifty chaired by a Chinese astronomer—Dr. Cui Chenzhou from NAOC. This will pave the way for enhancing China's international status in astronomy popularization education. This presents an extremely favorable opportunity for promoting WWT-based astronomy popularization in China, with talent cultivation being the top priority.

- (1) **Integrate WWT into university teaching activities** by combining it with astronomy, physics, and geography major courses or general elective courses, leveraging the talent effect of higher education institutions to cultivate strong reserve talent for China's astronomy popularization education. As centers of education and scientific research, universities should utilize their advantages of abundant scientific and technological achievements, concentrated research talent, and advanced experimental platforms to courageously undertake the important responsibility of science popularization.
- (2) **Utilize government science popularization special funds** to support WWT talent training activities, appropriately increasing training scale and frequency while reducing the economic burden on participants (especially through subsidies and encouragement for underdeveloped regions). This will enable more teachers interested in or already engaged in astronomy popularization to access and learn the latest astronomy popularization education concepts and methods, minimizing regional distribution gaps in human resources.
- (3) **Continue steadily advancing national training activities**, scheduling two events annually during winter and summer vacations to accelerate the dissemination of advanced science popularization education concepts nationwide. Ensure diversity in event locations to better leverage the promotional role of training activities, attract and cultivate outstanding local astronomy popularization education talent, and narrow regional development disparities. Simultaneously, conduct regional training activities where participants of national training events can share and teach locally, creating a favorable astronomy learning environment and promoting WWT-based astronomy popularization education activities to flourish nationwide.
- (4) **Balance the proportion of in-service teachers, astronomy popularization workers, and university volunteer students** among training participants. Given the current lack of astronomy courses in primary and secondary schools, extracurricular astronomy popularization has become an important pathway for students to acquire astronomical knowledge. WWT training organizers should guide more astronomy popularization workers and university volunteer students to participate in learning, helping them master data-driven astronomy popularization education methods and technologies for practical application, thereby effectively advancing astronomy popularization education in China.

### **3.3.1 Promoting WWT Tour Creation Competitions at All Levels and Guiding Primary and Secondary School Student Participation**

The aim is to create a platform where astronomy enthusiasts nationwide can showcase their unique concepts, ideas, and methods in astronomy popularization creation through WWT Tour works and conveniently exchange creative insights, fostering a positive atmosphere for astronomy popularization.

Gradually increase and stabilize the frequency of national WWT Tour creation competitions, shorten individual competition durations, and conduct competitions online during summer vacations to reduce participants' burden. Meanwhile, local astronomy-related units and organizations should actively organize regional WWT Tour creation competitions. First, these competitions can strengthen astronomy publicity through their topicality and serve as opportunities to implement WWT astronomy popularization applications (winning Tour works can be exhibited in local primary and secondary schools, youth palaces, cultural centers, or science museums), providing the public with refreshing astronomy engagement pathways and promoting local astronomy popularization education. Second, regional competitions can serve as preliminaries for national competitions, improving efficiency, creating brand effects, expanding publicity and promotion scope, and narrowing regional disparities in astronomy popularization education.

WWT Tour creation competitions provide excellent opportunities and platforms for inquiry-based practical activities using project-based learning in primary and secondary schools. To express their ideas or team concepts through Tour works, students must complete a series of steps including "theme determination," "material collection," "script writing," "WWT software operation for Tour production," and "background music and narration matching." Throughout this process, students need to utilize various resources and mobilize multiple intelligences including communication, observation, calculation, reasoning, spatial imagination, and music appreciation. The combination of these different talents reflects an individual's genuine intelligence, fully embodying constructivist learning theory and multiple intelligences theory while responding to and implementing new requirements of national education reform. This approach facilitates the popularization of scientific data-based education concepts in primary and secondary schools, stimulates students' astronomical interest and exploration enthusiasm, and cultivates data utilization awareness and information processing abilities, representing an important method for promoting astronomy popularization nationwide.

### **3.3.2 Leveraging University Human Resources for Systematic and Structured WWT Works Creation to Provide Sufficient High-Quality Tour Resources**

At the 2012 National Science Popularization Open Day main venue, General Secretary Xi Jinping pointed out: "Universities should focus not only on teaching

and research but also on science popularization. Higher education institutions harbor the richest human resources for conducting science popularization education activities and possess irreplaceable advantages in carrying out public science popularization activities.”

Local relevant units should actively organize and guide the establishment of clear Tour works development frameworks, setting up WWT-based astronomy popularization development projects or even specialized programs. By leveraging university human resources, specialized Tour creation project teams can be formed, or university astronomy or science tutoring clubs can undertake specialized work on a voluntary basis. This provides astronomy enthusiasts and science popularization volunteers in universities with an additional pathway to realize self-worth and participate in China’ s astronomy popularization cause. It also stimulates more Tour works creation while ensuring quality, providing sufficient structured resources and materials for WWT-based astronomy popularization education applications, meeting the growing cultural demands of learners and educators, and promoting the development of astronomy popularization education in China.

### **3.3.3 WWT Platform-Based Astronomy Popularization Innovation Combined with Virtual Reality Technology**

WWT supports connection with interactive devices and can provide immersive experiences when paired with virtual reality (VR) headsets, delivering unprecedented sensations that enhance users’ astronomy learning experiences and increase interest in astronomy. Many foreign planetariums and schools have applied WWT in VR headsets, kiosks, and other interactive devices, though such practices remain rare in China.

Therefore, VR professionals and WWT professionals need to strengthen collaboration, combining VR technology with WWT to fully leverage WWT’ s powerful functions and innovate WWT platform-based astronomy popularization application models and methods. Through format innovation and excellent user experience, more users can be attracted to meet people’ s diverse cultural needs. Simultaneously, VR’ s popularity can strengthen WWT-related publicity, increase astronomy audiences, create a favorable astronomy popularization atmosphere and environment domestically, and add new development momentum to China’ s astronomy popularization.

### **3.3.4 Establishing a Tour Works Repository and Broadening WWT Promotion Pathways Through New Media Platforms**

Science cannot be entertainment-oriented, but science popularization can employ enjoyable methods that people love. It is necessary to break the stereotype that science popularization activities are dull and rigid, leveraging new media forms of the information age. WWT features built-in Tour exploration and community sections where users can share and browse Tour works. However,

due to China's small astronomy audience and limited WWT software users, dissemination remains relatively closed. We must break out of this inherent circle and actively integrate with media forms that people enjoy, striving to broaden WWT publicity and dissemination pathways, expand promotion scope, and thereby narrow regional development disparities.

First, ensure high-quality and abundant Tour resources. Relevant responsible units should establish and improve Tour works repositories (including both original format and standard video format Tour works), maintaining collection and updates while strictly controlling quality. Based on this, resources can be made available through relevant websites and WeChat public platforms, giving more people opportunities to access WWT Tours and experience refreshing astronomy popularization.

Second, conduct more open online live broadcasts of WWT talent training activities, enabling more like-minded individuals to learn new WWT-based astronomy popularization methods and increasing the benefits and impact of training activities.

Third, attempt to create astronomy popularization influencer streamers (or teams) who regularly share the latest domestic and international developments in astronomy popularization education under the data-driven astronomy popularization background on educational live-streaming platforms, teaching WWT usage skills and science popularization education application methods.

Fourth, strengthen cooperation with universities and science popularization education institutions to design and create online courses (MOOCs) focusing on astronomy knowledge popularization, WWT software usage, Tour production, and practical applications. This can to some extent address the current and future long-term shortage of astronomy courses and astronomy teachers in China's primary and secondary schools.

## 4 Conclusion

Through in-depth interviews, investigations, and textual analysis of WWT's decade-long development in China, particularly regarding practical activities such as WWT talent training and Tour works creation, this study reaches the following conclusions:

- (1) Overall, domestic WWT talent training activities are insufficient, WWT astronomy popularization resources are inadequate, and significant regional development disparities exist. The active regions for WWT and its popularization applications have historically concentrated in a few provinces such as Beijing, Hubei, Guangdong, and Chongqing, far from achieving nationwide promotion.
- (2) Modern science education cannot be separated from effective utilization of scientific data. The "data-driven astronomy popularization education" concept introduced in this paper has gained international recognition and

promotion and will become an important guiding ideology and theory for conducting astronomy popularization education.

- (3) Based on summarizing problems and deficiencies in domestic WWT development, this paper proposes a series of targeted promotion measures and recommendations across three major dimensions: “enhancing and implementing science popularization education consciousness based on scientific data,” “strengthening talent cultivation,” and “encouraging the creation and promotion of astronomy popularization works based on WWT,” providing references for astronomy popularization education activities in China, particularly for primary and secondary schools.

### Acknowledgments

We thank the Information and Computing Center of the National Astronomical Observatories for providing data resources. We also thank Dr. Cui Chenzhou, Director of the Information and Computing Center of NAOC, for his support and valuable suggestions.

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*Source: ChinaXiv –Machine translation. Verify with original.*