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EDITORIAL

Overview on Space Solar Power Station

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This special issue is dedicated to the field of Space Solar Power Station (SSPS). Proposed by the American scientist Peter Glaser, SSPS is a grand idea to build an extra-large solar power station on the Earth orbit and to transmit electricity to the surface ground wirelessly, such as through microwaves.

SSPS has huge potential economic and social benefits. It can provide a new energy development way to use solar energy, which will greatly improve the capacity of space technology and become a strategic choice to deal with global climate change. It is of great strategic significance to solve the world's energy and environmental problems.

With the globally urgent demand for clean energies, the great pressure caused by climate changes and the rapid development of space technology, the international space community generally believes that the next decades will be an important period for the breakthroughs and applications of key technologies for SSPS. By around 2040, it is highly possible to develop a complete system of SSPS with commercial applications.

Not only required to have the functions of solar energy collection and conversion, power transmission, wireless energy transmission, etc., the SSPS also needs to realize information collection and system operation management necessary to maintain the normal operation of the space platform. For a long time, researches in the field of SSPS have mainly focused on overall concept innovation and continuous improvement according to the development of the related technologies. So far, more than 20 innovative SSPS concepts have been proposed in the world, most of which are platform-based or concentrated monolithic configurations, that is, the SSPS system is connected as a whole, with a relative motion among the generator array, concentrator array and microwave transmitting array. In recent years, the SSPS innovative concepts of separated structure using formation control have also emerged. By comparison, the platform-based SSPS, due to its simple configuration, high energy utilization efficiency, easy engineering construction and suitable modular expansion, will be an important development direction in the future.

Generally, the platform-based SSPS must adopt high-power transmission conductive joints because of its orientation to the Sun, and the concentrated SSPS need to deal with complex optical control and thermal control. Both are facing huge technology challenges. While the separated structure SSPS is difficult to solve the continuous energy transmission to the Earth and the utilization efficiency of solar energy. The SSPS research team in China Academy of Space Technology (CAST) proposed a multi-rotary joint concept (MR-SPS, shown in Fig. 1) which decomposed the high-power conductive rotary joint into a number of low-power conductive rotary joints so that it can strengthen the expansibility of the generator array and avoid the single point of failure by reducing the power of a singer conductive joint. The MR-SPS concept won the first prize in the 2015 International Space Solar Satellite Design Competition. Moreover, the research team of Xidian University in China proposed an OMEGA (Orb-shape Membrane Energy Gathering Array, shown in Fig. 2) concentrating innovative solution with arbitrary axisymmetric "spherical-line focusing", which makes the SSPS highly efficient, stable and easy to control.

China has proposed a two-stage SSPS development roadmap of building a Mega Watt level (MW-level, indicating that the electrical power continuously received on the surface ground is about 1 Mega Watt) demonstrated SSPS by 2030 and a commercial SSPS by 2050. Relevant research teams have carried out extensive researches on the overall concept design and key technologies of the MW-level demonstrated SSPS. Comprehensively considering the engineering realizability and economic feasibility of MW-level demonstrated SSPS, adopting the modular and integrated design ideas based on the MR-SPS concept, the research team of the CAST used the hollow bidirectional confluence conductive rotary joints to replace the conventional SADA to easily achieve the power expansion and modular construction of the generator array, and used 3D folded truss structure as the central load bearing structure to connect the generator array and microwave antenna array so as to achieve the mod-

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Fig. 1 MR-SPS

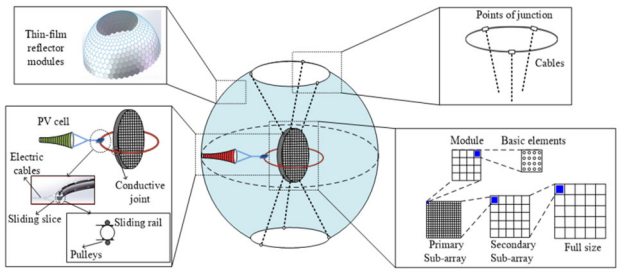

Fig. 2 OMEGA

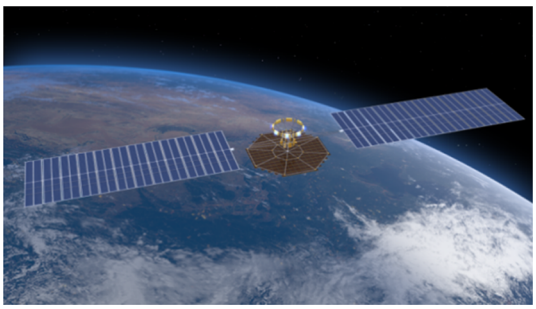

Fig. 3 MD-SPS

ular hierarchical control of SSPS, which greatly reduced the construction difficulty of MW-level demonstrated SSPS. The proposed Modular Demonstrated Space Power Station (MD-SPS) is shown in Fig. 3.

The MW-level MD-SPS adopts 3D folded truss and I-shaped structure as the main load bearing structure to make the load-bearing structure be the full truss. The main body of the MD-SPS comprises the generator array and microwave transmitting antenna array, where the microwave antenna array is in the center, oriented to the Earth ground, and the generator array is arranged on both sides, oriented to the Sun. Both are connected by trusses. The whole structure layout is I-shaped. The high-voltage thin-film solar generator arrays are combined with light trusses and inflatable auxiliary pod rods are used to greatly improve the power weight ratio and the modular construction efficiency and to ensure the enough structural stiffness. Each solar generator sub-array is connected at the center with the generator array truss structure by an independent hollow bidirectional confluence conductive rotary joint to achieve the relative constant speed rotation between them. The microwave transmitting antenna is approximately round and is integrated with the microwave circuit and the transmitting antenna. At the module level, the integration of microwave energy conversion and emission and the collaborative design of mechanical, electrical and thermal dimensions are solved integratedly, which enables high-integration antenna modules and greatly reduces the weight of the antenna array surface. The MW-level MD-SPS adopts the power system topology of multi-network hybrid bus and load direct drive distribution, and achieves the modular hierarchical control based on the structure-control integrated design method.

This special issue covers the researches on SSPS concept design, space high-efficiency solar cells, microwave/laser wireless energy transmission, space high-pressure high-power power system, and so on, which shows the latest progresses in SSPS in China. In the next few years, the construction of the MW-level MD-SPS will be focused on, and the researches on some key technologies will be emphasized, such as SSPS overall technology, space ultra-large modular structure assembly, construction and control technology, space ultra-high power and high-voltage power system technology, and long-distance efficient wireless energy transmission technology, and so on.

Finally, I would like to express my gratitude to the Chinese Society of Astronautics and the Advances in Astronautics Science and Technology for their attention and support to the development of SSPS technology, and for introducing the technological progresses in this field to global scholars through this special issue. The next decade will be an important period for SSPS key technological breakthroughs and in-orbit verification. I believe that there will be massive technological innovations and cutting-edge researches in this field.