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现代应用光学

双向大视场消畸变低温红外目标模拟光学系统设计

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摘要: 为了选择合适的低温红外目标模拟光学系统, 针对国内现有离轴三反射光学系统多存有弧矢视场较大, 子午视场很小的问题, 本文基于光学系统对称性法则, 设计了子午和弧矢都为 5° , 波长为 $3\sim 5\ \mu\text{m}$ 的矩形双向大视场离轴三反系统, 其焦距为 $400\ \text{mm}$, $F\#$ 为 8 。利用光学系统结构参数和反射镜的非球面系数, 调整三镜的偏心及倾斜来消除畸变及其它像差, 系统光学传递函数在 $6.5\ \text{lp/mm}$ 时优于 0.71 , 全视场均方根波像差达到 $\lambda/250$, 均方根最大弥散斑半径不超过 $7.0\ \mu\text{m}$, 达到衍射极限。另外, 系统在各个波段全视场范围内的最大畸变量小于 0.04% 。设计的系统可用于红外及可见波段, 成像质量均良好。

关键词: 红外目标模拟 光学设计 离轴三反射系统 大视场 消畸变

Design of cryogenic infrared target simulation system with bidirectional and wide field for eliminating distortion

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Abstract: To overcome the shortcomings of off-axis Three Mirror Anastigmatic (TMA) optical systems in larger sagittally FOVs and smaller meridionally FOVs, this paper designs a bidirectional TMA optical system for cryogenic infrared target simulation system based on the symmetric rule of optical system. Both the sagittally and meridionally FOVs are 5° , the larger FOV optical system at $3\sim 5\ \mu\text{m}$ has a focal length of $400\ \text{mm}$ and a F number of 8 . By using the structural parameters of the optical system and the non-spherical coefficients of the mirrors to adjust and correct the eccentric and tilt of the three-mirror and to eliminate distortion and other aberrations, the system shows that the MTF is better than 0.71 at $6.5\ \text{lp/mm}$, the aberration of the whole FOV is $\lambda/250(\text{RMS})$ and the maximum radius of diffuse point is less than $7.0\ \mu\text{m}(\text{RMS})$, which achieves diffraction limit. Moreover, the maximum distortion in the whole FOV is less than 0.04% . Finally, it proves that the optical system has good imaging quality both in the visible and infrared spectral regions.

Keywords: infrared target simulation optical design off-axis Three Mirror Anastigmatic(TMA) system wide field eliminating distortion

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