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KEY TECHNOLOGY FOR NEW GENERATION QUANTUM SATELLITE IN CHINA

Abstract

China launched a LEO satellite called QUESS (Quantum Experiments at Space Scale) in 2016, which demonstrates a satellite-to-ground quantum communication over a distance scale of 1,200 km. Recently, scientists raise a plan of developing a satellite for more challenging objectives, including all-day quantum communication over 10000 km, optical bidirectional time-frequency transmission based on the optical comb and ultra-cold atoms experiment in space. The ambitious satellite aims at a final location at GEO after several self-orbital promotion for deep demonstration under different link conditions. To increase the link efficiency for longer distance and all-day communication, new techniques like larger telescopes, better acquiring, pointing and tracking (APT) system and adaptive optics are required. Large optical driving system indicates complexity of optical axis matching and attitude coupling control in the satellite. To achieve a 10-18 level stability accuracy, time-frequency transmission depends on ultra-stable laser as stable frequency source for optical comb and accurate orbit measurement to compensate for Doppler frequency errors in real time. The ultra-stable lasers, whose stability are extremely susceptible to external environmental disturbances, require a dedicated vibration isolation device and a systematic optimization of vibration performance. The ultra-cold atom experiment is currently the most ideal quantum control system, and also one of the most complicated experimental systems. The microgravity in MEO/GEO will provide an ideal environment for preparing ultra-cold atoms close to the quantum limit. However, it also has relatively higher requirements for micro-vibration acceleration, ambient magnetic field, temperature field and vacuity. Therefore, the new generation quantum satellite plan has posed a series of strict demands on satellite design, like mission orbit optimization, multi-payload integration, high-precision measurement and micro-vibration suppression. In order to explore the feasibility of the mission and provide effective solutions, this article firstly analyzes the basic requirements for satellites based on scientific test needs, and decomposes the system technical demand into subsystem requirement, and finally identify key technologies for system design and engineering.