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现代应用光学

旋转双棱镜光束指向解析解

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摘要： 光束指向机构实现光束指向调整时，需要搞清两棱镜的方位与出射光束指向位置之间的关系。本文采用一级近轴近似方法和非近轴光线追迹方法研究了旋转双棱镜指向系统的光束指向机制，由两棱镜的旋转角度推算出了出射光束指向的解析公式。对比分析了两种方法的研究结果并设计旋转双棱镜光束指向实验进行了验证。结果显示，非近轴光线追迹方法能准确地描述系统光束偏转机制，而传统的一级近轴近似方法的分析结果与实验值存在偏差，且光束的偏转角越大，偏转角的一级近轴近似解与实验值的差异越明显。当两棱镜旋转角之差为90°时，光束方位角的一级近轴近似解与实验值的差异最大。实验表明，对于大偏转角度旋转双棱镜光束指向系统，应采用非近轴光线追迹方法来探讨其光束偏转机制。

关键词： 光通信 光束指向 旋转双棱镜 一级近轴近似 非近轴光线追迹

Analytic Solution of Optical Beam Steering Based on Rotational Double Prisms

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Abstract: The relation between the prisms′ orientations and the corresponding pointing positions of an outgoing beam should be figured out when a beam steering mechanism was used to steer the direction of optical beam. Therefore, this paper explored the beam steering mechanism of a rotational double-prism pointing system by applying first-order paraxial approximation method and nonparaxial ray tracing method. Then, it calculated the analytic formulae of the pointing position for the outgoing beam based on the prisms′ rotational angles. The results obtained with the two methods were compared and validated by designed beam steering experiments of rotational double-prisms. The results show that the nonparaxial ray tracing method can describe accurately the beam steering mechanism, while the results obtained with the conventional first-order paraxial approximation method has a difference from the experiment value. The larger the beam′s angular deviation is, the more obvious the difference between the solutions with first-order paraxial approximation method and the corresponding experiment values is. When the difference of the prisms′ rotational angles is 90°, the difference between the solutions of azimuth with first-order paraxial approximation method and the corresponding experiment values becomes a maximum one. It suggests that the nonparaxial ray tracing method is suitable for discussing the beam steering mechanism for the rotating double-prism beam steering system with a large angular deviation.

Keywords: Optical communication Beam steering Rotational Double-prism First-order paraxial approximation Nonparaxial ray tracing

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