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1. 5m口径空间相机主镜组件的结构设计

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Structural design of 1.5 m mirror subassembly for space camera

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摘要 研究了1.5 m口径空间相机反射镜组件的结构, 设计了主镜组件结构系统.采用RB-SiC作为反射镜镜坯材料,分析并优化了反射镜支撑形式和镜体的结构参数,得到了重131.9 kg,轻量化率达到81%的反射镜结构.在主镜基本构型确定的基础上,设计了主镜支撑结构,通过合理设计柔性卸载结构满足了主镜结构系统的力、热环境适应性和抗振性要求.最后,利用有限元法综合分析了主镜组件的性能.试验结果表明:主镜在1*g*重力作用下的面形精度RMS达到0.025*λ*(*λ*=632.8 nm),(20±4)℃温变环境中主镜面形变化量在RMS 0.01*λ*范围内,主镜组件一阶固有频率为95.8 Hz,有限元分析结果的误差为4%.得到的结果表明主镜组件的静态刚度、动态刚度及热环境适应性完全满足设计指标要求.

关键词 : 空间相机, 主镜, 轻量化, 支撑, 振动测试

Abstract : The subassembly of a 1.5 m diameter primary mirror in a space camera was researched and the structure system of subassembly for the primary mirror was designed. RB-SiC was chosen as the material of the primary mirror, the lightweight design, support scheme and the structure design of the concrete support were analyzed, and a mirror structure with a mass of 131.9 kg and lightweight ratio of 81% was obtained. The support structure of the primary mirror was designed after determining the basic configuration of the primary mirror. Then, a flexible support structure was reasonably designed to adjust the force, thermal environment adaptability and vibration resistance. Finally, the Finite Element Method (FEM) was used to analyze the performance of the subassembly of the primary mirror synthetically. The experimental results show that the surface figure accuracy(Root Mean Square,RMS) of the primary mirror reaches 0.025*λ*(*λ*=632.8 nm)under the action of gravity of 1*g* and the changed scope is 0.01*λ*(RMS) in the (20±4) ℃ temperature environment. The first order natural frequency of the subassembly of the primary mirror is 95.8 Hz and the error obtained by the FEM is 4%. It demonstrates that the static stiffness, dynamic stiffness, and the thermal environment adaptability of the subassembly of the primary mirror have met the requirements of design criterion.

Key words : space camera primary mirror lightweight support vibration test

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