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论文

湍流特征光学测试对比

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摘要:

在10℃~230℃温差下,对大气相干长度r_0分别采用夏克-哈特曼的到达角起伏法、差分像运动法、波面法三种测量法和四象限探测器进行了测试和对比;对折射率结构常量C_n^2及闪烁功率谱分别采用夏克-哈特曼和光电倍增管进行对比.实验结果表明:对于r_0,在强湍流时四象限探测器比夏克-哈特曼的稳定性明显降低,且对夏克-哈特曼三种方法,差分像运动法可克服设备抖动等问题,但引入了方向上不一致的问题,波面法可有效避免该问题;对于C_n^2,夏克-哈特曼比光电倍增管测量更稳定,拟合相关系数高达0.96;对于闪烁功率谱,由于噪音影响,在200℃时夏克-哈特曼比光电倍增管测得的最大频率高15 Hz;最后,通过对夏克-哈特曼子孔径的闪烁功率谱分析得出,若同一子孔径入射光强不在CCD响应的线性区间时无法准确测量闪烁功率谱,否则可通过不同子孔径可完成湍流均匀性的测量.这将为湍流池提供最优的测试方法及理论依据.

关键词: 湍流模拟池 光学测试 夏克-哈特曼 闪烁功率谱 到达角起伏 光强闪烁

Turbulence Characteristics Optical Test Contrast

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Abstract:

During the temperature difference of 10℃~230℃, three kinds of Shack-Hartman measuring methods are used to contrast atmospheric coherence length r_0 with quadrant detector(QD), and Shack-Hartman (SH) and photomultiplier tube(PMT) respectively are applied to contrast refractive index structure parameter C_n^2 with scintillation power spectrum. The experimental results show that: for r_0, the stability of QD decreases more obviously than SH when there is strong turbulence, and for three Shack-Hartman methods, DIMM overcomes problems such as device jitter but brings in problem of inconsistency in direction which wave front method can avoid; for C_n^2, SH is more precise than PMT which fitting correlation coefficient is up to 0.96; for scintillation power spectrum, the maximum frequency SH tested is 15 Hz higher than that of PMT when it is 200℃ influenced by noise; through the analysis of Shack-Hartman sub-aperture scintillation power spectrum, the scintillation power spectrum is not able to be measured precisely and different sub-apertures accomplish the measurement turbulence uniformity when the same sub-aperture incident intensity is not in the CCD response linear interval. The results will provide an optimal test method and theoretical basis for turbulence cell.

Keywords: Turbulent simulation cell Optical test Shack-Hartmann Scintillation power spectrum Angle of arrival fluctuation Intensity scintillation

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