光学精密工程 » 2015, **Vol. 23** » Issue (10): 2733-2739 DOI: 10.3788/OPE.20152310.2733

低温辐射计斜底腔吸收比测量

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Absorptance measurement for sloping bottom cavity of cryogenic radiometer

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全文: PDF (1360 KB) RICH HTML NEW

输出: BibTeX | EndNote (RIS)

摘要

考虑在轨绝对辐射定标基准辐射计(ARCPR)要求其测量太阳总辐照度(TSI)的TSI腔的吸收比优于0.999 9,同时测量不确定度在0.001%以下, 本文提出采用在空间和低温环境下性能优越的圆柱形斜底腔作为标定太阳总辐照度的黑体腔,并对斜底腔吸收比进行了测量与研究。介绍了斜底腔的特性,分析了低温辐射计多使用斜底腔作为黑体腔的原因。阐述了替代法测量腔体吸收比的原理,增加了参考光路用于监测激光功率,以提高测量重复性和准确性。通过测量信号与参考光路信号的比值计算了斜体腔的吸收比,并对测量结果进行了不确定度分析。测试实验显示,斜底腔吸收比为0.999 928±0.000 005, 优于ARCPR对标定黑体腔的要求,验证了将斜底腔作为测量太阳总辐照度的TSI腔的可行性。实验还表明:计算信号电压与参考电压比值,通过比值计算腔体吸收比的方法可以提高测量结果的不确定度,适用于测量超高吸收比腔体的吸收比。

关键词 : 低温辐射计, 太阳总辐照度, 斜底腔, 吸收比测量, 替代法

Abstract :

The Total Solar Irradiance (TSI) cavity in an Absolute Radiance Calibration Primary Radiometer(ARCPR) for space remote sensing should have an absorptance more than 0.999 9 and the measurement uncertainty superior to 0.001%. Therefore, a cylindrical sloping bottom cavity was used as a receiver cavity for calibration of the TSI because of its superior performance in the space and cryogenic environments. Then,the absorptance of the cylindrical sloping bottom cavity was measured. The characteristics of the cylindrical sloping bottom cavity were introduced, and why the cavity was used as the receiver cavity in cryogenic radiometer was analyzed. Furthermore, the principle of the absorptance measured by a substitution method was expounded. A reference light path was added to monitor the stability of a laser to improve the measurement repeatability and accuracy. Finally, the absorptance of sloping bottom cavity was measured using this method, and the uncertainty of measurement results was analyzed. Experimental results indicate that the absorptance of sloping bottom cavity is 0.999 928±0.000 005, superior to that of the calibration standard of the blackbody cavity, which verifies it is feasibility to use the sloping bottom cavity as the TSI cavity for measuring the TSI. The experiments also verify that the ratio of single voltage and reference voltage could be used to calculate the cavity absorptance, and could improve the uncertainty of measurement result. This method is fit for measuring the absorptance of an ultra high absorptance cavity.

Key words : cryogenic radiometer total solar irradiance sloping bottom cavity absorptance measurement substitution method

收稿日期: 2015-01-09

中图分类号: P414.5

P422.1

基金资助:

国家自然科学基金资助项目(No.41227003)

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引用本文:

衣小龙, 杨振岭, 叶新, 王凯, 方伟, 王玉鹏. 低温辐射计斜底腔吸收比测量[J]. 光学精密工程, 2015, 23(10): 2733-2739. YI Xiao-long, YANG Zhen-ling, YE Xin, WANG Kai, FANG Wei, WANG Yu-peng. Absorptance measurement for sloping bottom cavity of cryogenic radiometer. Editorial Office of Optics and Precision Engineering, 2015, 23(10): 2733-2739.

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